

# RECLAMATION

*Managing Water in the West*

## **Coordinated Long-Term Operation of the Central Valley Project and State Water Project**

**Mid-Pacific Region  
Bay-Delta Office**

### **Final Environmental Impact Statement**



## **Mission Statements**

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

# 1 **Executive Summary**

## 2 **ES.1 Introduction**

3 This Environmental Impact Statement (EIS) for the Coordinated Long-Term  
4 Operation of the Central Valley Project (CVP) and State Water Project (SWP) has  
5 been prepared by the Department of the Interior, Bureau of Reclamation  
6 (Reclamation). Reclamation is the Federal lead agency for compliance with the  
7 National Environmental Policy Act (NEPA) and is completing the EIS as ordered  
8 by the United States District Court for the Eastern District of California (District  
9 Court). In 2008 and 2009, following litigation on previous Biological Opinion  
10 (BOs), Reclamation provisionally accepted and began implementing the BOs on  
11 continued long-term operation of the CVP, in coordination with the operation of  
12 the SWP issued by the U.S. Fish and Wildlife Service (USFWS) and the National  
13 Marine Fisheries Service (NMFS), respectively, pursuant to the Federal  
14 Endangered Species Act of 1973 (ESA) as amended (United States Code [U.S.C.]  
15 1531 et. seq.). In 2014, the Ninth Circuit upheld the District Court's ruling that  
16 Reclamation's provisional acceptance and implementation of the BOs required  
17 Reclamation to comply with NEPA. The District Court remanded Reclamation's  
18 decision back to the agency to comply with the court's ruling.

19 The EIS evaluates potential long-term direct, indirect, and cumulative impacts on  
20 the environment that could result from implementation of modifications to the  
21 continued long-term operation of the CVP and SWP.

## 22 **ES.2 Background**

### 23 **ES.2.1 Central Valley Project**

24 The first Federal action authorizing the CVP was by the Rivers and Harbors Act  
25 of August 30, 1935. The CVP was reauthorized for construction, operation, and  
26 maintenance by the Secretary of the Department of the Interior (Secretary),  
27 pursuant to the Reclamation Act of 1902, as amended and supplemented (the  
28 Federal Reclamation laws), and by the Rivers and Harbors Act of  
29 August 26, 1937. In 1992, the Central Valley Project Authorization Act of  
30 August 26, 1937 was amended by Section 3406(a) of the Central Valley Project  
31 Improvement Act (CVPIA), Public Law 102-575.  
32 (<http://www.usbr.gov/history/cvpintro.html>)

1 The CVP is composed of 20 reservoirs with a combined storage capacity of more  
2 than 11 million acre-feet, over 10 hydroelectric powerplants, and more than  
3 500 miles of major canals and aqueducts. The major CVP facilities are located in  
4 the Sacramento-San Joaquin Rivers Delta Estuary (Delta) watershed including:

- 5 • **Major Reservoirs:** Trinity Lake (Trinity River), Whiskeytown Lake (Clear  
6 Creek); Shasta Lake (Sacramento River), Folsom Lake (American River),  
7 New Melones Reservoir (Stanislaus River), portions of the San Luis Reservoir  
8 complex (local drainages), and Millerton Lake (San Joaquin River).
- 9 • **Major Pumping Plants and Conveyance Facilities:** Red Bluff Pumping  
10 Plant (diverts water from Sacramento River into CVP Tehama-Colusa Canal),  
11 Folsom South Canal (diverts water from Folsom Lake to portions of  
12 Sacramento County), Contra Costa Canal Pumping Plant (diverts water from  
13 the Delta into CVP Contra Costa Canal), C.W. “Bill” Jones Pumping Plant  
14 (diverts water from the Delta into CVP Delta-Mendota Canal), Clear Creek  
15 Tunnel (conveys water from Trinity Lake to Whiskeytown Lake), Pacheco  
16 Tunnel and Conduit (conveys water from San Luis Reservoir to Santa Clara  
17 and San Benito counties), and Friant Kern and Madera canals (convey water  
18 from Millerton Lake to the eastern San Joaquin Valley).

19 These facilities are operated as an integrated project, although they are authorized  
20 and categorized in distinct units or divisions.

## 21 **ES.2.2 State Water Project**

22 The State Legislature appropriated funds to the California Department of Water  
23 Resources (DWR) to construct the SWP under the State Central Valley Project  
24 Act (Water Code section 11100 et seq.), Burns-Porter Act (California Water  
25 Resources Development Bond Act), State Contract Act (Public Contract Code  
26 section 10100 et seq.), Davis-Dolwig Act (Water Code sections 11900 - 11925),  
27 and other acts of the State Legislature.

28 Major SWP facilities include:

- 29 • **Reservoirs:** Lake Oroville and the Thermalito Complex (Feather River);  
30 Antelope Lake, Lake Davis, and Frenchman Lake (upper Feather River  
31 upstream of Lake Oroville); portions of the San Luis Reservoir complex (local  
32 drainages); reservoirs located downstream of San Luis Reservoir along the  
33 California Aqueduct and other SWP conveyance facilities (Quail Lake,  
34 Pyramid Lake, Castaic Lake, Silverwood Lake, Crafton Hills Reservoir, and  
35 Lake Perris).
- 36 • **Major Pumping Plants and Conveyance Facilities:** Barker Slough Pumping  
37 Plant (diverts water into SWP North Bay Aqueduct); Clifton Court Forebay  
38 and Harvey O. Banks Pumping Plant (diverts water from the Delta into SWP  
39 South Bay Aqueduct and the SWP California Aqueduct); California Aqueduct  
40 and associated pumping plants (convey water to the San Joaquin Valley,  
41 San Luis Obispo and Santa Barbara counties along the central coast, and  
42 southern California); Coastal Branch of the California Aqueduct (conveys

1 water to San Luis Obispo and Santa Barbara counties); and East Branch and  
2 West Branch (convey water to Southern California).

### 3 **ES.2.3 Coordinated Operation of the CVP and SWP**

4 The CVP and SWP are operated in a coordinated manner in accordance with  
5 Public Law 99-546 (October 27, 1986), directing the Secretary to execute the  
6 Coordinated Operation Agreement (COA). The CVP and SWP are also operated  
7 under State Water Resources Control Board (SWRCB) decisions and water right  
8 orders related to the CVP's and SWP's water right permits and licenses to  
9 appropriate water by diverting to storage, by directly diverting to use, or by  
10 re-diverting releases from storage later in the year or in subsequent years.

11 The CVP and SWP are permitted by SWRCB to store water, divert water and re-  
12 divert CVP and SWP water that has been stored in upstream reservoirs. The CVP  
13 and SWP have built water storage and water delivery facilities in the Central  
14 Valley to deliver water supplies to CVP and SWP contractors, including senior  
15 water users. The CVP's and SWP's water rights are conditioned by the SWRCB  
16 to protect the beneficial uses of water within the watersheds.

17 As conditions of the water right permits and licenses, SWRCB requires the CVP  
18 and SWP to meet specific water quality objectives within the Delta. Reclamation  
19 and DWR coordinate operation of the CVP and SWP, pursuant to the COA, to  
20 meet these and other operating requirements. The COA is an agreement between  
21 the Federal government and the State of California for the coordinated operation  
22 of the CVP and SWP.

23 Implementation of the COA has evolved continually since 1986 as CVP and SWP  
24 facilities, operational criteria, and physical and regulatory environment have  
25 changed. For example, adoption of the CVPIA in 1992 changed the purposes and  
26 operations of the CVP, and ESA responsibilities have affected operation of the  
27 CVP and SWP. DWR and Reclamation have operational arrangements to  
28 accommodate new facilities, water quality objectives, the CVPIA, other SWRCB  
29 criteria, and the ESA, but the COA has not been formally modified to address  
30 these newer operating conditions.

### 31 **ES.2.4 Federal Endangered Species Consultation**

32 The following species and their critical habitat listing rules were considered in  
33 recent ESA consultations with the USFWS and NMFS for the coordinated long-  
34 term operation of the CVP and SWP and in the analyses in this EIS.

- 35 • The Sacramento River winter-run Chinook Salmon (*Oncorhynchus*  
36 *tshawytscha*) evolutionarily significant unit (ESU) was originally listed as  
37 threatened in August 1989, under emergency provisions of the ESA, and  
38 formally listed as threatened in November 1990 (55 Federal Register (FR)  
39 46515). They were re-classified as an endangered species on January 4, 1994  
40 (59 FR 440).
- 41 • Central Valley spring-run Chinook Salmon (*O. tshawytscha*) ESU was listed  
42 as threatened on June 18, 2005 (70 FR 37160).

- 1 • The Central Valley Steelhead (*O. mykiss*) distinct population segment (DPS)  
2 was listed as threatened on January 5, 2006 (71 FR 834).
- 3 • Southern Oregon/Northern California Coast Coho Salmon (*O. kisutch*) ESU  
4 was listed as threatened on June 18, 2005 (70 FR 37160).
- 5 • Southern DPS of the North American Green Sturgeon (*Acipenser medirostris*)  
6 was listed as threatened on June 6, 2006 (71 FR 17757).
- 7 • The Southern Resident DPS of Killer Whales (*Orcinus orca*) was listed as  
8 endangered on November 18, 2005 (NMFS 2005).
- 9 • The Delta Smelt (*Hypomesus transpacificus*) was listed as threatened on  
10 March 5, 1993 (58 FR 12854). The species was recently proposed for re-  
11 listing as endangered under the ESA.

12 Fall and late-fall runs of Chinook Salmon are currently Federal Species of  
13 Concern, but have not been formally listed.

14 The Central California Coast Steelhead (*O. mykiss*) DPS was listed as threatened  
15 on January 5, 2006 (71 FR 834). The 2009 NMFS BO determined that the long-  
16 term operation of the CVP and SWP would not likely adversely affect Central  
17 California Coast Steelhead DPS and its critical habitat. Therefore, no further  
18 analysis of this DPS was performed and addressed in this EIS.

#### 19 **ES.2.4.1 Recent ESA Consultation Activities and Court Rulings**

20 In August 2008, Reclamation submitted a biological assessment (BA) to the  
21 USFWS and NMFS to initiate formal consultation. BO's were issued by the  
22 USFWS (December 15, 2008) and NMFS (June 4, 2009) with separate  
23 Reasonable and Prudent Alternative (RPA) actions to allow CVP and SWP to  
24 continue operating without causing jeopardy to listed species or adverse  
25 modification to designated critical habitat. Reclamation provisionally accepted  
26 and began implementing the two BOs with the RPAs.

27 Several lawsuits were filed in the District Court challenging aspects of the 2008  
28 USFWS BO and the 2009 NMFS BO and Reclamation's acceptance and  
29 implementation of the associated RPAs. Many of the lawsuits consolidated into  
30 two proceedings focused on each BO. The outcomes of the *Consolidated Delta*  
31 *Smelt Cases* and the *Consolidated Salmonid Cases* are summarized below.

- 32 • *Consolidated Delta Smelt Cases*
  - 33 – On November 16, 2009, the District Court ruled that Reclamation violated  
34 NEPA by failing to conduct a NEPA review of the potential impacts to the  
35 human environment before provisionally accepting and implementing the  
36 2008 USFWS BO, including the RPA.
  - 37 – On December 14, 2010, the District Court found certain portions of the  
38 2008 USFWS BO to be arbitrary and capricious in several respects, and  
39 remanded those portions of the BO to the USFWS without vacatur for  
40 further consideration. The District Court ordered Reclamation to review

- 1 its decision to provisionally accept and implement the BO and RPA in  
2 accordance with NEPA.
- 3 – The decision of the District Court related to the USFWS BO was appealed  
4 to the United States Court of Appeals for the Ninth Circuit (Appellate  
5 Court). On March 13, 2014, the Appellate Court reversed the District  
6 Court decision and upheld the BO. However, the Appellate Court  
7 affirmed the judgment of the District Court with respect to the NEPA  
8 claims.
- 9 – The District Court amended the Judgment on September 30, 2014  
10 consistent with the Appellate Court’s decision. Petitions for Writ of  
11 Certiorari were submitted to the U.S. Supreme Court; however, the U.S.  
12 Supreme Court decided to not hear the cases.
- 13 • *Consolidated Salmonid Cases*
- 14 – On March 5, 2010, the District Court ruled that Reclamation violated  
15 NEPA by failing to undertake a NEPA analysis of potential impacts to the  
16 human environment before provisionally accepting and implementing the  
17 2009 NMFS BO and RPA.
- 18 – On September 20, 2011, the District Court found the 2009 NMFS BO was  
19 arbitrary and capricious in several respects, and remanded the 2009 NMFS  
20 BO without vacatur for further consideration.
- 21 – The decisions of the District Court related to the 2009 NMFS BO were  
22 appealed to the Appellate Court. On December 22, 2014, the Appellate  
23 Court reversed the District Court decision and upheld the BO.
- 24 – The District Court issued the Final Order on May 5, 2015 consistent with  
25 the Appellate Court’s Decision.

### 26 **ES.3 Need to Prepare this Environmental Impact** 27 **Statement**

28 To comply with the District Court’s 2010 orders regarding NEPA for the  
29 coordinated long-term operation of the CVP and SWP, Reclamation initiated  
30 preparation of this EIS in 2011. This EIS documents Reclamation’s analysis of  
31 the effects of modifications to the coordinated long-term operation of the CVP  
32 and SWP that are likely to avoid jeopardy to listed species and destruction or  
33 adverse modification of designated critical habitat.

34 In accordance with the October 1, 2014, District Court’s order in the *Consolidated*  
35 *Delta Smelt Cases*, the Final EIS and Record of Decision are to be completed on  
36 or before December 1, 2015. By order dated October 8, 2015, this date has been  
37 extended to January 12, 2016.

38 Many of the provisions of the RPAs, as set forth in the 2008 USFWS BO and the  
39 2009 NMFS BO, require further study, monitoring, consultation, implementation

1 of adaptive management programs, and subsequent environmental documentation  
2 for future facilities to be constructed or modified. Specific actions related to these  
3 provisions are not known at this time. Therefore, this EIS assumes the  
4 completion of future actions, including provisions of the RPAs, in a manner that  
5 would be consistent with ESA and does not address impacts during construction  
6 or start-up phases of these actions.

## 7 **ES.4 Use of the Environmental Impact Statement**

8 This EIS may be used by Reclamation or cooperating agencies that are  
9 participating in the preparation of this EIS to inform future decisions related to  
10 operation of the CVP and SWP, and implementation of the RPAs in the 2008  
11 USFWS BO and 2009 NMFS BO.

## 12 **ES.5 Purpose and Need**

13 NEPA regulations require a statement regarding “the underlying purpose and need  
14 to which the agency is responding in proposing the alternatives, including the  
15 proposed action” (40 Code of Federal Regulations (CFR) 1502.13).

### 16 **ES.5.1 Purpose of the Action**

17 The purpose of the action considered in this EIS is to continue the operation of the  
18 CVP in coordination with operation of the SWP, for its authorized purposes, in a  
19 manner that:

- 20 • Is similar to historic operational parameters with certain modifications;
- 21 • Is consistent with Federal Reclamation law; other Federal laws and  
22 regulations; Federal permits and licenses; State of California water rights,  
23 permits, and licenses; and
- 24 • Enables Reclamation and DWR to satisfy their contractual obligations to the  
25 fullest extent possible.

### 26 **ES.5.2 Need for the Action**

27 Continued operation of the CVP is needed to provide river regulation, navigation;  
28 flood control; water supply for irrigation and domestic uses; fish and wildlife  
29 mitigation, protection, and restoration; fish and wildlife enhancement; and power  
30 generation. The CVP and the SWP facilities are also operated to provide  
31 recreation benefits and in accordance with the water rights and water quality  
32 requirements adopted by the SWRCB.

33 The USFWS and NMFS concluded in their 2008 and 2009 BOs, respectively, that  
34 the coordinated long-term operation of the CVP and SWP, as described in the  
35 2008 Reclamation BA, jeopardized the continued existence of listed species and  
36 adversely modified critical habitat. To remedy this, the USFWS and NMFS  
37 provided RPAs in their respective BOs.



1 The Appellate Court confirmed the District Court ruling that Reclamation must  
2 conduct a NEPA review to determine whether the provisional acceptance and  
3 implementation of the RPA actions cause a significant effect to the human  
4 environment.

## 5 **ES.6 Project Area**

6 The project area boundaries are defined by the locations of most of the CVP  
7 facilities and their service areas; and all of the SWP facilities and the SWP service  
8 areas. The CVP facilities associated with Millerton Lake, including the Madera  
9 and Friant-Kern canals and their service areas, and the San Joaquin River  
10 Restoration Program are not part of the project area for this EIS because the  
11 operations of these facilities were not addressed in either the 2008 USFWS BO or  
12 2009 NMFS BO.

## 13 **ES.7 Study Period**

14 The coordinated long-term operation of the CVP and SWP, as described in this  
15 EIS, would continue to at least 2030 before CVP and SWP operations would  
16 change. These changes could include projects considered as part of the  
17 cumulative effects analyses. Therefore, the EIS analyzes future conditions  
18 projected for the Year 2030. It is recognized that many changes between existing  
19 conditions and 2030 would occur without changes to CVP and SWP operations,  
20 including local land use decisions, implementation of new water management  
21 facilities, and climate change.

22 As the changing conditions described above and other future changes occur,  
23 changes in long-term operation of the CVP and SWP may be required. This may  
24 require the re-initiation of consultation on the 2008 USFWS BO and 2009 NMFS  
25 BO. Therefore, because the above-described changes in conditions are likely to  
26 occur by 2030 and because new BOs would be required, this EIS considers a  
27 study period that concludes in 2030.

## 28 **ES.8 Proposed Action and Preferred Alternative**

29 The Notice of Intent to prepare this EIS was published in March 2012 identified  
30 an “initial Proposed Action” that included the operational actions of the 2008  
31 USFWS BO and 2009 NMFS BO, without structural changes included in the RPA  
32 actions that would require future studies and environmental documentation to  
33 define recommended actions, including fish passage around the CVP dams. The  
34 initial Proposed Action is included in this EIS as Alternative 2.

35 Based upon the analysis in this EIS of aquatic resources by 2030, climate change  
36 may result in substantially higher air temperatures than during recent conditions.  
37 Higher air temperatures would likely increase water temperatures in both the CVP

1 reservoirs and in the rivers downstream of the CVP dams. Under these  
2 conditions, Reclamation may not be able to operate the reservoirs under the initial  
3 Proposed Action without fish passage in a manner that would meet water  
4 temperature objectives; and it may not be possible to avoid jeopardizing the  
5 continued existence of listed species and/or resulting in an adverse modification  
6 of critical habitat.

7 Based upon the results of the impact analyses presented in this EIS, the Preferred  
8 Alternative is the No Action Alternative. The No Action Alternative contains all  
9 of the RPA actions in the 2008 USFWS BO and 2009 NMFS BO, as amended,  
10 including the RPA actions to evaluate fish passage to upstream habitats that  
11 exhibit lower water temperatures. Further discussion of the selection of the  
12 Preferred Alternative will be included in the Record of Decision.

13 The Environmentally Preferred Alternative also will be identified and disclosed in  
14 the Record of Decision, as required by the Council of Environmental Quality  
15 regulations.

## 16 **ES.9 Summary Description of Alternatives**

17 Identification of the No Action Alternative and the range of alternatives for this  
18 EIS were developed to respond to the purpose and need for the action and to  
19 comments received during the scoping process and preparation of the EIS.

20 Twenty-three alternative concepts were identified during the scoping process and  
21 through meetings with stakeholders and agencies during preparation of this EIS.  
22 The alternative concepts were compared to screening criteria that were developed  
23 based on the purpose of the action. The alternative concepts were also reviewed  
24 to determine if they addressed substantial issues. Based upon the comparison of  
25 screening criteria to the alternative concepts, 17 of the 23 alternative concepts  
26 were identified to be included in one or more of the alternatives evaluated in this  
27 EIS. The alternative concepts were combined into five specific alternatives that  
28 were consistent with assumptions for the year 2030. Further development of the  
29 alternatives was informed by subsequent comments received during preparation  
30 of the EIS.

31 All of the alternatives, including the No Action Alternative, include the same  
32 assumptions related to (1) climate change and sea level rise in Year 2030, and  
33 (2) development throughout California in accordance with existing general plans,  
34 existing contracts, and implementation of reasonable and foreseeable water  
35 resources management projects.

### 36 **ES.9.1 Inclusion of the Second Basis of Comparison**

37 The No Action Alternative is defined as the projections of current conditions and  
38 trends into the future without implementation of the alternatives. These projected  
39 conditions are defined in Question 3 of the Council on Environmental Quality  
40 (CEQ) Forty Most Asked Questions as “no change’ from current management  
41 direction or level of management intensity.” The No Action Alternative also can

1 be defined as “no project” in cases where a new project is proposed for  
2 implementation. However, all of the alternatives evaluated in this EIS are to  
3 continue the coordinated long-term operation of the CVP and SWP. Therefore,  
4 the definition of the No Action Alternative used for this EIS is continuation of the  
5 current management direction and level of intensity.

6 For this EIS, the No Action Alternative is based upon the continued operation of  
7 the CVP and SWP in the same manner as was occurring at the time of the  
8 publication of the Notice of Intent in March 2012. Thus, the No Action  
9 Alternative consists of the coordinated long-term operation of the CVP and SWP,  
10 including full implementation of the RPAs in the 2008 USFWS BO and 2009  
11 NMFS BO, because Reclamation provisionally accepted the BOs in 2008 and  
12 2009, respectively, began implementing the RPAs, and continues to implement  
13 the RPAs to date. The No Action Alternative also includes changes not related to  
14 the long-term operation of the CVP and SWP or implementation of the RPAs in  
15 the 2008 USFWS BO and 2009 NMFS BO.

16 Numerous scoping comments requested that the No Action Alternative not  
17 include the RPAs in the 2008 USFWS BO and 2009 NMFS BO because, at that  
18 time, the District Court had remanded the BOs back to USFWS and NMFS. The  
19 comments indicated that the EIS should include a “basis of comparison” for the  
20 alternatives that was similar to conditions prior to implementation of the RPAs.  
21 Scoping comments also indicated that a “No Action Alternative scenario” without  
22 implementation of the RPAs in the 2008 USFWS BO and 2009 NMFS BO could  
23 be used to analyze the effects of implementing the RPAs.

24 Determining an appropriate baseline without the 2008 USFWS BO and 2009  
25 NMFS BO actions and yet continuing to meet all of Reclamation’s statutory and  
26 regulatory requirements is a difficult task. Simply analyzing a No Action  
27 Alternative that is similar to the project description described in either the 2004  
28 Biological Assessment or 2008 Biological Assessment is insufficient, as each was  
29 found to jeopardize listed species, the 2004 Biological Assessment by the District  
30 Court in 2007, and the 2008 Biological Assessment by USFWS and NMFS.  
31 Either of these operations would be inconsistent with Reclamation’s existing  
32 policy and management direction.

33 Because the RPAs were provisionally accepted and the No Action Alternative  
34 represents a continuation of existing policy and management direction, the No  
35 Action Alternative includes the RPAs. However, in response to scoping  
36 comments and subsequent comments from stakeholders and interest groups, and  
37 to provide a basis for comparison of the effects of implementation of the RPAs  
38 (per the District Court’s mandate), this EIS includes a “Second Basis of  
39 Comparison” that represents a condition in 2030 without implementation of the  
40 2008 USFWS BO and 2009 NMFS BO. All of the alternatives are compared to  
41 the No Action Alternative and to the Second Basis of Comparison to describe the  
42 effects that could occur in 2030 under both bases of comparison.

43 Several of the 2008 USFWS BO RPA and 2009 NMFS BO RPA actions had been  
44 initiated prior to issuance of the 2009 NMFS BO; those actions are included in the

1 Second Basis of Comparison. Reasonably foreseeable actions included in the No  
2 Action Alternative that are not related to the 2008 USFWS BO or 2009 NMFS  
3 BO are also included in the Second Basis of Comparison.

4 **ES.9.2 No Action Alternative**

5 The definition of the No Action Alternative is based upon the following  
6 assumptions.

- 7 • Continued long-term operation of the CVP and SWP in accordance with  
8 ongoing management policies, criteria, and regulations, including water right  
9 permits and licenses issued by the SWRCB; and operational requirements of  
10 the 2008 USFWS BO and the 2009 NMFS BO.
- 11 • Implementation of existing and future actions described in the 2008 USFWS  
12 BO and 2009 NMFS BO that would occur by 2030 without implementation of  
13 the BOs, including:
  - 14 – 2008 USFWS BO RPA Component 4, Habitat Restoration and 2009  
15 NMFS BO RPA Action I.6.1, Restoration of Floodplain Habitat; and  
16 Action I.6.2, Near-Term Actions at Liberty Island/Lower Cache Slough  
17 and Lower Yolo Bypass; Action I.6.3, Lower Putah Creek Enhancements;  
18 Action I.6.4, Improvements to Lisbon Weir; and Action I.7, Reduce  
19 Migratory Delays and Loss of Salmon, Steelhead, and Sturgeon at  
20 Fremont Weir and Other Structures in the Yolo Bypass - Restoration of  
21 more than 10,000 acres of intertidal and associated subtidal wetlands in  
22 Suisun Marsh and Cache Slough; and at least 17,000 to 20,000 acres of  
23 seasonal floodplain restoration in Yolo Bypass.
  - 24 – 2009 NMFS BO RPA Action I.1.3, Clear Creek Spawning Gravel  
25 Augmentation - Gravel augmentation in Clear Creek in addition to several  
26 gravel augmentation programs in the Sacramento Valley watershed being  
27 implemented in accordance with CVPIA.
  - 28 – 2009 NMFS BO RPA Action I.1.4, Spring Creek Temperature Control  
29 Curtain Replacement - Replacement of the Spring Creek Temperature  
30 Control Curtain.
  - 31 – 2009 NMFS BO RPA Action I.2.6, Restore Battle Creek for Winter-Run,  
32 Spring-Run, and Central Valley Steelhead - Habitat restoration of Battle  
33 Creek.
  - 34 – 2009 NMFS BO RPA Action I.3.1, Operate Red Bluff Diversion Dam  
35 with Gates Out - Implementation of Red Bluff Pumping Plant.
  - 36 – 2009 NMFS BO RPA Action I.5, Funding for CVPIA Anadromous Fish  
37 Screen Program - Implementation of the CVPIA Anadromous Fish Screen  
38 Program.
  - 39 – 2009 NMFS BO RPA Action II.1, Lower American River Flow  
40 Management - Implementation of the American River Flow Management  
41 Standard.

- 1 • Implementation of existing and future actions not described in the 2009
- 2 NMFS BO that would occur by 2030 without implementation of any
- 3 alternatives considered in this EIS, including:
- 4 – Trinity River Restoration Program.
- 5 – Clear Creek Mercury Abatement and Fisheries Restoration Project.
- 6 – Iron Mountain Mine Superfund Site cleanup.
- 7 – Mainstem Sacramento River and American River Gravel Augmentation
- 8 Programs.
- 9 – Nimbus Fish Hatchery Fish Passage Project.
- 10 – Folsom Dam Water Control Manual Update.
- 11 – FERC Relicensing for Middle Fork of the American River Project.
- 12 – Lower Mokelumne River Spawning Habitat Improvement Project.
- 13 – Dutch Slough Tidal Marsh Restoration.
- 14 – Suisun Marsh Habitat Management, Preservation, and Restoration Plan
- 15 Implementation.
- 16 – Tidal Wetland Restoration in the Delta and Suisun Marsh.
- 17 – San Joaquin River Restoration Program.
- 18 – Stockton Deep Water Ship Channel Demonstration Dissolved Oxygen
- 19 Project.
- 20 – Grasslands Bypass Project.
- 21 – Central Valley Salinity Alternatives for Long-Term Sustainability
- 22 (CV-SALTS).
- 23 – Municipal Water Supply Projects identified in Urban Water Management
- 24 Plans that have undergone environmental review and are reasonably
- 25 foreseeable.
- 26 – Water Transfer Projects.

### 27 **ES.9.3 Second Basis of Comparison**

28 The definition of the Second Basis of Comparison is based upon the following  
29 assumptions.

- 30 • Continued long-term operation of the CVP and SWP in accordance with
- 31 ongoing management policies, criteria, and regulations, including water right
- 32 permits and licenses issued by the SWRCB without implementation of the
- 33 2008 USFWS BO and the 2009 NMFS BO.
- 34 • Implementation of existing and future actions that would occur by 2030
- 35 without implementation of the BOs, including actions that have already been
- 36 constructed or have substantial progress:

## Executive Summary

- 1       – Restoration of more than 10,000 acres of intertidal and associated subtidal  
2       wetlands in Suisun Marsh and Cache Slough; and at least 17,000 to  
3       20,000 acres of seasonal floodplain restoration in Yolo Bypass (as being  
4       implemented under a separate program adopted in 2014, Suisun Marsh  
5       Habitat Management, Preservation, and Restoration Plan, and referenced  
6       in 2008 USFWS BO RPA Component 4, Habitat Restoration; and as being  
7       developed under Yolo Bypass Salmonid Habitat Restoration and Fish  
8       Passage Implementation Plan and referenced in 2009 NMFS BO RPA  
9       Action I.6.1, Restoration of Floodplain Habitat; and Action I.6.2, Near-  
10      Term Actions at Liberty Island/Lower Cache Slough and Lower Yolo  
11      Bypass; Action I.6.3, Lower Putah Creek Enhancements; Action I.6.4,  
12      Improvements to Lisbon Weir; and Action I.7, Reduce Migratory Delays  
13      and Loss of Salmon, Steelhead, and Sturgeon at Fremont Weir and Other  
14      Structures in the Yolo Bypass).
- 15      – Gravel augmentation in the Sacramento Valley and Stanislaus River  
16      watershed (as being implemented under a separate program and including  
17      program under CVPIA and referenced in 2009 NMFS BO RPA  
18      Action I.1.3, Clear Creek Spawning Gravel Augmentation).
- 19      – Replacement of the Spring Creek Temperature Control Curtain (as was  
20      constructed and placed into operation in 2011 and referenced in 2009  
21      NMFS BO RPA Action I.1.4, Spring Creek Temperature Control Curtain  
22      Replacement).
- 23      – Habitat restoration of Battle Creek (as being implemented under a separate  
24      program and referenced in 2009 NMFS BO RPA Action I.2.6, Restore  
25      Battle Creek for Winter-Run, Spring-Run, and Central Valley Steelhead).
- 26      – Implementation of Red Bluff Pumping Plant (as was constructed and  
27      placed into operation in 2012 and referenced in 2009 NMFS BO RPA  
28      Action I.3.1, Operate Red Bluff Diversion Dam with Gates Out).
- 29      – Implementation of the CVPIA Anadromous Fish Screen Program (as was  
30      initiated in the 1990s and referenced in 2009 NMFS BO RPA Action I.5,  
31      Funding for CVPIA Anadromous Fish Screen Program).
- 32      – Implementation of the American River Flow Management Standard (as  
33      was initiated in 2006 and referenced in 2009 NMFS BO RPA Action II.1,  
34      Lower American River Flow Management).
- 35      – Trinity River Restoration Program.
- 36      – Clear Creek Mercury Abatement and Fisheries Restoration Project.
- 37      – Iron Mountain Mine Superfund Site cleanup.
- 38      – Mainstem Sacramento River and American River Gravel Augmentation  
39      Programs.
- 40      – Nimbus Fish Hatchery Fish Passage Project.
- 41      – FERC Relicensing for Middle Fork of the American River Project.

- 1       – Lower Mokelumne River Spawning Habitat Improvement Project.
- 2       – Dutch Slough Tidal Marsh Restoration.
- 3       – Tidal Wetland Restoration in the Delta and Suisun Marsh.
- 4       – San Joaquin River Restoration Program.
- 5       – Stockton Deep Water Ship Channel Demonstration Dissolved Oxygen
- 6       Project.
- 7       – Grasslands Bypass Project.
- 8       – Municipal Water Supply Projects identified in Urban Water Management
- 9       Plans that have undergone environmental review and are reasonably
- 10      foreseeable.
- 11      – Water Transfer Projects.

12      **ES.9.4    Alternative 1**

13      Alternative 1 was created because many comments requested an alternative that  
 14      reflected conditions without implementation of the 2008 USFWS BO and the  
 15      2009 NMFS BO RPAs. Since the Second Basis of Comparison is not a true  
 16      alternative, in accordance with NEPA guidelines, Reclamation could not select  
 17      the Second Basis of Comparison as a preferred alternative. Therefore,  
 18      Alternative 1 is identical to the Second Basis of Comparison.

19      **ES.9.5    Alternative 2**

20      Alternative 2 was first included in the Notice of Intent and identified as an initial  
 21      proposed action that included the operational actions of the 2008 USFWS BO and  
 22      2009 NMFS BO. Alternative 2 does not include RPA actions that would require  
 23      future studies and environmental documentation to define recommended actions  
 24      (generally, structural actions). Therefore, Alternative 2 includes the assumptions  
 25      in the No Action Alternative except:

- 26      • 2009 NMFS BO RPA Action I.2.5, Winter-Run Passage and Re-Introduction
- 27      Program at Shasta Dam.
- 28      • 2009 NMFS BO RPA Action II.3, Structural Improvements for Temperature
- 29      Management on the American River.
- 30      • 2009 NMFS BO RPA Action II.5, Fish Passage at Nimbus and Folsom Dams.
- 31      • 2009 NMFS BO RPA Action II.6, Implement Actions to Reduce Genetic
- 32      Effects of Nimbus and Trinity River Fish Hatchery Operations.
- 33      • 2009 NMFS BO RPA Action III.2.1, Increase and Improve Quality of
- 34      Spawning Habitat with Addition of Gravel.
- 35      • 2009 NMFS BO RPA Action III.2.2, Conduct Floodplain Restoration and
- 36      Inundation Flows in Winter or Spring to Inundate Steelhead Juvenile Rearing
- 37      Habitat on Stanislaus River.

- 1 • 2009 NMFS BO RPA Action III.2.3, Restore Freshwater Migratory Habitat  
2 for Juvenile Steelhead on Stanislaus River.
- 3 • 2009 NMFS BO RPA Action III.2.4, Fish Passage at New Melones, Tulloch,  
4 and Goodwin Dams.
- 5 • 2009 NMFS BO RPA Action IV.4, Tracy Fish Collection Facility  
6 Improvements to Reduce Pre-Screen Loss and Improve Screening Efficiency.
- 7 • 2009 NMFS BO RPA Action IV.4.2 Skinner Fish Collection Facility  
8 Improvements to Reduce Pre-Screen Loss and Improve Screening Efficiency.
- 9 • 2009 NMFS BO RPA Action IV.4.3 Tracy Fish Collection Facility and the  
10 Skinner Fish Collection Facility Actions to Improve Salvage Monitoring,  
11 Reporting and Release Survival Rates.
- 12 • 2009 NMFS BO RPA Action V Fish Passage.

### 13 **ES.9.6 Alternative 3**

14 Alternative 3 was developed based upon a scoping comment from the Coalition  
15 for a Sustainable Delta, including actions related to their “RPA Alternative 1,”  
16 and a scoping comment received from Oakdale Irrigation District (OID) and  
17 South San Joaquin Irrigation District (SSJID). The definition of Alternative 3 is  
18 based upon the following assumptions.

- 19 • Continued long-term operation of the CVP and SWP in accordance with  
20 ongoing management policies, criteria, and regulations, including water right  
21 permits and licenses issued by the SWRCB; without the operational  
22 requirements of the 2008 USFWS BO and the 2009 NMFS BO RPAs.
- 23 • Implementation of the 2012 operations plan for New Melones Reservoir  
24 proposed by OID and SSJID.
- 25 • Additional demands for American River water supplies for up to 17,000 acre-  
26 feet/year under a Warren Act contract for El Dorado Irrigation District and  
27 15,000 acre-feet/year under a water service contract for El Dorado County  
28 Water Agency.
- 29 • Implementation of actions described in the scoping comments letter from the  
30 Coalition for a Sustainable Delta related to their “RPA Alternative 1.”
  - 31 – The Old and Middle River (OMR) flow criteria under Alternative 3 are  
32 based on concepts addressed in the 2008 USFWS BO and 2009 NMFS BO  
33 related to adaptive restrictions for temperature, turbidity, salinity, and  
34 presence of Delta Smelt.
  - 35 – Flood control operations for the New Melones Reservoir would be the  
36 same as under the No Action Alternative. However, New Melones  
37 Reservoir would be operated for different fishery flows, water quality  
38 flows, and San Joaquin River base flows and pulse flows at Vernalis.



- 1       – Implement predator control programs for Black Bass, Striped Bass, and  
2       Pikeminnow to protect salmonids and Delta Smelt, including  
3       establishment of new catch limits.
- 4       – Restore or create at least 10,000 acres of tidally influenced seasonal or  
5       perennial wetlands (these conditions are the same as under the No Action  
6       Alternative and Second Basis of Comparison).
- 7       – Establish a trap and haul program for juvenile salmonids entering the  
8       Delta from the San Joaquin River upstream of the Head of Old River in  
9       March through June with a release site near Chipps Island.
- 10      – Modify ocean harvest limits for consistency with Viable Salmonid  
11      Population Standards; including harvest management plan to show that  
12      abundance, productivity, and diversity (age-composition) are not  
13      appreciably reduced.
- 14      • Implementation of future actions that would occur by 2030 without  
15      implementation of any alternatives considered in this EIS, as described above  
16      for the Second Basis of Comparison.

#### 17   **ES.9.7   Alternative 4**

18   Alternative 4 was developed based upon a scoping comment from the Coalition  
19   for a Sustainable Delta, including actions related to their “RPA Alternative 2.”  
20   The definition of Alternative 4 is based upon the following assumptions.

- 21      • Continued long-term operation of the CVP and SWP in accordance with  
22      ongoing management policies, criteria, and regulations, including water right  
23      permits and licenses issued by the SWRCB; without the operational  
24      requirements of the 2008 USFWS BO and the 2009 NMFS BO, as described  
25      under Second Basis of Comparison.
- 26      • Implementation of actions described in the scoping comments letter from the  
27      Coalition for a Sustainable Delta related to their “RPA Alternative 2.”
  - 28         – Limit floodplain development to protect salmonids and Delta Smelt by  
29         incorporating guidance into flood hazard mapping to comply with ESA;  
30         prioritizing consideration of ESA listed species and critical habitats in  
31         flood insurance studies; refine community rating system to provide credits  
32         for natural and beneficial functions; prohibit new development and  
33         substantial improvements to existing development within any designated  
34         floodway or within 170 feet of the ordinary high water line of any  
35         floodway.
  - 36         – Modify the requirements of the U.S. Army Corps of Engineers related to  
37         removal of vegetation on levees to allow for the planting of trees and  
38         shrubs along the levees; and installation of vegetation, woody material,  
39         and root re-enforcement material on the levees instead of riprap for  
40         erosion protection.

- 1       – Implement predator control programs for Black Bass, Striped Bass, and  
2       Pikeminnow to protect salmonids and Delta Smelt, including  
3       establishment of new catch limits.
- 4       – Restore or create at least 10,000 acres of tidally influenced seasonal or  
5       perennial wetlands (these conditions are the same as under the No Action  
6       Alternative and Second Basis of Comparison).
- 7       – Establish a trap and haul program for juvenile salmonids entering the  
8       Delta from the San Joaquin River upstream of the Head of Old River in  
9       March through June with a release site near Chipps Island.
- 10      – Modify ocean harvest limits to reduce by-catch of winter-run and spring-  
11      run Chinook Salmon to less than 10 percent of age-3 cohort in all years.
- 12      • Implementation of future actions that would occur by 2030 without  
13      implementation of any alternatives considered in this EIS, as described above  
14      for the Second Basis of Comparison.

15      **ES.9.8    Alternative 5**

16      Alternative 5 was developed considering comments from environmental interest  
17      groups during the scoping process. Alternative 5 is similar to the No Action  
18      Alternative with reduced potential for reverse flows in April and May and with  
19      associated increased Delta outflow; and use of the SWRCB D-1641 pulse flow at  
20      Vernalis. The definition of Alternative 5 is based upon the following  
21      assumptions.

- 22      • Continued long-term operation of the CVP and SWP in accordance with  
23      ongoing management policies, criteria, and regulations, including water right  
24      permits and licenses issued by the SWRCB; including the requirements of the  
25      2008 USFWS BO and the 2009 NMFS BO.
- 26      • The OMR flow criteria similar to the RPA criteria in the 2008 USFWS BO  
27      and 2009 NMFS BO plus a requirement for positive OMR (no reverse flows)  
28      in April and May of all water year types.
- 29      • New Melones Reservoir operations are similar to assumptions under the No  
30      Action Alternative except additional requirements were added to meet the  
31      SWRCB D-1641 April and May pulse flows at Vernalis on the San Joaquin  
32      River.
- 33      • Additional demands for American River water supplies for up to 17,000 acre-  
34      feet/year under a Warren Act Contract for El Dorado Irrigation District and  
35      15,000 acre-feet/year under a water service contract for El Dorado County  
36      Water Agency.
- 37      • Implementation of future actions that would occur by 2030 without  
38      implementation of any alternatives considered in this EIS, as described above  
39      for the No Action Alternative.

## 1 **ES.10 Impact Analysis**

2 An EIS must evaluate the effects of implementation of the alternatives on the  
3 environment; and identify any adverse environmental effects which cannot be  
4 avoided, the relationship between short-term uses of the human environment and  
5 long-term productivity; and any irreversible or irretrievable commitments of  
6 resources if the alternatives are implemented. The impact analyses section of  
7 each resource chapter (Chapters 5 through 21 of the EIS) address direct, indirect,  
8 and cumulative effects of the alternatives as compared to the No Action  
9 Alternative and the Second Basis of Comparison in the following manner:

- 10 • Alternatives 1 through 5 are compared to the No Action Alternative.
- 11 • Alternatives 1 through 5 and the No Action Alternative are compared to the  
12 Second Basis of Comparison.

13 Potential mitigation measures are presented to the extent possible for each  
14 resource to avoid, minimize, rectify, reduce, eliminate, or compensate for adverse  
15 environmental effects of Alternatives 1 through 5 as compared to the No Action  
16 Alternative. Mitigation measures were not included to address adverse impacts  
17 under the alternatives as compared to the Second Basis of Comparison because  
18 this analysis was included in this EIS for information purposes only.

19 Tables ES.1 and ES.2 present summaries of the environmental changes of  
20 Alternatives 1 through 5 as compared to the No Action Alternative and the  
21 Second Basis of Comparison, respectively. These tables are located at the end of  
22 this Executive Summary.

23 These tables summarize the results of both the quantitative and qualitative impact  
24 analyses. The tables include relative quantitative differences for adverse impacts  
25 to provide a basis for consideration of mitigation measures. Differences in the  
26 quantitative analyses of 5 percent or less are considered to be “similar” because  
27 the modeling analyses are based on CalSim II model output which operates with  
28 monthly time steps. Therefore, it was determined that changes in the model of  
29 5 percent or less were related to the uncertainties in the model processing.

30 Changes in surface water conditions are provided as a basis for identifying the  
31 impacts as described in Aquatic, Terrestrial, and Recreation resources. Therefore,  
32 no mitigation measures are presented for Surface Water Resources.

## 33 **ES.11 Public Involvement and Next Steps**

34 Public involvement was initiated with the scoping process on March 28, 2012,  
35 with the publication of the Notice of Intent in the Federal Register (FR) and  
36 continued through June 28, 2012. Initially, the public scoping process was to be  
37 completed on May 29, 2012. During the public scoping process, other agencies  
38 and interested persons requested an extension of the public scoping period to  
39 allow additional opportunities to provide scoping comments. In response to these  
40 requests, Reclamation published a notice on May 25, 2012, extending the public

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1 scoping period through June 28, 2012. Reclamation held five scoping meetings  
2 which were attended by 256 individuals. Scoping comments were used in the  
3 development of a reasonable range of alternatives and identification of key issues.

4 Reclamation also posted on its website an initial range of alternatives discussed at  
5 a stakeholders meeting on October 19, 2012. Several project status meetings were  
6 held with cooperating agencies and other stakeholders during preparation of the  
7 Draft EIS. Comments received during these processes were used to refine the  
8 description of the alternatives.

9 The Draft EIS was issued for public review in July 2015. Reclamation posted  
10 notification of the availability of the Public Draft EIS and the location and timing  
11 of four public meetings on its website, in the Federal Register, and through press  
12 releases. Approximately 860 written and verbal comments were received on the  
13 Draft EIS. All of the comments received on the Draft EIS were considered in  
14 preparation of the Final EIS. Written responses to all substantive comments  
15 received are included in Appendices 1A through 1E of the Final EIS.

16 Reclamation will make the Final EIS available for 30 days before finalizing the  
17 Record of Decision (ROD). In the ROD, which is the final step in the NEPA  
18 process, Reclamation will document its decision on which actions, if any, to take  
19 to address the primary objectives. Reclamation will also identify the  
20 Environmentally Preferred Alternative, describe other risk reduction plans it  
21 considered, identify any mitigation plans, and describe factors and comments  
22 taken into consideration when making its decision.

1 **Table ES.1 Comparison of Alternatives 1 through 5 to the No Action Alternative**

	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
<b>Surface Water</b>					
Trinity Lake	Water surface elevations similar. Storage similar or increased.	No change.	Water surface elevations similar. Storage similar or increased.	Water surface elevations similar. Storage similar or increased.	Water surface elevations similar. Storage similar or increased.
Trinity River at Lewiston Dam	Flows similar or increased.	No change.	Flows similar or increased.	Flows similar or increased.	Water surface elevations similar. Storage similar.
Shasta Lake	Water surface elevations similar. Storage similar or increased.	No change.	Water surface elevations similar. Storage similar or increased.	Water surface elevations similar. Storage similar or increased.	Water surface elevations similar. Storage similar.
Sacramento River at Keswick Dam	Flows similar or increased except reduced in September and November (up to 44%).	No change.	Flows similar or increased except reduced in September and November (up to 42%).	Flows similar or increased except reduced in September and November (up to 44%).	Flows similar.
Sacramento River at Freeport	Flows similar or increased except reduced in September and November (up to 47%).	No change.	Flows similar or increased except reduced in September and November (up to 48%).	Flows similar or increased except reduced in September and November (up to 47%).	Flows similar.
Clear Creek near Igo	Flows same except reduced in May (41%).	No change.	Flows same except reduced in May (29%).	Flows same except reduced in May (41%).	No change.
Lake Oroville	Water surface elevations similar. Storage reduced except in June (up to 22%).	No change.	Water surface elevations similar. Storage similar or increased.	Water surface elevations similar. Storage reduced except in June (up to 22%).	Water surface elevations similar. Storage similar.

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	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
Feather River downstream of Themalito Complex	Flows similar or increased except reduced in July-September and November-December (up to 65%).	No change.	Flows similar or increased except reduced in July-September and October-January (up to 70%).	Flows similar or increased except reduced in July-September and November-December (up to 65%).	Flows similar or increased except reduced in April-May (up to 27%).
Folsom Lake	Water surface elevations similar Storage similar or increased except reduced in June-August in above normal and below normal years (up to 15%).	No change.	Water surface elevations similar Storage similar or increased except reduced in July-August in above normal and August-September in below normal years (up to 10%).	Water surface elevations similar Storage similar or increased except in reduced June-August in above normal and below normal years (up to 15%).	Water surface elevations similar. Storage similar.
American River at Nimbus Dam	Flows similar or increased except reduced in September-November and June-July (up to 48%).	No change.	Flows similar or increased except reduced in August-November and June (up to 46%).	Flows similar or increased except reduced in September-November and June-July (up to 48%).	Flows similar or increased except reduced in September and April-May (up to 14%).
New Melones Reservoir	Water surface elevations similar Storage similar or increased.	No change.	Water surface elevations similar Storage similar or increased.	Water surface elevations similar Storage similar or increased.	Water surface elevations similar. Storage reduced in July-September in above normal years (up to 6%); and all months in below normal, dry, and critical dry years (up to 19 percent).
Stanislaus River at Goodwin Dam	Flows similar or increased except reduced in July-August, December, and March (up to 18%).	No change.	Flows similar or increased except reduced in October and February-July (up to 73%).	Flows similar or increased except reduced in July-August, December, and March (up to 18%).	Flows similar or increased except reduced in June-August (up to 18%).

	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
San Joaquin River at Vernalis	Flows similar or increased except reduced in October and April (up to 19%).	No change.	Flows similar or increased except reduced in October and May-June (up to 21%).	Flows similar or increased except reduced in October and April (up to 19%).	Flows similar or increased.
San Luis Reservoir	Water surface elevations similar Storage similar or increased.	No change.	Water surface elevations similar Storage similar or increased.	Water surface elevations similar Storage similar or increased.	Water surface elevations similar Storage similar or increased except in below normal years in June-July (up to 9%); in dry years in April-September (up to 17%); and in critical dry years in April-January (up to 18%).
Flows into Yolo Bypass	Flows similar or increased except in October in wet years (20%).	No change.	Flows similar or increased except in October in wet years (25%).	Flows similar or increased except in October in wet years (20%).	Flows similar.
Delta Outflow	Reduced flows in many months. Increased flows in some months, including in December, February-March, and June in wet years (up to 1,492 cfs); and similar or increased flows in June and September in dry years (up to 385 cfs).	No change.	Reduced flows in many months. Increased flows in some months, including in December-March, in wet years (up to 3,307cfs); and increased flows in January-February and June-July in dry years (up to 277 cfs).	Reduced flows in many months. Increased flows in some months, including in December, February-March, and June in wet years (up to 1,492 cfs); and similar or increased flows in June and September in dry years (up to 385 cfs).	Flows would be similar or increased.
Reverse Flows in Old and Middle Rivers	Increased negative flows except in July-September.	No change.	Increased negative flows except in July-September.	Increased negative flows except in July-September.	Increased positive flows except in July-August.

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	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
<b>Water Supplies</b>					
Non-CVP and Non-SWP Deliveries	Deliveries similar. No mitigation needed.	No change. No mitigation needed.	Deliveries similar. No mitigation needed.	Deliveries similar. No mitigation needed.	Deliveries similar. No mitigation needed.
CVP Water Deliveries (including CVP agricultural and municipal and industrial water service contracts; Sacramento River Settlement Contracts, San Joaquin River Exchange Contracts, and Eastside Division Contracts)	Deliveries similar or increased. No mitigation needed.	No change. No mitigation needed.	Deliveries similar or increased. No mitigation needed.	Deliveries similar or increased. No mitigation needed.	Deliveries similar or increased in wet to dry years. Reduced deliveries in the Eastside Division Contractors in critical dry years (8%). Potential Mitigation measure: Reclamation would support water transfers from other basin water rights holders.
SWP Water Deliveries (In accordance with Table A contracts without Article 21 water)	Deliveries similar or increased. No mitigation needed.	No change. No mitigation needed.	Deliveries similar or increased. No mitigation needed.	Deliveries similar or increased. No mitigation needed.	Deliveries similar or increased. No mitigation needed.



	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
<b>Surface Water Quality</b>					
Salinity in Northern Delta (near Emmaton)	Salinity increased in fall and winter months (up to 377%). Reduced in June in wet to dry years (up to 30%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	No change. No mitigation needed.	Salinity increased in fall and winter months in wet and above normal years (up to 378%). Reduced in June of above normal years and September of below normal years (up to 8%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in the western Delta in fall and winter months (up to 377%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in January-February in all years (up to 8%). Reduced in April-June in critical dry years (up to 15%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.
Salinity in Western Delta (near Port Chicago)	Salinity increased in Oct-March in below normal, dry, and critical dry years, and September wet and above normal years (up to 96%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	No change. No mitigation needed.	Salinity increased in October-January, April-May, June, and September in wet and above normal years (up to 95%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in Oct-March in below normal, dry, and critical dry years, and September wet and above normal years (up to 96%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity similar in most months except reduced in April-May in dry and critical dry years (up to 8%). No mitigation needed.

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	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
Salinity in Western Central Delta (near Antioch)	Salinity increased in fall and winter months (up to 265%). Reduced in June in wet to below normal years (up to 14%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	No change. No mitigation needed.	Salinity increased in fall and winter months (up to 262%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in fall and winter months (up to 265%). Reduced in June in wet to below normal years (up to 14%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in February in critical dry years (7%). Reduced in April-May in below normal to critical dry years, and in June in critical dry years (up to 20%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.
Salinity in Western Central Delta (near Contra Costa Water District Intakes)	Salinity increased in October-January and September in wet and above normal years (up to 65%). Reduced in March-June in wet to below normal years (up to 32%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	No change. No mitigation needed.	Salinity increased in October-December in all year types, and January in above normal to dry years, and in September in wet and above normal years (up to 76%). Reduced in April-June (up to 34%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in October-January and September in wet and above normal years (up to 65%). Reduced in March-June in wet to below normal years (up to 32%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in April-June in below normal to critical dry years (up to 40%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.

	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
Salinity in Southern Delta (near CVP and SWP intakes)	Salinity increased in fall and early winter months (up to 65%). Reduced in February-June (up to 22%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	No change. No mitigation needed.	Salinity increased in October-December (up to 29% at Jones Pumping Plant intake and up to 41% at Clifton Court intake). Reduced in June (up to 13% at Jones Pumping Plant intake and up to 19% at Clifton Court intake). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in fall and early winter months (up to 65%). Reduced in February-June (up to 22%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in June in dry and critical dry years (up to 12%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.
Mercury in Delta Fish	Mercury concentrations similar or reduced concentrations. No mitigation needed.	No change. No mitigation needed.	Mercury concentrations similar or reduced concentrations. No mitigation needed.	Mercury concentrations similar or reduced concentrations. No mitigation needed.	Mercury concentrations similar concentrations. No mitigation needed.
Selenium in Delta and Delta Fish	Selenium concentrations similar concentrations. No mitigation needed.	No change. No mitigation needed.	Selenium concentrations similar concentrations. No mitigation needed.	Selenium concentrations similar concentrations. No mitigation needed.	Selenium concentrations similar concentrations. No mitigation needed.
<b>Groundwater Resources</b>					
Trinity River Region	Similar groundwater conditions. No mitigation needed.	No change. No mitigation needed.	Similar groundwater conditions. No mitigation needed.	Similar groundwater conditions. No mitigation needed.	Similar groundwater conditions. No mitigation needed.

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	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
Central Valley Region: Sacramento Valley	Similar groundwater conditions. No mitigation needed.	No change. No mitigation needed.	Similar groundwater conditions. No mitigation needed.	Similar groundwater conditions. No mitigation needed.	Similar groundwater conditions. No mitigation needed.
Central Valley Region: San Joaquin Valley	Reduced groundwater pumping (8%); and higher groundwater elevations (2-200 feet). Potentially improved groundwater quality. Reduced subsidence potential. No mitigation needed.	No change. No mitigation needed.	Reduced groundwater pumping (6%); and higher groundwater elevations (2-200 feet). Potentially improved groundwater quality. Reduced subsidence potential. No mitigation needed.	Reduced groundwater pumping (8%); and higher groundwater elevations (2-200 feet). Potentially improved groundwater quality. Reduced subsidence potential. No mitigation needed.	Similar groundwater pumping; and similar to higher groundwater elevations (2-25 feet). Similar groundwater quality. Similar subsidence potential. No mitigation needed.
San Francisco Bay Area, Central Coast, and Southern California Region	Potentially reduced groundwater pumping; and potentially higher groundwater elevations. Potentially improved groundwater quality. Less subsidence potential. No mitigation needed.	No change. No mitigation needed.	Potentially reduced groundwater pumping; and potentially higher groundwater elevations. Potentially improved groundwater quality. Less subsidence potential. No mitigation needed.	Potentially reduced groundwater pumping; and potentially higher groundwater elevations. Potentially improved groundwater quality. Less subsidence potential. No mitigation needed.	Similar groundwater pumping; and groundwater elevations. Potentially similar groundwater quality. Similar subsidence potential. No mitigation needed.
<b>CVP and SWP Energy Resources</b>					
Energy Generated and Used by CVP and SWP Water Users	Similar CVP net generation. Decreased SWP net generation over the long-term (41%). Potentially reduced energy use by CVP and SWP water users. No mitigation needed.	No change. No mitigation needed.	Similar CVP net generation. Decreased SWP net generation over the long-term (27%). Potentially reduced energy use by CVP and SWP water users. No mitigation needed.	Similar CVP net generation. Decreased SWP net generation over the long-term (41%). Potentially reduced energy use by CVP and SWP water users. No mitigation needed.	Similar CVP and SWP net generation. Similar reduced energy use. No mitigation needed.

	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
<b>Aquatic Resources</b>					
Trinity River: Coho Salmon	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Trinity River: Spring-run Chinook Salmon	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Trinity River: Fall-run Chinook Salmon	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Trinity River: Steelhead	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Trinity River: Green Sturgeon	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Trinity Lake and Lewiston Reservoir: Reservoir Fish	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Trinity River: Pacific Lamprey	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Trinity River: Eulachon	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.

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	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
Sacramento River System: Winter-run Chinook Salmon	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Potential mitigation measure: Implement fish passage around dams.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030; reduced pulse flows along lower Clear Creek; and lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants. Potential mitigation measure: Implement fish passage around dams to reduce temperature impacts. No mitigation measures have been identified for remaining impacts.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Improved conditions due to predator controls. Potential mitigation measure: Implement fish passage around dams.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Improved conditions due to predator controls. Potential mitigation measure: Implement fish passage around dams.	Similar conditions. No mitigation needed.

	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
Sacramento River System: Spring-run Chinook Salmon	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Potential mitigation measure: Implement fish passage around dams.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030; reduced pulse flows along lower Clear Creek; and lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants. Potential mitigation measure: Implement fish passage around dams to reduce temperature impacts. No mitigation measures have been identified for remaining impacts.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Improved conditions due to predator controls. Potential mitigation measure: Implement fish passage around dams.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Improved conditions due to predator controls. Potential mitigation measure: Implement fish passage around dams.	Similar conditions. No mitigation needed.
Sacramento River System: Fall-run Chinook Salmon	Similar conditions. No mitigation needed.	Reduced habitat conditions due to reduced pulse flows along lower Clear Creek; and lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants. No mitigation measures have been identified for remaining impacts.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.

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	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
Sacramento River System: Late Fall-run Chinook Salmon	Similar conditions. No mitigation needed.	Reduced habitat conditions due to lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants. Potential mitigation measure: Implement fish passage around dams to reduce temperature impacts. No mitigation measures have been identified for remaining impacts.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Sacramento River System: Steelhead	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Potential mitigation measure: Implement fish passage around dams.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Potential mitigation measure: Implement fish passage around dams.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Potential mitigation measure: Implement fish passage around dams.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Potential mitigation measure: Implement fish passage around dams.	Similar conditions. No mitigation needed.
Sacramento River System: Green Sturgeon and White Sturgeon	Likely to result in improved conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Likely to result in improved conditions. No mitigation needed.	Likely to result in improved conditions. No mitigation needed.	Similar conditions. No mitigation needed.



	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
Delta: Delta Smelt	Reduced habitat conditions due to increased potential for entrainment during larval and juvenile stages, and increased salinity in the fall in the western Delta. No mitigation measures have been identified at this time.	Similar conditions. No mitigation needed.	Reduced habitat conditions due to increased potential for entrainment during larval and juvenile stages, and increased salinity in the fall in the western Delta. No mitigation measures have been identified at this time.	Reduced habitat conditions due to increased potential for entrainment during larval and juvenile stages, and increased salinity in the fall in the western Delta. No mitigation measures have been identified at this time.	Similar conditions. No mitigation needed.
Delta: Longfin Smelt	Reduced habitat conditions due to more negative Old and Middle River flows and other factors (as indicated by lower Longfin Smelt abundance indices). No mitigation measures have been identified at this time.	Similar conditions. No mitigation needed.	Reduced habitat conditions due to more negative Old and Middle River flows and other factors (as indicated by lower Longfin Smelt abundance indices). No mitigation measures have been identified at this time.	Reduced habitat conditions due to more negative Old and Middle River flows and other factors (as indicated by lower Longfin Smelt abundance indices). No mitigation measures have been identified at this time.	Similar conditions. No mitigation needed.
Delta: Sacramento Splittail	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Sacramento River System: Reservoir Fish	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Sacramento River System: Pacific Lamprey	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.

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	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
Sacramento River System: Striped Bass, American Shad, and Hardhead	<p>Similar conditions for Hardhead.</p> <p>Reduced habitat conditions for Striped Bass and American Shad due to reduced survival in larval and juvenile stages and increased salinity in the spring in the western Delta.</p> <p>No mitigation measures have been identified at this time.</p>	<p>Similar conditions.</p> <p>No mitigation needed.</p>	<p>Similar conditions for Hardhead.</p> <p>Reduced habitat conditions for Striped Bass and American Shad due to reduced survival in larval and juvenile stages and increased salinity in the spring in the western Delta.</p> <p>Adverse conditions for Striped Bass due to changes in harvest limitations.</p> <p>No mitigation measures have been identified at this time.</p>	<p>Similar conditions for Hardhead.</p> <p>Reduced habitat conditions for Striped Bass and American Shad due to reduced survival in larval and juvenile stages and increased salinity in the spring in the western Delta.</p> <p>Adverse conditions for Striped Bass due to changes in harvest limitations.</p> <p>No mitigation measures have been identified at this time.</p>	<p>Similar conditions.</p> <p>No mitigation needed.</p>

	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
Stanislaus River: Fall-run Chinook Salmon	Similar conditions. No mitigation needed.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030; and lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants. Potential mitigation measure: Implement fish passage around dams to reduce temperature impacts. No mitigation measures have been identified for remaining impacts.	Potential improved habitat conditions due to predator controls, trap and haul operations, and harvest restrictions; however, the effectiveness of these measures is uncertain. No mitigation needed.	Potential improved habitat conditions due to predator controls, trap and haul operations, and harvest restrictions; however, the effectiveness of these measures is uncertain. No mitigation needed.	Similar conditions. No mitigation needed.

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	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
Stanislaus River: Steelhead	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030; and lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants. Potential mitigation measure: Implement fish passage around dams to reduce temperature impacts. No mitigation measures have been identified for remaining impacts.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030; and lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants. Potential mitigation measure: Implement fish passage around dams to reduce temperature impacts. No mitigation measures have been identified for remaining impacts.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030; and lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants. Potential improved habitat conditions due to predator controls and trap and haul operations; however, the effectiveness of these measures is uncertain. Potential mitigation measure: Implement fish passage around dams to reduce temperature impacts. No mitigation measures have been identified for remaining impacts.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030; and lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants. Potential improved habitat conditions due to predator controls and trap and haul operations; however, the effectiveness of these measures is uncertain. Potential mitigation measure: Implement fish passage around dams to reduce temperature impacts. No mitigation measures have been identified for remaining impacts.	Similar conditions. No mitigation needed.
Stanislaus River: White Sturgeon	Conditions may be similar; however, adverse impacts could occur due to higher water temperatures. No mitigation measures have been identified at this time.	Similar conditions. No mitigation needed.	Conditions may be similar; however, adverse impacts could occur due to higher water temperatures. No mitigation measures have been identified at this time.	Conditions may be similar; however, adverse impacts could occur due to higher water temperatures. No mitigation measures have been identified at this time.	Similar conditions. No mitigation needed.

	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
New Melones Reservoir; Reservoir Fish	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Stanislaus River: Other Fish	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions for lampreys and Hardheads. Adverse conditions for Striped Bass due to changes in harvest limitations. No mitigation needed for lamprey and Hardhead. No mitigation measures have been identified at this time for Striped Bass.	Similar conditions for lampreys and Hardheads. Adverse conditions for Striped Bass due to changes in harvest limitations. No mitigation needed for lamprey and Hardhead. No mitigation measures have been identified at this time for Striped Bass.	Similar conditions. No mitigation needed.
Pacific Ocean: Killer Whale	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
<b>Terrestrial Resources</b>					
Terrestrial Resources along Shoreline of CVP and SWP Reservoirs	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Terrestrial Resources along Rivers Downstream of CVP and SWP Reservoirs	Similar or improved conditions along Trinity, Sacramento, American, and Feather rivers. Reduced conditions along Stanislaus River. No mitigation measures identified at this time for changes along the Stanislaus River.	No change. No mitigation needed.	Similar or improved conditions along Trinity, Sacramento, American, and Feather rivers. Reduced conditions along Stanislaus River. No mitigation measures identified at this time for changes along the Stanislaus River.	Similar or improved conditions along Trinity, Sacramento, American, and Feather rivers. Reduced conditions along Stanislaus River. No mitigation measures identified at this time for changes along the Stanislaus River.	Similar or improved conditions along Trinity, Sacramento, American, and Feather rivers. Improved conditions along Stanislaus River. No mitigation needed.

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	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
Terrestrial Resources in Yolo Bypass	Similar conditions in Yolo Bypass. No mitigation needed.	No change. No mitigation needed.	Similar or improved conditions in Yolo Bypass. No mitigation needed.	Similar conditions in Yolo Bypass. No mitigation needed.	Similar conditions in Yolo Bypass. No mitigation needed.
Terrestrial Resources in Western Delta	Increased extent of salt water in the fall months of wet and above normal years in western Delta which could adversely affect terrestrial resources that use freshwater habitat. No mitigation measures identified at this time.	No change. No mitigation needed.	Increased extent of salt water in the fall months of wet and above normal years in western Delta which could adversely affect terrestrial resources that use freshwater habitat. No mitigation measures identified at this time.	Increased extent of salt water in the fall months of wet and above normal years in western Delta which could adversely affect terrestrial resources that use freshwater habitat. No mitigation measures identified at this time.	Similar habitat in western Delta. No mitigation needed.
<b>Geology and Soils Resources</b>					
Geology and Soils Resources	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
<b>Agricultural Resources</b>					
Agricultural Production and Employment	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
<b>Land Use</b>					
Municipal and Industrial Land Use	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
<b>Visual Resources</b>					
Visual Resources of Land Irrigated with CVP and SWP Water	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Visual Resources at Reservoirs that Store CVP and SWP Water	Similar or improved conditions. No mitigation needed.	No change. No mitigation needed.	Similar or improved conditions. No mitigation needed.	Similar or improved conditions. No mitigation needed.	Similar conditions. No mitigation needed.

	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
<b>Recreation Resources</b>					
Recreation Resources at Reservoirs that Store CVP and SWP Water	Similar or improved conditions. No mitigation needed.	No change. No mitigation needed.	Similar or improved conditions. No mitigation needed.	Similar or improved conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Recreation Resources in Rivers downstream of CVP and SWP Reservoirs	Similar or improved conditions. No mitigation needed.	No change. No mitigation needed.	Similar or improved conditions. Reduced opportunities for Striped Bass and sport ocean salmon fishing. No mitigation measures identified at this time.	Similar or improved conditions. Reduced opportunities for Striped Bass and sport ocean salmon fishing. No mitigation measures identified at this time.	Similar conditions. No mitigation needed.
<b>Air Quality and Greenhouse Gas Emissions</b>					
Emissions of Criteria Air Pollutants and Precursors and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants from Diesel Engines at Groundwater Wells	Similar air quality conditions in the Trinity River Region and Sacramento Valley. Improved air quality conditions in the San Joaquin Valley and the San Francisco Bay Area, Central Coast, and Southern California regions. No mitigation needed.	No change. No mitigation needed.	Similar air quality conditions in the Trinity River Region and Sacramento Valley. Reduced air quality conditions in the San Joaquin Valley and the San Francisco Bay Area, Central Coast, and Southern California regions. No mitigation needed.	Similar air quality conditions in the Trinity River Region and Sacramento Valley. Improved air quality conditions in the San Joaquin Valley and the San Francisco Bay Area, Central Coast, and Southern California regions. No mitigation needed.	Similar air quality conditions in the Trinity River Region and Sacramento Valley. Similar air quality conditions in the San Joaquin Valley and the San Francisco Bay Area, Central Coast, and Southern California regions. No mitigation needed.

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	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
Increased Greenhouse Gas Emissions (GHG) due to Changes in Energy Resources Related to CVP and SWP Water Use	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could increase in the San Francisco Bay Area, Central Coast, and Southern California regions.	No change.	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could increase in the San Francisco Bay Area, Central Coast, and Southern California regions.	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could increase in the San Francisco Bay Area, Central Coast, and Southern California regions.	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could increase in the San Francisco Bay Area, Central Coast, and Southern California regions.
<b>Cultural Resources</b>					
Potential for Disturbance of Cultural Resources	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
<b>Public Health</b>					
Water Supply Availability for Wildland Firefighting	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Potential Exposure to Mercury in Fish in Delta	Similar or reduced concentrations. No mitigation needed.	No change. No mitigation needed.	Similar or reduced concentrations. No mitigation needed.	Similar or reduced concentrations. No mitigation needed.	Similar concentrations. No mitigation needed.
<b>Socioeconomics</b>					
Agricultural and Municipal and Industrial Employment	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Municipal and Industrial Water Supply Operating Expenses	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Recreational Economics CVP and SWP Reservoirs	Similar or improved conditions. No mitigation needed.	No change. No mitigation needed.	Similar or improved conditions. No mitigation needed.	Similar or improved conditions. No mitigation needed.	Similar or improved conditions. No mitigation needed.



	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
Recreational Economics Related to Striped Bass Fishing in Delta	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Reduced recreational opportunities and associated economics. No mitigation identified at this time.	Reduced recreational opportunities and associated economics. No mitigation identified at this time.	Similar conditions. No mitigation needed.
Commercial and Sport Ocean Salmon Fishing	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Reduced commercial and sport ocean salmon fishing and associated economics. No mitigation identified at this time.	Reduced commercial and sport ocean salmon fishing and associated economics. No mitigation identified at this time.	Similar conditions. No mitigation needed.
<b>Indian Trust Assets</b>					
Potential for Disturbance of Indian Trust Assets	No change. No mitigation needed.	No change. No mitigation needed.	No change. No mitigation needed.	No change. No mitigation needed.	No change. No mitigation needed.
<b>Environmental Justice</b>					
Emissions of Criteria Air Pollutants and Precursors and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants from Diesel Engines at Groundwater Wells	Improved air quality conditions. No mitigation needed.	No change. No mitigation needed.	Reduced air quality conditions. No mitigation needed.	Improved air quality conditions. No mitigation needed.	Similar air quality conditions. No mitigation needed.
Potential Exposure to Mercury in Fish in Delta	Similar or reduced concentrations. No mitigation needed.	No change. No mitigation needed.	Similar or reduced concentrations. No mitigation needed.	Similar or reduced concentrations. No mitigation needed.	Similar concentrations. No mitigation needed.

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1 **Table ES.2 Comparison of Alternatives 1 through 5 and the No Action Alternative to the Second Basis of Comparison**

	No Action Alternative Compared to Second Basis of Comparison	Alternative 1 Compared to the Second Basis of Comparison	Alternative 2 Compared to the Second Basis of Comparison	Alternative 3 Compared to the Second Basis of Comparison	Alternative 4 Compared to the Second Basis of Comparison	Alternative 5 Compared to the Second Basis of Comparison
<b>Surface Water Conditions</b>						
Trinity Lake	Water surface elevations similar Storage would be similar in most months, except reduced in November-December in above normal years (up to 6%) and all months in critical dry years (up to 10%).	No change.	Water surface elevations similar Storage would be similar in most months, except reduced in November-December in above normal years (up to 6%) and all months in critical dry years (up to 10%).	Water surface elevations similar Storage similar or increased.	No change.	Water surface elevations similar Storage would be similar in most months, except reduced in all months in critical dry years (up to 10%).
Trinity River at Lewiston Dam	Flows similar or increased except reduced in December-February in wet to below normal years (up to 30%).	No change.	Flows similar or increased except reduced in December-February in wet to below normal years (up to 30%).	Flows similar or increased.	No change.	Flows similar or increased except reduced in December-February in wet to below normal years (up to 21%).
Shasta Lake	Water surface elevations similar Storage reduced in September-February in wet to dry years (up to 11%) and in all months in critical dry years (up to 14%).	No change.	Water surface elevations similar Storage reduced in September-February in wet to dry years (up to 11%) and in all months in critical dry years (up to 14%).	Water surface elevations similar Storage similar or increased.	No change.	Water surface elevations similar Storage reduced in September-February in most months of wet to dry years (up to 10%), and in all months in critical dry years (up to 17%).

	<b>No Action Alternative Compared to Second Basis of Comparison</b>	<b>Alternative 1 Compared to the Second Basis of Comparison</b>	<b>Alternative 2 Compared to the Second Basis of Comparison</b>	<b>Alternative 3 Compared to the Second Basis of Comparison</b>	<b>Alternative 4 Compared to the Second Basis of Comparison</b>	<b>Alternative 5 Compared to the Second Basis of Comparison</b>
Sacramento River at Keswick Dam	Flows reduced (up to 21%) except September and November.	No change.	Flows reduced (up to 21%) except September and November.	Flows similar or increased except reduced in August in below normal years (up to 6%).	No change.	Flows reduced (up to 16%) except September and November.
Sacramento River at Freeport	Flows similar or increased except reduced in May and June (up to 27%).	No change.	Flows similar or increased except reduced in May and June (up to 27%).	Flows similar or increased except reduced in June in below normal years (up to 13%).	No change.	Flows similar or increased except reduced in May and June (up to 28%).
Clear Creek near Igo	Flows similar or increased.	No change.	Flows similar or increased.	No change.	No change.	Flows similar or increased.
Lake Oroville	Water surface elevations similar. Similar in most months May-July in wet to dry years and in all months in critical dry years. Reduced in many months from September-February in all year types (up to 18%).	No change.	Water surface elevations similar. Similar in most months May-July in wet to dry years and in all months in critical dry years. Reduced in many months from September-February in all year types (up to 18%).	Water surface elevations similar. Storage similar.	No change.	Water surface elevations similar. Similar in most months May-July in wet to dry years and in all months in critical dry years. Reduced in many months from September-February in all year types (up to 18%).
Feather River downstream of Thermalito Complex	Flows similar or increased except reduced in August-June (up to 52%).	No change.	Flows similar or increased except reduced in August-June (up to 52%).	Flows similar or increased except reduced in August-June (up to 28%).	No change.	Flows similar or increased except reduced in August-June (up to 58%).

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Folsom Lake	Water surface elevations similar Storage similar in many months except reduced flows in September-January (up to 12%) in wet to below normal years and July-September in critical dry years (up to 11%).	No change.	Water surface elevations similar Storage similar in many months except reduced flows in September-January (up to 12%) in wet to below normal years and July-September in critical dry years (up to 11%).	Water surface elevations similar Storage similar.	No change.	Water surface elevations similar Storage similar in many months except reduced flows in August-January (up to 13%) in wet to below normal years and July in critical dry years (8%).
American River at Nimbus Dam	Flows similar or increased except reduced in June-August, December, February, and April (up to 25%).	No change.	Flows similar or increased except reduced in June-August, December, February, and April (up to 25%).	Flows similar or increased except reduced flows in June-August and April (up to 17%).	No change.	Flows similar or increased except reduced in December-February, April, June, and August (up to 25%).
New Melones Reservoir	Water surface elevations similar Storage similar in wet, below normal, and dry years, and in most months in above normal and critical dry years. Storage reduced in October in above normal water years (6%) and in October-January and April-June in critical dry years (up to 7%).	No change.	Water surface elevations similar Storage similar in wet, below normal, and dry years, and in most months in above normal and critical dry years. Storage reduced in October in above normal water years (6%) and in October-January and April-June in critical dry years (up to 7%).	Water surface elevations similar Storage similar or increased.	No change.	Water surface elevations similar Storage reduced in all months in all water year types (up to 23%).

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Stanislaus River at Goodwin Dam	Flows similar or increased except reduced in November-March and May-June (up to 25%).	No change.	Flows similar or increased except reduced in November-March and May-June (up to 25%).	Flows reduced in all months (up to 79%) except April and August.	No change.	Flows reduced in all months (up to 25%) except October, April, and May.
San Joaquin River at Vernalis	Flows similar or increased except reduced in November and May-June (up to 9%).	No change.	Flows similar or increased except reduced in November and May-June (up to 9%).	Flows similar or increased except reduced in May-June (up to 27%).	No change.	Flows similar or increased except reduced in November and June (up to 10%).

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San Luis Reservoir	Water surface elevations reduced in all months in wet to below normal water years and in February-September in dry and critical dry years (up to 16%). Storage reduced in October-June in most water years (up to 71%).	No change.	Water surface elevations reduced in all months in wet to below normal water years and in February-September in dry and critical dry years (up to 16%). Storage reduced in October-June in most water years (up to 71%).	Water surface elevations similar except reduced in January-February in above normal years (up to 6%) and February-August in critical dry years (up to 7%). Storage similar or increased in some months except in December-February and June in wet years (up to 16%), October-July in above normal and below normal years (up to 40%), January-September in dry years (up to 19%), and October-August in critical dry years (up to 29%).	No change.	Water surface elevations reduced in all months in all year types (up to 70%). Storage would be reduced in October-August in wet to below normal years (up to 17%), in January-September in dry years (up to 14%), and in all months in critical dry years (up to 14%).

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Flows into Yolo Bypass	Flows similar or increased except reduced in November-December in wet years (up to 15%), January-March in above normal years (14%), December-March in below normal years (up to 25%), and December in dry years (6%).	No change.	Flows similar or increased except reduced in November-December in wet years (up to 15%), January-March in above normal years (14%), December-March in below normal years (up to 25%), and December in dry years (6%).	Flows similar except reduced in October of wet years (6%).	No change.	Flows similar or increased except reduced in November-January in wet years (up to 15%), January-March in above normal years (15%), December-March in below normal years (up to 24%), and December in dry years (7%).
Delta Outflow	Flows similar or increased in many months. Reduced flows in some months, including in December, February-March, and June in wet years (up to 1,590 cfs).	No change.	Flows similar or increased in many months. Reduced flows in some months, including in December, February-March, and June in wet years (up to 1,590 cfs).	Flows would increase in many months. Reduced flows in some months, including October and March-June in wet years (up to 1,127 cfs), and October and May-June in dry years (up to 373 cfs).	No change.	Flows similar or increased in many months. Reduced flows in some months, including in December, February-March, and June in wet years (up to 1,713 cfs), and June in dry years (526 cfs).
Reverse Flows in Old and Middle Rivers	Increased positive flows except in June-August in most years and March in wet years.	No change.	Increased positive flows except in June-August in most years and March in wet years.	Increased negative flows in June-August in most years and March in wet years.	No change.	Increased negative flows in July-August in most years and March and June in wet years.

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<b>Water Supplies</b>						
Non-CVP and Non-SWP Deliveries	Deliveries similar.	Deliveries similar.	Deliveries similar.	Deliveries similar.	Deliveries similar.	Deliveries similar.
North of Delta CVP Water Deliveries: Agricultural Water Contractors	Deliveries reduced up to 16% over the long-term to 34% in critical dry years.	No change.	Deliveries reduced up to 16% over the long-term to 34% in critical dry years.	Deliveries similar over the long-term. Reduced up to 9% in dry years to 11% in critical dry years.	No change.	Deliveries reduced up to 16% over the long-term to 31% in critical dry years.
North of Delta CVP Water Deliveries: Municipal and Industrial Water Contractors	Deliveries similar.	No change.	Deliveries similar.	Deliveries similar.	No change.	Deliveries similar.
South of Delta CVP Water Deliveries: Agricultural Water Contractors	Deliveries reduced up to 23% over the long-term to 33% in critical dry years.	No change.	Deliveries reduced up to 23% over the long-term to 33% in critical dry years.	Deliveries similar over the long-term. Reduced up to 8% in dry years to 14% in critical dry years.	No change.	Deliveries reduced up to 24% over the long-term to 33% in critical dry years.
South of Delta CVP Water Deliveries: Municipal and Industrial Water Contractors	Deliveries reduced up to 10% over the long-term to 5% in critical dry years.	No change.	Deliveries reduced up to 10% over the long-term to 5% in critical dry years.	Deliveries similar.	No change.	Deliveries reduced up to 10% over the long-term to 8% in critical dry years.
CVP Water Deliveries: Eastside Division Contractors	Deliveries reduced up to 19% in critical dry years.	No change.	Deliveries reduced up to 19% in critical dry years.	Deliveries similar.	No change.	Deliveries reduced up to 19% in critical dry years.
North of Delta: SWP Water Deliveries under Table A without Article 21 water	Deliveries reduced up to 13% over the long-term to 20% in critical dry years.	No change.	Deliveries reduced up to 13% over the long-term to 20% in critical dry years.	Deliveries similar over the long-term and in dry years. Reduced by 10% in critical dry years.	No change.	Deliveries reduced up to 19% over the long-term to 21% in critical dry years.



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North of Delta: SWP Water Deliveries under Table A without Article 21 water	Deliveries reduced up to 18% over the long-term to 22% in critical dry years.	No change.	Deliveries reduced up to 18% over the long-term to 22% in critical dry years.	Deliveries similar over the long-term and in dry years. Reduced by 11% in critical dry years.	No change.	Deliveries reduced up to 19% over the long-term to 23% in critical dry years.
<b>Surface Water Quality</b>						
Salinity in Northern Delta (near Emmaton)	Salinity increased in June in wet to dry years (up to 21%). Reduced in fall and winter months in wet and above normal years (up to 79%).	No change.	Salinity increased in June in wet to dry years (up to 21%). Reduced in fall and winter months in wet and above normal years (up to 79%).	Salinity increased in June in wet to dry years (up to 35%). Reduced in fall and winter months in wet and above normal years (up to 24%).	No change.	Salinity increased in June in wet to dry years (up to 21%). Reduced in fall and winter months in wet and above normal years (up to 79%).
Salinity in Western Delta (near Port Chicago)	Salinity reduced in September-May (up to 49%).	No change.	Salinity reduced in September-May (up to 49%).	Salinity increased in June in wet to below normal years (up to 9%). Reduced in January-March (up to 25%).	No change.	Salinity reduced in September-May (up to 49%).
Salinity in Western Central Delta (near Antioch)	Salinity increased in June in wet to below normal years (up to 16%). Reduced in fall and winter months (up to 73%).	No change.	Salinity increased in June in wet to below normal years (up to 16%). Reduced in fall and winter months (up to 73%).	Salinity increased in May in wet years and June in wet to dry years (up to 20%). Reduced in January-April (up to 40%).	No change.	Salinity increased in June in wet to below normal years (up to 14%). Reduced in fall and winter months (up to 73%).

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Salinity in Western Central Delta (near Contra Costa Water District Intakes)	Salinity increased in March-June (up to 47%). Reduced in October-January and September (up to 42%).	No change.	Salinity increased in March-June (up to 47%). Reduced in October-January and September (up to 42%).	Salinity increased in March-April in dry and critical dry years (up to 16%). Reduced in December-February in dry and critical dry years (up to 23%).	No change.	Salinity increased in March-June (up to 63%). Reduced in October-January and September (up to 41%).
Salinity in Southern Delta (near CVP and SWP intakes)	Salinity increased in February-June (up to 23%). Reduced in October-January (up to 28%).	No change.	Salinity increased in February-June (up to 23%). Reduced in October-January (up to 28%).	Salinity increased in February-May in dry and critical dry years (up to 23%).	No change.	Salinity increased in February-June (up to 26%). Reduced in October-January (up to 28%).
Mercury in Delta Fish	Mercury concentrations increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).	No change.	Mercury concentrations increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).	Similar conditions.	No change.	Mercury concentrations increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).
Selenium in Delta and Delta Fish	Selenium concentrations similar concentrations.	No change.	Selenium concentrations similar concentrations.	Selenium concentrations similar concentrations.	No change.	Selenium concentrations similar concentrations.
<b>Groundwater Resources</b>						
Trinity River Region	Similar groundwater conditions.	No change.	Similar groundwater conditions.	Similar groundwater conditions.	No change.	Similar groundwater conditions.
Central Valley Region: Sacramento Valley	Similar groundwater conditions.	No change.	Similar groundwater conditions.	Similar groundwater conditions.	No change.	Similar groundwater conditions.

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Central Valley Region: San Joaquin Valley	Increased groundwater pumping (8%); and lower groundwater elevations (2-200 feet). Potentially reduced groundwater quality. Increased subsidence potential.	No change.	Increased groundwater pumping (8%); and lower groundwater elevations (2-200 feet). Potentially reduced groundwater quality. Increased subsidence potential.	Similar groundwater pumping; and similar to lower groundwater elevations (2-25 feet). Similar groundwater quality. Similar subsidence potential.	No change.	Increased groundwater pumping (8%); and lower groundwater elevations (2-200 feet). Potentially reduced groundwater quality. Increased subsidence potential.
San Francisco Bay Area, Central Coast, and Southern California Region	Potentially increased groundwater pumping; and potentially lower groundwater elevations. Potentially reduced groundwater quality. Increased subsidence potential.	No change.	Potentially increased groundwater pumping; and potentially lower groundwater elevations. Potentially reduced groundwater quality. Increased subsidence potential.	Potentially increased groundwater pumping; and potentially lower groundwater elevations. Potentially reduced groundwater quality. Increased subsidence potential.	No change.	Potentially increased groundwater pumping; and potentially lower groundwater elevations. Potentially reduced groundwater quality. Increased subsidence potential.
<b>CVP and SWP Energy Resources</b>						
Energy Generated and Used by CVP and SWP Water Users	Similar CVP net generation. Increased net generation over the long-term (29%). Potentially increased energy use by CVP and SWP water users.	No change.	Similar CVP net generation. Increased net generation over the long-term (29%). Potentially increased energy use by CVP and SWP water users.	Similar CVP net generation. Increased net generation over the long-term (10%). Potentially increased energy use by CVP and SWP water users.	No change.	Similar CVP net generation. Increased net generation over the long-term (30%). Potentially increased energy use by CVP and SWP water users.

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<b>Aquatic Resources</b>						
Trinity River: Coho Salmon	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Trinity River: Spring-run Chinook Salmon	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Trinity River: Fall-run Chinook Salmon	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Trinity River: Steelhead	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Trinity River: Green Sturgeon	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Trinity Lake and Lewiston Reservoir: Reservoir Fish	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Trinity River: Pacific Lamprey	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Trinity River: Eulachon	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Sacramento River System: Winter-run Chinook Salmon	Improved habitat conditions due to fish passage at dams and other actions to address high water temperatures caused by climate change by 2030.	No change.	Similar conditions.	Improved habitat conditions due to improved escapement potential and predator controls.	Similar conditions.	Improved habitat conditions due to fish passage at dams and other actions to address high water temperatures caused by climate change by 2030.

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Sacramento River System: Spring-run Chinook Salmon	Improved habitat conditions due to fish passage at dams and other actions to address high water temperatures caused by climate change by 2030.	No change.	Similar conditions.	Improved habitat conditions due to harvest limitations and predator controls.	Similar conditions.	Improved habitat conditions due to fish passage at dams and other actions to address high water temperatures caused by climate change by 2030.
Sacramento River System: Fall-run Chinook Salmon	Similar conditions.	No change.	Similar conditions.	Similar conditions.	Similar conditions.	Similar conditions.
Sacramento River System: Late Fall-run Chinook Salmon	Improved habitat conditions due to measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants.	No change.	Similar conditions.	Similar conditions.	Similar conditions.	Improved habitat conditions due to measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants.

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Sacramento River System: Steelhead	Improved habitat conditions due to fish passage programs to address high water temperatures caused by climate change by 2030; and measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants.	No change.	Similar conditions.	Similar conditions.	Similar conditions.	Improved habitat conditions due to fish passage programs to address high water temperatures caused by climate change by 2030; and measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants.
Sacramento River System: Green Sturgeon and White Sturgeon	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030 that are not improved by other actions.	No change.	Similar conditions.	Improved habitat conditions due to lower water temperatures.	No change.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030 that are not improved by other actions.
Delta: Delta Smelt	Improved habitat conditions due to reduced potential for entrainment during larval and juvenile stages, and reduced salinity in the fall in the western Delta.	No change.	Similar conditions.	Similar conditions.	No change.	Improved habitat conditions due to reduced potential for entrainment during larval and juvenile stages, and reduced salinity in the fall in the western Delta.

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Delta: Longfin Smelt	Improved habitat conditions due to more positive Old and Middle River flows and other factors (as indicated by higher Longfin Smelt abundance indices).	No change.	Similar conditions.	Similar conditions.	No change.	Improved habitat conditions due to more positive Old and Middle River flows and other factors (as indicated by higher Longfin Smelt abundance indices).
Delta: Sacramento Splittail	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Sacramento River System: Reservoir Fish	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Sacramento River System: Pacific Lamprey	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Sacramento River System: Striped Bass, American Shad, and Hardhead	Similar conditions for Hardhead. Improved habitat conditions for Striped Bass and American Shad due to improved survival in larval and juvenile stages and reduced salinity in the spring in the western Delta.	No change.	Similar conditions.	Similar habitat conditions for Hardhead, Striped Bass, and American Shad. Adverse conditions for Striped Bass due to changes in harvest limitations.	No change in habitat conditions for Hardhead, Striped Bass, and American Shad. Adverse conditions for Striped Bass due to changes in harvest limitations.	Similar conditions for Hardhead. Improved habitat conditions for Striped Bass and American Shad due to improved survival in larval and juvenile stages and reduced salinity in the spring in the western Delta.

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Stanislaus River: Fall-run Chinook Salmon	Similar or improved conditions.	No change.	Similar conditions.	Potential improved habitat conditions due to predator controls, trap and haul operations, and harvest restrictions; however, the effectiveness of these measures is uncertain.	Potential improved habitat conditions due to predator controls, trap and haul operations, and harvest restrictions; however, the effectiveness of these measures is uncertain.	Similar or improved conditions.
Stanislaus River: Steelhead	Improved habitat conditions due to measures to address high water temperatures caused by climate change by 2030; and measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants.	No change.	Similar conditions.	Potential improved habitat conditions due to predator controls and trap and haul operations; however, the effectiveness of these measures is uncertain.	Potential improved habitat conditions due to predator controls and trap and haul operations; however, the effectiveness of these measures is uncertain.	Improved habitat conditions due to measures to address high water temperatures caused by climate change by 2030; and measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants.
Stanislaus River: White Sturgeon	Conditions may be similar; however, improved conditions could occur due to lower water temperatures.	No change.	Similar conditions.	Similar conditions.	No change.	Conditions may be similar; however, improved conditions could occur due to lower water temperatures.
New Melones Reservoir; Reservoir Fish	Similar conditions.	No change.	Similar conditions.	Improved conditions for black bass nest survival.	No change.	Similar conditions.



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Stanislaus River: Other Fish	Similar conditions.	No change.	Similar conditions.	Similar conditions for lamprey and Hardhead. Adverse conditions for Striped Bass due to changes in harvest limitations.	Similar conditions for lamprey and Hardhead. Adverse conditions for Striped Bass due to changes in harvest limitations.	Similar conditions.
Pacific Ocean: Killer Whale	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
<b>Terrestrial Resources</b>						
Terrestrial Resources along Shoreline of CVP and SWP Reservoirs	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Terrestrial Resources along Rivers Downstream of CVP and SWP Reservoirs	Similar or improved conditions along Trinity, Sacramento, American, and Stanislaus rivers. Reduced conditions along Feather River. No mitigation measures identified at this time for changes along Feather River.	No change.	Similar or improved conditions along Trinity, Sacramento, American, and Stanislaus rivers. Reduced conditions along Feather River. No mitigation measures identified at this time for changes along Feather River.	Similar or improved conditions along Trinity, Sacramento, Feather, and American rivers. Reduced conditions along Stanislaus River. No mitigation measures identified at this time for changes along Stanislaus River.	No change.	Similar or improved conditions along Trinity, American, and Stanislaus rivers. Reduced conditions along Feather and Sacramento rivers. No mitigation measures identified at this time for changes along Feather and Sacramento rivers.
Terrestrial Resources in Yolo Bypass	Similar conditions in Yolo Bypass.	No change.	Similar conditions in Yolo Bypass.	Similar conditions in Yolo Bypass.	No change.	Similar or reduced conditions in Yolo Bypass.

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Terrestrial Resources in Western Delta	Increased extent of freshwater habitat in western Delta.	No change.	Increased extent of freshwater habitat in western Delta.	Similar conditions.	No change.	Increased extent of freshwater habitat in western Delta.
<b>Geology and Soils Resources</b>						
Geology and Soils Resources	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
<b>Agricultural Resources</b>						
Agricultural Production and Employment	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
<b>Land Use</b>						
Municipal and Industrial Land Use	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
<b>Visual Resources</b>						
Visual Resources of Land Irrigated with CVP and SWP Water	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.

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Visual Resources at Reservoirs that Store CVP and SWP Water	<p>Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, and New Melones Reservoir.</p> <p>Similar conditions at San Luis Reservoir in above normal to dry years.</p> <p>Reduced conditions at San Luis Reservoir in wet and critical dry years (up to 6%).</p> <p>Potentially reduced conditions in the San Francisco Bay Area, Central Coast, and Southern California regions (up to 18%).</p>	No change.	<p>Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, and New Melones Reservoir.</p> <p>Similar conditions at San Luis Reservoir in above normal to dry years.</p> <p>Reduced conditions at San Luis Reservoir in wet and critical dry years (up to 6%).</p> <p>Potentially reduced conditions in the San Francisco Bay Area, Central Coast, and Southern California regions (up to 18%).</p>	Similar conditions.	No change.	<p>Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, and New Melones Reservoir.</p> <p>Similar conditions at San Luis Reservoir in above normal to dry years.</p> <p>Reduced conditions at San Luis Reservoir in wet and critical dry years (up to 9%).</p> <p>Potentially reduced conditions in the San Francisco Bay Area, Central Coast, and Southern California regions (up to 18%).</p>

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	<b>No Action Alternative Compared to Second Basis of Comparison</b>	<b>Alternative 1 Compared to the Second Basis of Comparison</b>	<b>Alternative 2 Compared to the Second Basis of Comparison</b>	<b>Alternative 3 Compared to the Second Basis of Comparison</b>	<b>Alternative 4 Compared to the Second Basis of Comparison</b>	<b>Alternative 5 Compared to the Second Basis of Comparison</b>
<b>Recreation Resources</b>						
Recreation Resources at Reservoirs that Store CVP and SWP Water	<p>Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, and New Melones Reservoir.</p> <p>Similar conditions at San Luis Reservoir in above normal to dry years.</p> <p>Reduced conditions at San Luis Reservoir in wet and critical dry years (up to 6%).</p> <p>Potentially reduced conditions in the San Francisco Bay Area, Central Coast, and Southern California regions (up to 18%).</p>	No change.	<p>Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, and New Melones Reservoir.</p> <p>Similar conditions at San Luis Reservoir in above normal to dry years.</p> <p>Reduced conditions at San Luis Reservoir in wet and critical dry years (up to 6%).</p> <p>Potentially reduced conditions in the San Francisco Bay Area, Central Coast, and Southern California regions (up to 18%).</p>	Similar conditions.	No change.	<p>Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, and New Melones Reservoir.</p> <p>Similar conditions at San Luis Reservoir in above normal to dry years.</p> <p>Reduced conditions at San Luis Reservoir in wet and critical dry years (up to 9%).</p> <p>Potentially reduced conditions in the San Francisco Bay Area, Central Coast, and Southern California regions (up to 18%).</p>

	<b>No Action Alternative Compared to Second Basis of Comparison</b>	<b>Alternative 1 Compared to the Second Basis of Comparison</b>	<b>Alternative 2 Compared to the Second Basis of Comparison</b>	<b>Alternative 3 Compared to the Second Basis of Comparison</b>	<b>Alternative 4 Compared to the Second Basis of Comparison</b>	<b>Alternative 5 Compared to the Second Basis of Comparison</b>
Recreation Resources in Rivers downstream of CVP and SWP Reservoirs	Similar or improved conditions; except reduced conditions in June and August along the Feather and American rivers, and in May along the Feather River and Sacramento River near Freeport.	No change.	Similar or improved conditions; except reduced conditions in June and August along the Feather and American rivers, and in May along the Feather River and Sacramento River near Freeport.	Similar or improved conditions along rivers. Reduced opportunities for Striped Bass and sport ocean salmon fishing.	No change along rivers. Reduced opportunities for Striped Bass and sport ocean salmon fishing.	Similar or improved conditions; except reduced conditions in May and June and August along the Sacramento and Feather rivers, in August along the American River; and in June-August along Stanislaus River.
<b>Air Quality and Greenhouse Gas Emissions</b>						
Emissions of Criteria Air Pollutants and Precursors and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants from Diesel Engines at Groundwater Wells	Similar air quality conditions in the Trinity River Region and Sacramento Valley. Potential increase in emissions (up to 18%) in the San Joaquin Valley and the San Francisco Bay Area, Central Coast, and Southern California regions.	No change.	Similar air quality conditions in the Trinity River Region and Sacramento Valley. Potential increase in emissions (up to 18%) in the San Joaquin Valley and the San Francisco Bay Area, Central Coast, and Southern California regions.	Similar conditions.	No change.	Similar air quality conditions in the Trinity River Region and Sacramento Valley. Potential increase in emissions (up to 18%) in the San Joaquin Valley and the San Francisco Bay Area, Central Coast, and Southern California regions.

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	<b>No Action Alternative Compared to Second Basis of Comparison</b>	<b>Alternative 1 Compared to the Second Basis of Comparison</b>	<b>Alternative 2 Compared to the Second Basis of Comparison</b>	<b>Alternative 3 Compared to the Second Basis of Comparison</b>	<b>Alternative 4 Compared to the Second Basis of Comparison</b>	<b>Alternative 5 Compared to the Second Basis of Comparison</b>
Increased Greenhouse Gas Emissions due to Changes in Energy Resources Related to CVP and SWP Water Use	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could be reduced in the San Francisco Bay Area, Central Coast, and Southern California regions.	No change.	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could be reduced in the San Francisco Bay Area, Central Coast, and Southern California regions.	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could be reduced in the San Francisco Bay Area, Central Coast, and Southern California regions.	No change.	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could be reduced in the San Francisco Bay Area, Central Coast, and Southern California regions.
<b>Cultural Resources</b>						
Potential for Disturbance of Cultural Resources	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
<b>Public Health</b>						
Water Supply Availability for Wildland Firefighting	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir. Reduced potential at San Luis Reservoir (6%).	No change.	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir. Reduced potential at San Luis Reservoir (6%).	Similar conditions.	No change.	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir. Reduced potential at San Luis Reservoir (9%).
Potential Exposure to Mercury in Fish in Delta	Increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).	No change.	Increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).	Similar conditions.	No change.	Increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).

	<b>No Action Alternative Compared to Second Basis of Comparison</b>	<b>Alternative 1 Compared to the Second Basis of Comparison</b>	<b>Alternative 2 Compared to the Second Basis of Comparison</b>	<b>Alternative 3 Compared to the Second Basis of Comparison</b>	<b>Alternative 4 Compared to the Second Basis of Comparison</b>	<b>Alternative 5 Compared to the Second Basis of Comparison</b>
<b>Socioeconomics</b>						
Agricultural and Municipal and Industrial Employment	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Municipal and Industrial Water Supply Operating Expenses	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Recreational Economics CVP and SWP Reservoirs	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir. Reduced potential at San Luis Reservoir and reservoirs that store CVP and SWP water in San Francisco Bay Area, Central Coast, and Southern California regions.	No change.	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir. Reduced potential at San Luis Reservoir and reservoirs that store CVP and SWP water in San Francisco Bay Area, Central Coast, and Southern California regions.	Similar conditions.	No change.	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir. Reduced potential at San Luis Reservoir and reservoirs that store CVP and SWP water in San Francisco Bay Area, Central Coast, and Southern California regions.
Recreational Economics Related to Striped Bass Fishing in Delta	Similar conditions.	No change.	Similar conditions.	Reduced recreational opportunities and associated economics.	Reduced recreational opportunities and associated economics.	Similar conditions.
Commercial and Sport Ocean Salmon Fishing	Similar conditions.	No change.	Similar conditions.	Reduced commercial and sport ocean salmon fishing and associated economics.	Reduced commercial and sport ocean salmon fishing and associated economics.	Similar conditions.

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	<b>No Action Alternative Compared to Second Basis of Comparison</b>	<b>Alternative 1 Compared to the Second Basis of Comparison</b>	<b>Alternative 2 Compared to the Second Basis of Comparison</b>	<b>Alternative 3 Compared to the Second Basis of Comparison</b>	<b>Alternative 4 Compared to the Second Basis of Comparison</b>	<b>Alternative 5 Compared to the Second Basis of Comparison</b>
<b>Indian Trust Assets</b>						
Potential for Disturbance of Indian Trust Assets	No change.	No change.	No change.	No change.	No change.	No change.
<b>Environmental Justice</b>						
Emissions of Criteria Air Pollutants and Precursors and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants from Diesel Engines at Groundwater Wells	Potential increase in emissions (up to 18%).	No change.	Potential increase in emissions (up to 18%).	Similar conditions.	No change.	Potential increase in emissions (up to 18%).
Potential Exposure to Mercury in Fish in Delta	Increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).	No change.	Increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).	Similar conditions.	No change.	Increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).



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# 1 Abbreviations and Acronyms

2	µg/g	Micrograms per gram
3	µg/L	Micrograms/liter
4	µg/m <sup>3</sup>	Micrograms per cubic meter
5	µmhos/cm	Micromhos per centimeter
6	µS/cm	MicroSiemens per centimeter
7	AB	Assembly Bill
8	ACID	Anderson-Cottonwood Irrigation District
9	ACS	American Community Survey
10	AF	Acre-foot/Acre-feet
11	AFRP	Anadromous Fish Restoration Program
12	AFSP	Anadromous Fish Screen Program
13	AIP	Alternative Intake Project
14	ANN	Artificial Neural Network
15	AQMP	Air Quality Management Plan
16	ARB	California Air Resources Board
17	ARG	American River Group
18	AVEK	Antelope Valley-East Kern Water Agency
19	(b)(2)IT	B2 Interagency Team
20	BA	Biological Assessment
21	BARDP	Bay Area Regional Desalination Project
22	BCAA	bromochloroacetic acid
23	BCC	Birds of Conservation Concern
24	BCDC	San Francisco Bay Conservation and Development Commission
25		
26	BCSD	Bias-correction and Spatial Disaggregation
27	BDCP	Bay Delta Conservation Plan
28	BIA	Bureau of Indian Affairs
29	BKD	Bacterial Kidney Disease
30	BLM	Bureau of Land Management
31	BO	Biological Opinion
32	BP	Before Present
33	BRT	Biological Review Team
34	BSPP	Barker Slough Pumping Plant
35	BVWD	Bella Vista Water District

## Abbreviations and Acronyms

1	°C	Centigrade degrees
2	CA	California Aqueduct
3	CAA	Clean Air Act
4	CAAQS	California Ambient Air Quality Standard
5	CAL FIRE	California Department of Forestry and Fire Prevention
6	CASGEM	California Statewide Groundwater Elevation Monitoring
7		Program
8	CalEPA	California Environmental Protection Agency
9	CAISO	California Independent System Operator Corporation
10	CALFED	CALFED Bay-Delta Program
11	CAL FIRE	California Department of Forestry and Fire Prevention
12	CAT	California Climate Action Team
13	CBMWD	Central Basin Municipal Water District
14	CCAA	California Clean Air Act
15	CCC	Criteria Continuous Concentration
16	CCF	Clifton Court Forebay
17	CCSD	Cambria Community Services District
18	CCTT	Clear Creek Technical Team
19	CCWD	Contra Costa Water District
20	CDFW	California Department of Fish and Wildlife
21		(previously known as Department of Fish and Game)
22	CDP	Census Designated Place
23	CDPH	California Department of Public Health
24	CDWA	Central Delta Water Agency
25	CEC	California Energy Commission
26	CEQ	Council on Environmental Quality
27	CEQA	California Environmental Quality Act
28	CESA	California Endangered Species Act
29	CFR	Code of Federal Regulations
30	cfs	Cubic feet per second
31	CGS	California Geological Survey
32	CH <sub>4</sub>	Methane
33	CHRIS	California Historical Resources Information System
34	cm	centimeter
35	CMARP	Comprehensive Monitoring, Assessment and Research
36		Program
37	CMC	Criteria Maximum Concentration
38	CMIP3	Coupled Model Intercomparison Project Phase 3



1	CNAGPRA	California Native American Grave Protection and Repatriation Act
2		
3	CNAHC	California Native American Heritage Commission
4	CNDDDB	California Natural Diversity Database
5	CNPS	California Native Plant Society
6	CPUC	California Public utilities Commission
7	CO	Carbon monoxide
8	CO <sub>2</sub>	Carbon dioxide
9	CO <sub>2e</sub>	Carbon dioxide equivalent
10	COA	Coordinated Operation Agreement
11	COC	Constituents of Concern
12	CRD	Contract Rate of Delivery
13	CRHR	California Register of Historical Resources
14	CRPR	California Rare Plant Rank
15	CSD	Community Service District
16	CSJWCD	Central San Joaquin Water Conservation District
17	CTR	California Toxics Rule
18	CVHM	Central Valley Hydrologic Model
19	CVOO	Central Valley Operations Office
20	CVP	Central Valley Project
21	CVPA	Central Valley Project Act
22	CVPIA	Central Valley Project Improvement Act
23	CVPM	Central Valley Production Model
24	CVRWQCB	Central Valley Regional Water Quality Control Board
25	CV-Salts	Central Valley Salinity Alternatives for Long-term Sustainability
26		
27	CWA	Clean Water Act
28	CZMA	Coastal Zone Management Act
29	D-893	State Water Resources Control Board Decision 893
30	D-1422	State Water Resources Control Board Decision 1422
31	D-1485	State Water Resources Control Board Decision 1485
32	D-1616	State Water Resources Control Board Decision 1616
33	D-1629	State Water Resources Control Board Decision 1629
34	D-1641	State Water Resources Control Board Decision 1641
35	DAT	Data Assessment Team
36	DBCP	Dibromochloropropane
37	DBP	Disinfection byproducts
38	DBW	Department of Boating and Waterways

## Abbreviations and Acronyms

1	DCC	Delta Cross Channel
2	DCCA	Dichloroacetic Acid
3	DCID	Deer Creek Irrigation District
4	DCT	Delta Condition Team
5	DDD	Dichlorodiphenyldichloroethane
6	DDE	Dichlorodiphenyldichloroethylene
7	DDT	Dichlorodiphenyltrichloroethane
8	Delta	Sacramento-San Joaquin Rivers Delta Estuary
9	Delta Reform Act	Sacramento-San Joaquin Delta Reform Act of 2009
10	DFA	California Department of Food and Agriculture
11	DICU	Delta Island Consumptive Use
12	District Court	U.S. District Court for the Eastern District of California
13	DMC	Delta-Mendota Canal
14	DMC/CA Intertie	Delta-Mendota Canal and California Aqueduct Intertie
15	DO	Dissolved Oxygen
16	DOC	Dissolved organic carbon
17	DOI	Department of the Interior
18	DOM	Dissolved Organic Matter
19	DOSS	Delta Operations Salmonid and Sturgeon
20	DPC	Delta Protection Commission
21	DPM	Delta Passage Model
22	DPS	Distinct Population Segment
23	DSRAM	Delta Smelt Risk Assessment Matrix
24	dw	dry weight
25	DWR	California Department of Water Resources
26	EDWPA	El Dorado Water and Power Authority
27	EBMUD	East Bay Municipal Utility District
28	EC	Electrical Conductivity
29	ECe	Electrical Conductivity of a Saturated Soil Index
30	ECw	Electrical Conductivity
31	EFH	Essential Fish Habitat
32	E:I	Export to Inflow Ratio
33	EID	El Dorado Irrigation District
34	EIR	Environmental Impact Report
35	EIS	Environmental Impact Statement
36	EJ	Environmental Justice
37	EO	Executive Order
38	EOM	end-of-month

1	EOS	End-of-September
2	EQ	exceedance quotient
3	ERP	Ecosystem Restoration Program
4	ESA	Endangered Species Act
5	ESU	Evolutionary Significant Unit
6	ET	evapotranspiration
7	ETM	Estuarine Turbidity Maximum
8	EWA	Environmental Water Account
9	EWP	Environmental Water Program
10	°F	Fahrenheit degrees
11	FCAA	Federal Clean Air Act
12	FEMA	Federal Emergency Management Agency
13	FERC	Federal Energy Regulatory Commission
14	FID	Fresno Irrigation District
15	FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
16	FMMP	Farmland Mapping and Monitoring Program
17	FMP	Farm Process
18	FMS	Flow Management Standard
19	FMWT	Fall Midwater Trawl Survey
20	FP	Fully-Protected Species
21	FPPA	Farmland Protection Policy Act
22	FR	Federal Register
23	FRFH	Feather River Fish Hatchery
24	FRPA	Fish Restoration Program Agreement
25	FRPP	Farm and Ranch Land Protection Program
26	FRWP	Freeport Regional Water Project
27	ft	Foot/Feet
28	ft/s	Feet per second
29	FTE	full-time equivalent
30	GAMA	Groundwater Ambient Monitoring and Assessment
31	GBP	Grasslands Bypass Project
32	GCID	Glenn-Colusa Irrigation District
33	GCM	global climate model
34	GDP	gross domestic product
35	GHG	Greenhouse Gas
36	GIS	geographic information system
37	gpm	Gallons per minute

## Abbreviations and Acronyms

1	GORT	Gate Operations Review Team
2	GSA	Groundwater Sustainability Agency
3	GSP	Groundwater Sustainability Plan
4	GWh	Gigawatt-hour
5	GWMP	Groundwater Management Plans
6	GWP	Global Warming Potential
7	HAP	Hazardous Air Pollutants
8	HC	Hydrocarbons
9	HCP	Habitat Conservation Plan
10	HFC	hydrofluorocarbons
11	HFC	High Flow Channel
12	HGMP	Hatchery Genetic Management Plan
13	HOR	Head of Old River
14	HORB	Head of Old River Barrier
15	I/E or I:E	Inflow to Export Ratio (San Joaquin River)
16	I-O	Input-Output Model
17	ID	Irrigation District
18	IEP	Interagency Ecological Program
19	IEUA	Inland Empire Utilities Agency
20	IFIM	Instream Flow Incremental Methodology
21	IHN	Infectious Hematopoietic Necrosis
22	ILRP	Irrigated Lands Regulatory Program
23	in	Inch/Inches
24	IPCC	Intergovernmental Panel on Climate Change
25	IPO	Interim Plan of Operation
26	IRWMP	Integrated Regional Water Management Plan
27	ISRMA	Interlakes Special Recreation Management Area
28	ITA	Indian Trust Assets
29	JCSD	Jurupa Community Services District
30	JPOD	Joint Point of Diversion
31	Km	Kilometers
32	KRCD	Kings River Conservation District
33	LACSD	Los Angeles County Sanitation District
34	lbs	Pounds
35	LFC	Low Flow Channel
36	LIM	Land Inventory and Monitoring System

1	LYRA	Lower Yuba River Accord
2	m	meter
3	m/day	meters per day
4	M&I	Municipal and Industrial
5	m/s	meter per second
6	MACT	Maximum Achievable Control Technology
7	MAF	Million acre-feet or Million acre-foot
8	MBTA	Migratory Bird Treaty Act
9	MCAA	Monochloroacetic Acid
10	MCL	Maximum Contaminant Level
11	MERP	Mercury Exposure Reduction Program
12	Metropolitan	Metropolitan Water District of Southern California
13	mg/L	Milligrams per liter
14	mgd	Million gallons per day
15	MIDS	Morrow Island Distribution System
16	MLD	Most Likely Descendent
17	mm	Millimeter
18	mmhos/cm	millimhos per centimeter
19	MMPA	Marine Mammal Protection Act
20	MOA	Memorandum of Agreement
21	MORE	Mokelumne River Water & Power Authority
22	MOU	Memorandum of Understanding
23	MRR	minimum release requirements
24	msl	Mean Sea Level
25	mS/cm	MilliSiemens per Centimeter
26	MVCD	Mosquito and Vector Control Districts
27	MW	Megawatt
28	MWDOC	Metropolitan Water District of Orange County
29	MWDSC	Metropolitan Water District of Southern California
30	MWh	Megawatt-hours
31	N	Nitrogen
32	N <sub>2</sub> O	Nitrous oxide
33	NAA	No Action Alternative
34	NAAQS	National Ambient Air Quality Standard
35	NAGPRA	Native American Graves Protection and Repatriation Act
36	NAHC	Native American Heritage Commission
37	NAICS	North American Industry Classification

## Abbreviations and Acronyms

1	NASS	National Agricultural Statistics Service
2	NAWMP	North American Waterfowl Management Plan
3	NBA	North Bay Aqueduct
4	NCPA	Northern California Power Agency
5	NCCP	Natural Community Conservation Plan
6	NDMA	N-nitrosodimethylamine
7	NDWA	North Delta Water Agency
8	NESHAP	National Emission Standards for Hazardous Air Pollutants
9	NEPA	National Environmental Policy Act
10	ng/L	nanograms per liter
11	NHPA	National Historic Preservation Act
12	NHTSA	National Highway and Traffic Safety Administration
13	NMFS	National Marine Fisheries Service
14	NMFS BO	National Marine Fisheries Service 2009 Biological Opinion
15	NO <sub>2</sub>	nitrogen dioxide
16	NOAA	National Oceanic and Atmospheric Administration
17	NOI	Notice of Intent
18	NO <sub>x</sub>	Nitrogen oxides
19	NPDES	National Pollutant Discharge Elimination System
20	NPPA	Native Plant Protection Act
21	NPS	National Park Service
22	NRA	National Recreation Area
23	NRCS	Natural Resources Conservation Service
24	NRHP	National Register of Historic Places
25	NRWQC	National Recommended Water Quality Criteria
26	NSJCGBA	Northeastern San Joaquin County Groundwater Banking
27		Authority
28	NSPS	New Source Performance Standards
29	NSR	New Source Review
30	NTR	National Toxics Rule
31	NTU	Nephelometric Turbidity Unit
32	NWR	National Wildlife Refuge
33	O <sub>3</sub>	Ozone
34	OBB	Orange Blossom Bridge
35	OBTCC	Oak Bottom Temperature Control Curtain
36	OCAP	Operations Criteria and Plan
37	OEHHA	California Office of Environmental Health Hazard
38		Assessment

1	OFF	Operations and Fishery Forum
2	OID	Oakdale Irrigation District
3	OMR	Old and Middle Rivers
4	OMWD	Olivenhain Municipal Water District
5	OWA	Oroville Wildlife Area
6	P	Phosphorous
7	PAH	Polycyclic Aromatic Hydrocarbons
8	Pb	Lead
9	PBDE	Polybrominated Diphenyl Ethers
10	PBO	Programmatic Biological Opinion
11	PCB	Polychlorinated Biphenyls
12	PCE	Perchloroethylene
13	PCE	Primary Constituent Element
14	PCWA	Placer County Water Agency
15	PDA	Public-Domain Allotments
16	PEIS	Programmatic Environmental Impact Statement
17	PFC	perfluorocarbons
18	PFMC	Pacific Fishery Management Council
19	PG&E	Pacific Gas & Electric Company
20	PHG	Public Health Goal
21	PM	Particulate matter
22	PM <sub>10</sub>	Particulate matter less than 10 microns in aerodynamic
23		diameter
24	PM <sub>2.5</sub>	Particulate matter less than 2.5 microns in aerodynamic
25		diameter
26	POD	Pelagic Organism Decline
27	Porter-Cologne Act	Porter Cologne Water Quality Control Act
28	ppb	Parts per billion (by volume)
29	ppm	Parts per million (by volume)
30	PRC	California Public Records Code
31	Projects	Central Valley Project and State Water Project
32	PSD	Federal Prevention of Significant Deterioration
33	psu	Practical Salinity Unit
34	PTE	Potential To Emit
35	PWD	Palmdale Water District
36	RBDD	Red Bluff Diversion Dam
37	RBPP	Red Bluff Pumping Plant
38	RCWD	Rancho California Water District

## Abbreviations and Acronyms

1	Reclamation	Department of the Interior, Bureau of Reclamation
2	RHNA	Regional Housing Needs Assessment
3	RM	River Mile
4	RMP	Resource Management Plan
5	ROD	Record of Decision
6	ROG	Reactive Organic Gas
7	RPA	Reasonable and Prudent Alternative
8	RPS	California Renewable Portfolio Standard
9	RRDS	Roaring River Distribution System
10	RWQCB	Regional Water Quality Control Board
11	SA	Settlement Agreement
12	SAFCA	Sacramento Area Flood Control Agency
13	SB	Senate Bill
14	SBA	South Bay Aqueduct
15	SBC	Second Basis of Comparison
16	SBCWD	San Benito County Water District
17	SCDD	Spring Creek Debris Dam
18	SCE	Southern California Edison
19	SCI	Sacramento Catch Index
20	SCVWD	Santa Clara Valley Water District
21	SDWA	Safe Drinking Water Act
22	Secretary	Secretary of the Department of the Interior
23	SED	Substitute Environmental Document
24	SEWD	Stockton East Water District
25	SF6	sulfur hexafluoride
26	SGA	Sacramento Groundwater Authority
27	SGMA	California Sustainable Groundwater Management Act
28	Shasta-Trinity LRMP	Shasta-Trinity National Forest Land and
29		Resource Management Plan
30	SHPO	State Historic Preservation Officer
31	SIP	State Implementation Plan
32	SJRRRP	San Joaquin River Restoration Program
33	SJRTC	San Joaquin River Technical Committee
34	SJVAPCD	San Joaquin Valley Air Pollution Control District
35	SLC	State Lands Commission
36	SLE	St. Louis Encephalitis Virus
37	SMP	Suisun Marsh Habitat Management, Preservation,
38		and Restoration Plan



1	SMPA	Suisun Marsh Preservation Agreement
2	SMSCG	Suisun Marsh Salinity Control Gate
3	SMUD	Sacramento Municipal Utilities District
4	SNMP	Salt and Nitrate Management Plan
5	SO <sub>2</sub>	Sulfur Dioxide
6	SO <sub>x</sub>	sulfur oxides
7	SOG	Stanislaus Operations Group (also known as the Stanislaus
8		Operations Team [SOT])
9	SONCC	Southern Oregon/Northern California Coast
10	SRA	State Recreation Area
11	SRCA	Sacramento River Conservation Area
12	SRCD	Suisun Resource Conservation District
13	SRES	Special Report on Emissions Scenarios
14	SRTTG	Sacramento River Temperature Task Group
15	SRWA	Sacramento River Wildlife Area
16	SSC	Species of Special Concern
17	SSJID	South San Joaquin Irrigation District
18	SSWD	South Sutter Water District
19	SWAP	Statewide Agricultural Production Model
20	SWAMP	State Water Resources Control Board Surface Water
21		Ambient Monitoring Program
22	SWG	Smelt Working Group
23	SWP	State Water Project
24	SWPOCO	State Water Project Operations Control Office
25	SWRCB	State Water Resources Control Board
26	TAC	Toxic Air Contaminant
27	TAF	Thousands of acre-feet
28	TBP	Temporary Barrier Project
29	TCAA	Trichloroacetic Acid
30	TCDD	Temperature Control Device
31	TCDD	Tetrachlorodibenzodioxin
32	TCE	Trichloroethylene
33	TDS	Total Dissolved Solids
34	TFCF	Tracy Fish Collection Facility
35	TMDL	Total Maximum Daily Load
36	TOC	Total Organic Carbon
37	tpy	Tons per year
38	TRRP	Trinity River Restoration Program

## Abbreviations and Acronyms

1	TSS	Total Suspended Sediment
2	UCD	University of California, Davis
3	UCCE	University of California Cooperative Extension
4	USACE	U.S. Army Corps of Engineers
5	USC	United States Code
6	USDA	U.S. Department of Agriculture
7	USEPA	U.S. Environmental Protection Agency
8	USFS	U.S. Forest Service
9	USFWS	U.S. Fish and Wildlife Service
10	USFWS BO	U.S. Fish and Wildlife Service 2008 Biological Opinion
11	USGS	U.S. Geological Survey
12	USGVMWD	Upper San Gabriel Valley Municipal Water District
13	UWMP	Urban Water Management Plan
14	VAMP	Vernalis Adaptive Management Program
15	VIC	Variable Infiltration Capacity
16	VOC	Volatile organic compound
17	VVWRA	Victor Valley Wastewater Reclamation Authority
18	WBMWD	Western Basin Municipal Water District
19	WBS	water balance subregion
20	WDCWA	Woodland-Davis Clean Water Agency
21	WEE	Western Equine Encephalitis
22	Western	Western Area Power Administration
23	WMA	Wildlife Management Area
24	WMD	Western Municipal Water District
25	WNV	West Nile Virus
26	WOMT	Water Operations Management Team
27	WQCP	Water Quality Control Plan for the San Francisco
28		Bay/Sacramento–San Joaquin Delta Estuary
29	WR	Water Rights
30	WRESL	water resources simulation language
31	WRO	Water Rights Order
32	WSD	Water Storage District
33	WSRCD	Western Shasta Resource Conservation District
34	WUA	Weighted Useable Area
35	ww	wet weight
36	WY	Water Year

## Abbreviations and Acronyms

1	YCWA	Yuba County Water Agency
2	YOY	Young-of-the-Year
3	Yuba Accord	Lower Yuba River Accord

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## Chapter 1

# 1 Introduction

## 2 1.1 Introduction

3 This Environmental Impact Statement (EIS) on the Coordinated Long-Term  
4 Operation of the Central Valley Project (CVP) and State Water Project (SWP) has  
5 been prepared by the U.S. Department of the Interior, Bureau of Reclamation  
6 (Reclamation). Reclamation is the Federal lead agency for compliance with the  
7 National Environmental Policy Act (NEPA) as ordered by the United States  
8 District Court for the Eastern District of California (District Court). In 2008 and  
9 2009, following litigation on previous Biological Opinion (BOs), Reclamation  
10 provisionally accepted and began implementing the BOs on continued long-term  
11 operation of the CVP, in coordination with the operation of the SWP issued by the  
12 U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries  
13 Service (NMFS), respectively, pursuant to the Federal Endangered Species Act of  
14 1973 (ESA) as amended (United States Code [U.S.C.] 1531 et. seq.). In 2014, the  
15 Ninth Circuit upheld the District Court's ruling that Reclamation's provisional  
16 acceptance and implementation of the BOs required Reclamation to comply with  
17 NEPA. The District Court remanded Reclamation's decision back to the agency  
18 to comply with the court's ruling.

19 This EIS evaluates potential long-term direct, indirect, and cumulative impacts on  
20 the environment that could result from implementation of modifications to the  
21 continued long-term operation of the CVP and SWP. This EIS does not evaluate  
22 impacts related to implementing project-specific actions, such as impacts during  
23 construction and startup periods for actions that are not fully defined at this time  
24 and that may be implemented by Reclamation or other agencies as part of the  
25 long-term operation of the CVP and SWP.

## 26 1.2 Background

27 This chapter presents an overview of the CVP and SWP, the coordinated  
28 operation of the CVP and SWP, and endangered species consultations related to  
29 the long-term operation of the CVP and SWP. The long-term operation of the  
30 CVP and SWP is described in more detail in Chapter 3, Description of  
31 Alternatives; Chapter 5, Surface Water Resources and Water Supplies; and  
32 Appendix 3A, No Action Alternative: Central Valley Project and State Water  
33 Project Operations.

### 34 1.2.1 Overview of the Central Valley Project

35 California initiated a comprehensive water plan for the state more than 100 years  
36 ago to provide water conservation, flood control, water storage, and water  
37 distribution. In 1933, the state legislature, governor, and the electorate approved

1 construction of the CVP. Because of difficulty in marketing bonds to finance  
2 construction, the project could not be constructed by the state, and the Federal  
3 government was requested to construct the CVP.

4 The first Federal authorization of the CVP was by the Rivers and Harbors Act of  
5 August 30, 1935. The CVP was reauthorized for construction, operation, and  
6 maintenance by the Secretary of the Department of the Interior (Secretary),  
7 pursuant to the Reclamation Act of 1902, as amended and supplemented by the  
8 Rivers and Harbors Act of August 26, 1937. The 1937 act also provided that the  
9 dams and reservoirs of the CVP "... be used, first, for river regulation,  
10 improvement of navigation, and flood control; second, for irrigation and domestic  
11 uses; and, third, for power."

12 In 1992, the Central Valley Project Authorization Act of August 26, 1937, was  
13 amended by Section 3406(a) of the Central Valley Project Improvement Act  
14 (CVPIA), Public Law 102-575. The CVPIA modified the 1937 act and specified  
15 that the dams and reservoirs of the CVP be used "first, for river regulation,  
16 improvement of navigation, and flood control; second for irrigation and domestic  
17 uses and fish and wildlife mitigation, protection and restoration purposes; and  
18 third for power and fish and wildlife enhancement."

19 The CVP is composed of more than 18 reservoirs with a combined storage  
20 capacity of more than 11 million acre-feet, more than 10 hydroelectric power  
21 plants, and more than 500 miles of major canals and aqueducts (Figure 1.1 at the  
22 end of this chapter). The major CVP reservoirs are in the Sacramento-San  
23 Joaquin Rivers Delta Estuary (Delta) watershed, including Shasta Lake on the  
24 Sacramento River, Folsom Lake on the American River, New Melones Reservoir  
25 on the Stanislaus River, and Millerton Lake on the San Joaquin River. The CVP  
26 also diverts water from Trinity Lake (on the Trinity River) to the Sacramento  
27 River system. CVP pumping plants and canals include the Red Bluff Pumping  
28 Plant, which diverts water from the Sacramento River into the CVP Tehama-  
29 Colusa Canal; Folsom South Canal, which conveys water from Folsom Lake to  
30 southeastern Sacramento County; Contra Costa Canal Pumping Plant, which  
31 diverts water from Rock Slough in the Delta into the CVP Contra Costa Canal;  
32 and Jones Pumping Plant, which diverts water from the south Delta into the CVP  
33 Delta-Mendota Canal (DMC).

34 These facilities are generally operated as an integrated project, although they are  
35 authorized and categorized in more distinct units or divisions. However, not all  
36 facilities are operated to meet each of the above-identified project purposes. For  
37 example, flood control is not an authorized purpose of the CVP Trinity River  
38 Division.

39 The facilities, operational criteria and constraints, and authorizations of the CVP  
40 are described in Chapter 5, Surface Water Resources and Water Supplies.

### 41 **1.2.2 Overview of the State Water Project**

42 After World War II, California's population almost doubled, and more water was  
43 needed. In addition, devastating floods occurred in northern and central

1 California in the 1950s. To provide more reliable water supplies and reduce the  
 2 flood risk in the Sacramento Valley, the state legislature appropriated funds to the  
 3 California Department of Water Resources (DWR) to construct the SWP under  
 4 the State Central Valley Project Act (Water Code Section 11100 et seq.), Burns-  
 5 Porter Act (California Water Resources Development Bond Act), State Contract  
 6 Act (Public Contract Code Section 10100 et seq.), Davis-Dolwig Act (Water  
 7 Code Sections 11900 through 11925), and other acts of the state legislature. The  
 8 plans for the SWP included a reservoir on the Feather River near Oroville (Lake  
 9 Oroville), a Delta cross channel, an electric power transmission system, an  
 10 aqueduct to convey water from the Delta to Solano and Napa counties (North Bay  
 11 Aqueduct), an aqueduct to convey water from the Delta to the San Francisco Bay  
 12 Area (South Bay Aqueduct and a reservoir in Alameda County), an aqueduct  
 13 (California Aqueduct) with the San Luis Dam to convey water from the Delta to  
 14 the San Joaquin Valley and southern California, and several reservoirs in southern  
 15 California.

16 DWR is required to plan for recreational and fish and wildlife uses of water in  
 17 connection with the SWP and other state-constructed water projects (Water Code  
 18 Sections 233, 345, 346, 12582). The Davis-Dolwig Act (Water Code  
 19 Sections 11900 through 11925) established the policy that preservation of fish and  
 20 wildlife is part of state costs to be paid by SWP water supply contractors, and  
 21 recreation and enhancement of fish and wildlife are to be provided by  
 22 appropriations from the General Fund.

### 23 **1.2.3 Coordinated Operation of the CVP and SWP**

24 The CVP and SWP are operated in a coordinated manner in accordance with  
 25 Public Law 99-546 (October 27, 1986), directing the Secretary to execute the  
 26 Coordinated Operation Agreement (COA). The CVP and SWP are also operated  
 27 under State Water Resources Control Board (SWRCB) decisions and water right  
 28 orders related to the CVP's and SWP's water right permits and licenses to  
 29 appropriate water by diverting to storage, by directly diverting to use, or by  
 30 re-diverting releases from storage later in the year or in subsequent years.

31 The CVP and SWP are permitted by SWRCB to store water, divert water and  
 32 re-divert CVP and SWP water that has been stored in upstream reservoirs. The  
 33 CVP and SWP have built water storage and water delivery facilities in the Central  
 34 Valley to deliver water supplies to CVP and SWP contractors, including senior  
 35 water users. The CVP's and SWP's water rights are conditioned by the SWRCB  
 36 to protect the beneficial uses of water within the watersheds.

37 As conditions of the water right permits and licenses, SWRCB requires the CVP  
 38 and SWP to meet specific water quality objectives within the Delta. Reclamation  
 39 and DWR coordinate operation of the CVP and SWP, pursuant to the COA, to  
 40 meet these and other operating requirements. The COA is an agreement between  
 41 the Federal government and the State of California for the coordinated operation  
 42 of the CVP and SWP. The agreement suspended a 1960 agreement and  
 43 superseded annual coordination agreements that had been implemented following  
 44 construction of the SWP.

1 The COA established the operating framework for the CVP and SWP based upon  
2 conditions in the 1980s, by setting forth: (1) definitions of the CVP and SWP  
3 facilities and their water supplies, (2) procedures for coordination of operations,  
4 (3) formulas for sharing joint responsibilities for meeting Delta standards and  
5 ensuring no injury to other legal uses of water, (4) criteria for sharing unstored  
6 flow in the Delta, (5) a framework for exchange of water and services between the  
7 SWP and CVP, and (6) provisions for periodic reviews. Coordinated operation by  
8 agreed-on criteria can increase the efficiency of both the CVP and the SWP.

9 Implementation of the COA has evolved continually since 1986 as CVP and SWP  
10 facilities, operational criteria, and physical and regulatory environment have  
11 changed. For example, adoption of the CVPIA in 1992 changed purposes and  
12 operations of the CVP, and ESA responsibilities have affected operation of the  
13 CVP and SWP. Since 1986, facilities operations have been modified in response  
14 to statutory and regulatory requirements that were not part of the original COA  
15 assumptions or requirements. In addition, water quality objectives have been  
16 revised by the SWRCB since 1986 in the 1995 and 2006 Water Quality Control  
17 Plans and implemented through SWRCB Decision 1641. DWR and Reclamation  
18 have operational arrangements to accommodate new facilities, water quality  
19 objectives, the CVPIA, other SWRCB criteria, and the ESA, but the COA has not  
20 been formally modified to address these newer operating conditions.

#### 21 **1.2.4 Federal Endangered Species Consultation**

22 In addition to the conditions and limitations imposed by the SWRCB on the water  
23 rights permits and licenses for the CVP and SWP, Federal agencies have an  
24 obligation pursuant to Section (7a)(2) of the ESA to determine that any  
25 discretionary action authorized, funded, or carried out by the agency is not likely  
26 to jeopardize the continued existence of endangered or threatened species or result  
27 in the destruction or adverse modification of their critical habitat [16 U.S.C. 1536  
28 (a)(2)]. A discretionary agency action jeopardizes the continued existence of a  
29 listed species if the action is reasonably expected to directly or indirectly  
30 appreciably reduce the likelihood of both the survival and recovery of a listed  
31 species in the wild by reducing the reproduction, numbers, or distribution of the  
32 listed species (50 Code of Federal Regulations [CFR] 402.02).

33 In carrying out its obligations, Reclamation must consult with the appropriate  
34 regulatory agency or agencies (e.g., USFWS and NMFS) when an action may  
35 affect listed species. After the formal consultation process, those agencies render  
36 written statements (Biological Opinions or BOs) setting forth their opinion as to  
37 effects of the agency action on listed species and its designated critical habitat. If  
38 these agencies conclude that the action will jeopardize the continued existence of  
39 a listed species or result in the destruction or adverse modification of their  
40 designated critical habitat, they must suggest a Reasonable and Prudent  
41 Alternative (or RPA) to the agency action if one exists. As defined in the ESA,  
42 RPAs “refer to alternative actions identified during formal consultation that can  
43 be implemented in a manner consistent with the intended purpose of the action,  
44 that can be implemented consistent with the scope of the Federal agency’s legal  
45 authority and jurisdiction, that is economically and technologically feasible, and



1 that the Director believes would avoid the likelihood of jeopardizing the  
 2 continued existence of listed species or resulting in the destruction or adverse  
 3 modification of critical habitat” (40 CFR 402.02).

4 If the SWP seeks to avail itself of the incidental take exemption provided by the  
 5 BOs, the coordinated long-term operation of the SWP would be subject to the  
 6 BOs, including any reasonable and prudent measures, terms and conditions, or  
 7 RPAs required by the BOs.

8 **1.2.4.1 Threatened and Endangered Species Considered in ESA**  
 9 **Consultation for Coordinated Long-Term Operation of the CVP**  
 10 **and SWP**

11 The following species, and their associated ESA and critical habitat listing rules,  
 12 were considered in recent ESA consultations with USFWS and NMFS for the  
 13 coordinated long-term operation of the CVP and SWP analysis in this document:

- 14 • Sacramento River winter-run Chinook Salmon (*Oncorhynchus tshawytscha*)  
 15 Evolutionarily Significant Unit (ESU) was originally listed as threatened in  
 16 August 1989, under emergency provisions of the ESA, and formally listed as  
 17 threatened in November 1990 (55 FR 46515). They were re-classified as an  
 18 endangered species on January 4, 1994 (59 FR 440).
- 19 • Central Valley spring-run Chinook Salmon (*O. tshawytscha*) ESU was listed  
 20 as threatened on June 18, 2005 (70 FR 37160).
- 21 • Central Valley Steelhead (*O. mykiss*) Distinct Population Segment (DPS) was  
 22 listed as threatened on January 5, 2006 (71 FR 834).
- 23 • Southern Oregon/Northern California Coast Coho Salmon (*O. kisutch*) ESU  
 24 was reaffirmed as threatened on June 18, 2005 (70 FR 37160).
- 25 • Southern DPS of the North American Green Sturgeon (*Acipenser medirostris*)  
 26 was listed as threatened on June 6, 2006 (71 FR 17757).
- 27 • Southern Resident DPS of Killer Whales (*Orcinus orca*) was listed as  
 28 endangered on November 18, 2005 (70 FR 69903-69912).
- 29 • Delta Smelt (*Hypomesus transpacificus*) was listed as threatened on  
 30 March 5, 1993 (58 FR 12854). The species was recently proposed for  
 31 re-listing as endangered under the ESA.

32 Fall and late-fall runs of Chinook Salmon are currently Federal Species of  
 33 Concern, but have not been formally listed.

34 Central California Coast Steelhead (*O. mykiss*) DPS was listed as threatened on  
 35 January 5, 2006 (71 FR 834). The 2009 NMFS BO determined that the long-term  
 36 operation of the CVP and SWP would not likely adversely affect Central  
 37 California Coast Steelhead DPS and its critical habitat. Therefore, no further  
 38 analysis of this DPS was performed for this EIS.

1     **1.2.4.2     Recent ESA Consultation Activities and Court Rulings**

2     Reclamation submitted a biological assessment to USFWS and NMFS for  
3     consultation on the long-term operation of the CVP and SWP in June 2004.  
4     Because SWP operations are coordinated with CVP operations, SWP operations  
5     are included in Reclamation’s action. NMFS has responsibility for anadromous  
6     fish and marine mammals, and USFWS has jurisdiction over all other ESA listed  
7     species.

8     In July 2004, USFWS issued its BO “Formal and Early Section 7 Endangered  
9     Species Consultation on the Coordinated Operations of the Central Valley Project  
10    and State Water Project and the Operations Criteria and Plan to Address Potential  
11    Critical Habitat Issues.” In February 2005, USFWS issued the “Re-Initiation of  
12    Formal and Early Section 7 Endangered Species Consultation on the Coordinated  
13    Operations of the Central Valley Project and State Water Project and the  
14    Operational Criteria and Plan to Address Potential Critical Habitat Issues.”

15    On October 22, 2004, NMFS issued its “Biological Opinion and Conference  
16    Opinion on the Long-Term Operations of the Central Valley Project and State  
17    Water Project.”

18    On April 26, 2006, Reclamation requested that the NMFS consultation be  
19    re-initiated based on the new listing of the Southern DPS of the North American  
20    Green Sturgeon. On May 19, 2006, Reclamation requested that the USFWS  
21    consultation be re-initiated because of the potential for the re-initiation of the  
22    NMFS consultation to affect the Delta Smelt and because of recently compiled  
23    data related to the pelagic organism decline.

24    Following the issuance of the 2004 and 2005 BOs, litigation was filed against the  
25    Department of the Interior and the Department of Commerce challenging the  
26    validity of these BOs. Following a finding that the CVP/SWP operation analyzed  
27    in the 2005 BO jeopardized the continued existence of Delta Smelt, on  
28    December 14, 2007, the District Court issued an Interim Remedial Order in  
29    *Natural Resources Defense Council, et al. v. Kempthorne*, 1:05-cv-1207 OWW  
30    GSA (E.D. Cal. 2007), to provide additional protection for Delta Smelt pending  
31    completion of a new USFWS BO for the continued long-term operation of the  
32    CVP and SWP. The Interim Remedial Order remained in effect until USFWS  
33    issued a new BO for the continued long-term operation of the CVP and SWP on  
34    December 15, 2008.

35    On April 16, 2008, the District Court issued a Memorandum Decision and Order  
36    on the Cross-Motions for Summary Judgment filed in *Pacific Coast Federation of*  
37    *Fishermen’s Associations, et al. v. Gutierrez*, 1:06-cv-245-OWW-GSA (E.D.  
38    Cal. 2008). The District Court found that the BO issued by NMFS in 2004 was  
39    invalid. An evidentiary hearing followed, resulting in a Remedies Ruling on  
40    July 18, 2008. The ruling concluded that the District Court needed further  
41    evidence to consider the Plaintiffs’ proposed restrictions on the long-term  
42    coordinated CVP and SWP operation.

43    In August 2008, Reclamation submitted a biological assessment to USFWS and  
44    NMFS for consultation.

1 On December 15, 2008, USFWS issued a BO analyzing the effects of the  
 2 coordinated long-term operation of the CVP and SWP on Delta Smelt and its  
 3 designated critical habitat. The 2008 USFWS BO concluded that “the  
 4 coordinated operation of the CVP and SWP, as proposed, [was] likely to  
 5 jeopardize the continued existence of the Delta Smelt” and “adversely modify  
 6 Delta Smelt critical habitat.” The BO included an RPA for long-term operation  
 7 of the CVP and SWP designed to allow the projects to continue operating without  
 8 causing jeopardy to Delta Smelt or adverse modification of designated critical  
 9 habitat.

10 On December 15, 2008, Reclamation provisionally accepted and began  
 11 implementing the USFWS RPA.

12 On June 4, 2009, NMFS issued a BO analyzing the effects of the coordinated  
 13 long-term operation of the CVP and SWP on listed salmonids, Green Sturgeon,  
 14 and southern resident Killer Whale and their designated critical habitats. The  
 15 NMFS BO concluded that the long-term operation of the CVP and SWP, as  
 16 proposed, was likely to jeopardize the continued existence of Sacramento River  
 17 winter-run Chinook Salmon, Central Valley spring-run Chinook Salmon, Central  
 18 Valley Steelhead, Southern DPS of North American Green Sturgeon, and  
 19 Southern Resident Killer Whales. Further, the BO concluded that the proposed  
 20 action would destroy or adversely modify critical habitat for Sacramento River  
 21 winter-run Chinook Salmon, Central Valley spring-run Chinook Salmon, Central  
 22 Valley Steelhead, and Southern DPS of North American Green Sturgeon.

23 The 2009 NMFS BO included an RPA designed to allow the CVP and SWP to  
 24 continue operating without causing jeopardy to the analyzed species or adverse  
 25 modification of their designated critical habitat. On June 4, 2009, Reclamation  
 26 provisionally accepted and began implementing the NMFS RPA.

27 Several lawsuits were filed in the District Court challenging aspects of the 2008  
 28 USFWS BO and the 2009 NMFS BO and Reclamation’s acceptance and  
 29 implementation of the associated RPAs. Many of the lawsuits were consolidated  
 30 into two proceedings focused on each BO. The outcomes of the *Consolidated*  
 31 *Delta Smelt Cases* and the *Consolidated Salmonid Cases* are summarized below.

32 • *Consolidated Delta Smelt Cases*

33 – On November 16, 2009, the District Court ruled that Reclamation violated  
 34 NEPA by failing to conduct a NEPA review of the potential impacts on  
 35 the human environment before provisionally accepting and implementing  
 36 the 2008 USFWS BO, including the RPA.

37 – On December 14, 2010, the District Court found certain portions of the  
 38 2008 USFWS BO to be arbitrary and capricious in several respects and  
 39 remanded those portions of the BO to USFWS without vacatur for further  
 40 consideration. The District Court ordered Reclamation to review its  
 41 decision to provisionally accept and implement the BO and RPA in  
 42 accordance with NEPA.

- 1       – The decision of the District Court related to the USFWS BO was appealed  
2       to the United States Court of Appeals for the Ninth Circuit (Appellate  
3       Court). On March 13, 2014, the Appellate Court reversed the District  
4       Court and upheld the BO. However, the Appellate Court affirmed the  
5       judgment of the District Court with respect to the NEPA claims.
- 6       – The District Court amended the Judgment on September 30, 2014  
7       consistent with the Appellate Court’s decision. Petitions for Writ of  
8       Certiorari were submitted to the U.S. Supreme Court; however, the U.S.  
9       Supreme Court decided to not hear the cases.
- 10      • *Consolidated Salmonid Cases*
- 11      – On March 5, 2010, the District Court ruled that Reclamation violated  
12      NEPA by failing to undertake a NEPA analysis of potential impacts on the  
13      human environment before provisionally accepting and implementing the  
14      2009 NMFS BO and RPA.
- 15      – On September 20, 2011, the District Court found the NMFS BO was  
16      arbitrary and capricious in several respects and remanded the 2009 NMFS  
17      BO to NMFS without vacatur for further consideration.
- 18      – The decisions of the District Court related to the 2009 NMFS BO were  
19      appealed to the Appellate Court. On December 22, 2014, the Appellate  
20      Court reversed the District Court and upheld the BO.
- 21      – The District Court issued the Final Order on May 5, 2015 consistent with  
22      the Appellate Court’s Decision.

### 23      **1.3        Need to Prepare this Environmental Impact** 24      **Statement**

25      Compliance with NEPA is a Federal responsibility and involves the participation  
26      of Federal, state, tribal, and local agencies, as well as concerned and affected  
27      members of the public in the planning process. NEPA requires that Federal  
28      agencies analyze and disclose the potential environmental impacts and possible  
29      mitigation for Federal actions and a reasonable range of alternatives to the  
30      proposed action. NEPA is required when a discretionary Federal action is  
31      proposed. The regulations [40 CFR 1508.18(a)] define a Federal action as  
32      including new and continuing activities, actions partly or entirely financed by  
33      Federal agencies (where some control and responsibility over the action remain  
34      with the Federal agency [43 CFR 46.100]), actions conducted by Federal  
35      agencies, actions approved by Federal agencies, new or revised agency rules or  
36      regulations, and proposals for legislation.

37      Section 102 of NEPA (42 U.S.C. 4332) indicates that a detailed analysis, such as  
38      an EIS, should be completed with proposals for Federal actions that substantially  
39      affect the quality of the human environment, including the natural and physical

1 environment and the relationship of people with that environment (40 CFR  
2 1508.14).

3 To comply with the District Court’s 2010 orders regarding NEPA, Reclamation  
4 initiated preparation of this EIS in 2011. This EIS documents Reclamation’s  
5 analysis of the effects of modifications to the coordinated long-term operation of  
6 the CVP and SWP that are likely to avoid jeopardy to listed species and  
7 destruction or adverse modification of designated critical habitat.

8 In accordance with the District Court’s order in the *Consolidated Delta Smelt*  
9 *Cases*, the Final EIS and Record of Decision are to be completed on or before  
10 December 1, 2015. By order dated October 8, 2015, this date has been extended  
11 to January 12, 2016.

12 As described in Chapter 3, Description of Alternatives, many of the provisions of  
13 the RPAs, as set forth in the 2008 USFWS BO and the 2009 NMFS BO, require  
14 further study, monitoring, further consultation, implementation of adaptive  
15 management programs, and subsequent environmental documentation for future  
16 facilities to be constructed or modified. Specific actions related to these  
17 provisions are not known at this time. Therefore, this EIS assumes the  
18 completion of future actions, including provisions of the RPAs, in a manner that  
19 would be consistent with the ESA and does not address impacts during  
20 construction and startup phases of these actions.

## 21 **1.4 Use of the Environmental Impact Statement**

22 This EIS may be used by Reclamation or cooperating agencies that are  
23 participating in the preparation of this EIS to inform future decisions related to the  
24 ESA consultation and implementation of the RPAs in the 2008 USFWS BO and  
25 2009 NMFS BO. A cooperating agency is defined as any Federal agency, except  
26 the NEPA lead agency, that has jurisdiction by law or has special expertise with  
27 respect to any environmental issue that should be addressed in the EIS  
28 (40 CFR 1501.6). A cooperating agency also can include a governmental entity  
29 (state, tribal, or local) that has jurisdiction by law or special expertise with respect  
30 to any environmental impact associated with the action being considered. The  
31 cooperating agencies for this EIS are listed in Section 1.6.

## 32 **1.5 Proposed Action and Preferred Alternative**

33 The Notice of Intent identified an “initial Proposed Action” that included the  
34 operational actions of the 2008 USFWS BO and 2009 NMFS BO, without  
35 structural changes included in the RPA actions that would require future studies  
36 and environmental documentation to define recommended actions, including fish  
37 passage around the CVP dams. The initial Proposed Action is included in this  
38 EIS as Alternative 2.

1 Based upon the analysis of aquatic resources (see Chapter 9, Fish and Aquatic  
2 Resources), by 2030, climate change may result in substantially higher air  
3 temperatures than during recent conditions. Higher air temperatures would likely  
4 increase water temperatures in both the CVP reservoirs and in the rivers  
5 downstream of the CVP dams. Under these conditions, Reclamation may not be  
6 able to operate the reservoirs under the initial Proposed Action without fish  
7 passage in a manner that would meet water temperature objectives; and it may not  
8 be possible to avoid jeopardizing the continued existence of listed species and/or  
9 resulting in an adverse modification of critical habitat.

10 Based upon the results of the impact analyses presented in Chapters 5 through 21  
11 of this EIS, the Preferred Alternative is the No Action Alternative. The No  
12 Action Alternative contains all of the RPA actions in the 2008 USFWS BO and  
13 2009 NMFS BO, as amended, including the RPA actions to evaluate fish passage  
14 to upstream habitats that exhibit lower water temperatures. Further discussion of  
15 the selection of the Preferred Alternative will be included in the Record of  
16 Decision.

17 The Environmentally Preferred Alternative also will be identified and disclosed in  
18 the Record of Decision, as required by the Council of Environmental Quality  
19 regulations.

## 20 **1.6 Project Area**

21 The project area boundaries are defined by the locations of most of the CVP  
22 facilities and their service areas and all of the SWP facilities and the SWP service  
23 areas, as shown on Figure 1.1. The CVP facilities associated with Millerton Lake,  
24 including the Madera and Friant-Kern canals and their service areas, and the San  
25 Joaquin River Restoration Program are not part of the project area for this EIS  
26 because the operations of these facilities were not addressed in the 2008 USFWS  
27 BO and 2009 NMFS BO.

### 28 **1.6.1 CVP Facilities**

29 The CVP facilities evaluated in this EIS include reservoirs on the Trinity,  
30 Sacramento, American, and Stanislaus rivers; Mendota Pool on the San Joaquin  
31 River; rivers, streams, canals, and aqueducts used to convey CVP water; and the  
32 CVP service area that relies upon water from the following reservoirs (as  
33 described in Chapter 5, Surface Water Resources and Water Supplies, and  
34 Appendix 3A, No Action Alternative: Central Valley Project and State Water  
35 Project Operations).

- 36 • A portion of the water from Trinity River is stored and re-regulated in Trinity  
37 Lake, Lewiston Lake, and Whiskeytown Reservoir and diverted through  
38 tunnels and power plants into the Sacramento River. Water is also stored and  
39 re-regulated in Shasta Lake and Folsom Lake. Water from these reservoirs  
40 and other reservoirs owned or operated by the CVP flows into the Sacramento  
41 River. The Red Bluff Pumping Plant on the Sacramento River lifts water into

1 the Tehama Colusa Canal for delivery to CVP contractors. Water also is  
 2 delivered from the Sacramento River, American River, and the Folsom South  
 3 Canal to CVP contractors, water rights holders, and settlement contractors.

- 4 • The Sacramento River conveys water to the Delta for delivery through the  
 5 Contra Costa Canal and Jones Pumping Plant. The Contra Costa Canal  
 6 originates at Rock Slough near Oakley and extends to the Martinez Reservoir.  
 7 Water from the Contra Costa Canal is delivered to the Contra Costa Water  
 8 District. The Jones Pumping Plant at the southern end of the Delta lifts the  
 9 water into the DMC. This canal delivers water to CVP contractors, who  
 10 divert water directly from the DMC, and to San Joaquin River exchange  
 11 contractors, who divert directly from the San Joaquin River and the Mendota  
 12 Pool. CVP water is also conveyed to the San Luis Reservoir for deliveries to  
 13 CVP contractors through the San Luis Canal. Water from the San Luis  
 14 Reservoir is also conveyed through the Pacheco Tunnel to CVP contractors in  
 15 Santa Clara and San Benito counties.
- 16 • The CVP provides water stored in New Melones Reservoir for water rights  
 17 holders in the Stanislaus River watershed and CVP contractors in the northern  
 18 San Joaquin Valley and to meet existing water right permit conditions to  
 19 support fish and wildlife and water quality beneficial uses.

20 The project area includes portions of the watersheds upstream of the CVP  
 21 reservoirs that support anadromous fish species, as addressed in the NMFS BO,  
 22 and the service areas of CVP water users in the Trinity River Region, Sacramento  
 23 and San Joaquin valleys in the Central Valley Region, and the San Francisco-Bay  
 24 Area Region.

### 25 **1.6.2 SWP Facilities**

26 The SWP facilities evaluated in this EIS include Lake Oroville on the Feather  
 27 River; rivers, streams, canals, and aqueducts used to convey SWP water; and the  
 28 SWP service area that relies upon water from these reservoirs including:

- 29 • SWP water is stored and re-regulated in Lake Oroville and released into the  
 30 Feather River, which flows into the Sacramento River. Water also is  
 31 delivered from the Feather River to SWP contractors, water rights holders,  
 32 and settlement contractors.
- 33 • SWP water flows in the Sacramento River to the Delta and is exported from  
 34 the Delta at the Banks Pumping Plant. The Banks Pumping Plant pumps the  
 35 water into the California Aqueduct, which delivers water to the SWP  
 36 contractors and conveys water to the San Luis Reservoir for continued  
 37 delivery in the California Aqueduct to the San Joaquin Valley, Central Coast  
 38 Region, and southern California.
- 39 • The SWP provides water from the Delta to Solano and Napa counties through  
 40 the North Bay Aqueduct and to Alameda and Santa Clara counties through the  
 41 South Bay Aqueduct (including Lake Del Valle).

- 1 • The SWP provides water from the Delta to the Central Coast Region through  
2 the Coastal Branch Aqueduct.
  - 3 • The SWP provides water from the Delta to southern California through the  
4 California Aqueduct (including Quail, Pyramid, Castaic, Silverwood, and  
5 Perris lakes).
  - 6 • The SWP delivers water to the Cross-Valley Canal, when the systems have  
7 capacity, for CVP contractors.
- 8 The project area includes the service areas in the Sacramento and San Joaquin  
9 valleys in the Central Valley Region as well as the San Francisco-Bay Area,  
10 Central Coast, and Southern California regions.

## 11 **1.7 Study Period**

12 The coordinated long-term operation of the CVP and SWP, as described in this  
13 EIS, is assumed to continue to at least 2030 before CVP and SWP operations  
14 would change. These changes could include projects considered as part of the  
15 cumulative effects analyses, as described in Chapter 3, Description of  
16 Alternatives. Therefore, this EIS analyzes future conditions projected for 2030.  
17 It is recognized that many changes between existing conditions and 2030  
18 conditions would occur without changes to CVP and SWP operations, including:

- 19 • Land use changes will occur in the Delta watershed as growth occurs as  
20 projected in local agency general plans. Much of this growth is expected in  
21 the service areas of water users with water rights that may be senior to the  
22 CVP and SWP or within the Sacramento Valley, and municipal and industrial  
23 CVP contractors will increase water demands for population growth as  
24 described in the general plans. These actions could reduce the available water  
25 supplies for use by the CVP and SWP. This EIS assumes that this growth will  
26 occur by 2030. Therefore, the effects of land use changes by 2030 will be  
27 similar in the comparison of all alternatives.
- 28 • Climate change could change CVP and SWP water supplies if the amount of  
29 snow decreases and the amount of rain either decreases or occurs within a  
30 shorter period and limits the amount of water captured in reservoirs. Sea-level  
31 rise would increase salinity in the western, central, and southern Delta, which  
32 could limit the time when CVP and SWP divert water. These actions could  
33 reduce the available water supplies for use by the CVP and SWP. Federal and  
34 state agencies have completed numerous studies that project future climate  
35 change and sea-level rise scenarios. The specific characteristics of climate  
36 change and sea-level rise are not defined at this time because this EIS includes  
37 only qualitative analyses. All of the alternatives, including the No Action  
38 Alternative, evaluated in this EIS include the same assumptions for climate  
39 change and sea-level rise. Therefore, the effects of climate change and  
40 sea-level rise will be similar in the comparison of all alternatives.



1 • Numerous studies are being prepared by Federal, state, and local agencies to  
 2 evaluate implementation of storage projects in the Delta watershed, Delta  
 3 conveyance, Delta ecosystem restoration, Delta water quality improvement  
 4 through construction of treatment facilities for discharges into the Delta, and  
 5 changes to the SWRCB Water Quality Control Plan. As described in Chapter  
 6 3, Description of Alternatives, most of those studies have not been completed.  
 7 However, many of the facilities recommended by those studies are expected to  
 8 be constructed and operational by 2030. Therefore, the effects of  
 9 implementation of those facilities will be similar in the comparison of all  
 10 alternatives.

11 As the changing conditions described above and other future changes occur,  
 12 changes in long-term operation of the CVP and SWP may be required. This may  
 13 require the re-initiation of consultation on the 2008 USFWS BO and 2009 NMFS  
 14 BO. Therefore, because the above-described changes in conditions are likely to  
 15 occur by 2030 and because new BOs would be required, this EIS considers a  
 16 study period that concludes in 2030.

## 17 **1.8 Participants in Preparation of the EIS**

18 For this EIS, Reclamation is the Federal lead agency. The Federal cooperating  
 19 agencies include USFWS, NMFS, U.S. Environmental Protection Agency, U.S.  
 20 Army Corps of Engineers, and Bureau of Indian Affairs.

21 Reclamation also provided non-federal agencies with the opportunity to  
 22 participate in the NEPA process if they qualified under NEPA (as described  
 23 above) as a cooperating agency. In August 2012, Reclamation invited  
 24 747 non-federal entities to be cooperating agencies for this EIS, including:

- 25 • DWR
- 26 • SWRCB
- 27 • California Department of Fish and Wildlife
- 28 • Agencies that have contracts with the CVP or SWP for water delivery, water  
 29 service repayment, exchange or settlement, or use of CVP or SWP facilities  
 30 for conveyance
- 31 • State and Federal Contractors Water Agency
- 32 • Cities and counties within the CVP and SWP service areas
- 33 • Federally recognized tribes within the CVP and SWP service areas or areas  
 34 affected by long-term operation of the CVP and SWP

35 Non-federal entities that meet the specified criteria for cooperating agencies are  
 36 required to enter into a Memorandum of Understanding (MOU) [43 CFR  
 37 46.225(d)] with Reclamation. The MOU provides a framework for cooperating  
 38 agencies to agree to their respective roles, responsibilities, and limitations,  
 39 including, as appropriate, target schedules.

1 Reclamation has signed cooperating agency MOUs with the following entities:

- 2 • Anderson-Cottonwood Irrigation District
- 3 • California Department of Water Resources
- 4 • California Valley Miwok Tribe
- 5 • City of Hesperia
- 6 • Contra Costa Water District
- 7 • East Bay Municipal Utility District
- 8 • Friant Water Authority
- 9 • Glenn-Colusa Irrigation District
- 10 • Metropolitan Water District of Southern California
- 11 • Oakdale Irrigation District
- 12 • Reclamation District 108
- 13 • San Diego County Water Authority
- 14 • San Juan Water District
- 15 • San Luis & Delta-Mendota Water Authority
- 16 • Santa Clara Valley Water District
- 17 • Tehama Colusa Canal Authority
- 18 • Stockton East Water District
- 19 • Sutter Mutual Water District
- 20 • Zone 7 Water Agency

21 Reclamation also received a request from an interested party to include the  
22 Federal Emergency Management Agency (FEMA) as a cooperating agency.  
23 However, Reclamation concluded that FEMA does not meet the requirements for  
24 being a cooperative agency in accordance with Section 1501.6 of NEPA for a  
25 “Federal agency which has special expertise related to environmental issues,  
26 which should be addressed in the statement” and beyond that which could not be  
27 addressed by other cooperating Federal agencies.

### 28 **1.8.1 Stakeholder and Public Involvement during Preparation of** 29 **the EIS**

30 The scoping process was initiated on March 28, 2012, with the publication of the  
31 Notice of Intent in the Federal Register (FR) and continued through  
32 June 28, 2012. Initially, the public scoping process was to be completed on  
33 May 29, 2012. During the public scoping process, other agencies and interested  
34 persons requested an extension of the public scoping process to allow additional  
35 opportunities to provide scoping comments. In response to these requests,  
36 Reclamation published a notice on May 25, 2012, extending the public scoping  
37 period through June 28, 2012.

38 Scoping meetings were held to inform the public and interested stakeholders  
39 about the project and to solicit comments and input on the EIS. The scoping  
40 meetings were held in the following locations and resulted in the following level  
41 of public participation:

- 42 • Madera on April 25, 2012 (6 participants)

- 1 • Diamond Bar on April 26, 2012 (3 participants)
- 2 • Sacramento on May 2, 2012 (15 participants)
- 3 • Marysville on May 3, 2012 (2 participants)
- 4 • Los Banos on May 22, 2012 (230 participants)

5 Reclamation posted the scoping notices in the FR, on its website, and in  
6 newspapers that served areas where the scoping meetings were held. Reclamation  
7 also published press releases to news organizations and others that have requested  
8 notifications for all press releases.

9 Scoping comments were used in the development of a reasonable range of  
10 alternatives and identification of key issues that would require analysis in the  
11 Environmental Consequences sections of this EIS, as described in Chapter 3,  
12 Description of Alternatives, and Chapter 23, Consultation, Coordination, and  
13 Cooperation.

14 Reclamation also posted on its website an initial range of alternatives discussed at  
15 a stakeholders meeting on October 19, 2012. As described in Chapter 3,  
16 Description of Alternatives, comments received during that process were used to  
17 refine the description of the alternatives.

18 Project status meetings were held with cooperating agencies and other  
19 stakeholders during preparation of the Draft EIS, including meetings in  
20 Sacramento on January 16, May 29, and November 5, 2014; and February 20 and  
21 June 24, 2015.

## 22 **1.8.2 Stakeholder and Public Involvement during Preparation of** 23 **the Final EIS**

24 The Draft EIS was published for public review in July 2015. The distribution list  
25 for the Public Draft EIS is included in Chapter 24. Reclamation posted  
26 notification of the availability of the Public Draft EIS and the location and timing  
27 of public hearing(s) on its website, in the FR, and through press releases.

28 Four public meetings were held during the public review period for the Draft EIS  
29 in the following locations, with the following level of participation:

- 30 • Sacramento on September 9, 2015 (9 participants)
- 31 • Red Bluff on September 10, 2015 (9 participants)
- 32 • Los Banos on Tuesday, September 15, 2015 (9 participants)
- 33 • Irvine on September 17, 2015 (2 participants)

34 Approximately 860 written and verbal comments were received on the Draft EIS.  
35 All of the comments received on the Draft EIS were considered in preparation of  
36 the Final EIS. Written responses to all substantive comments received are  
37 included in Appendices 1A through 1E of the Final EIS.

## 1 **1.9 Related Projects and Activities**

2 Because the EIS study area is large, many activities and studies that are currently  
3 ongoing or planned for the near future could be affected by the findings of the EIS  
4 or are related actions of long-term operation of the CVP and SWP. Preliminary  
5 information from these studies and projects has been used to describe the No  
6 Action Alternative or to assess cumulative impacts of implementing alternatives  
7 evaluated in this EIS. Some of these projects are adjacent to, but not specifically  
8 part of the Study Area (e.g., San Joaquin River Restoration Program). However,  
9 these projects have been included in the cumulative effects analysis because of  
10 indirect effects on the Study Area. The following studies and projects are  
11 summarized in Chapter 3, Description of Alternatives, as either part of the No  
12 Action Alternative or the cumulative effects analyses:

- 13 • Trinity River Restoration Program
- 14 • Continued Implementation of the Central Valley Project Improvement Act  
15 Provisions
- 16 • Clear Creek Mercury Abatement and Fisheries Restoration Project
- 17 • Iron Mountain Mine Superfund Site
- 18 • Mainstem Sacramento River, American River, and Stanislaus River Gravel  
19 Augmentation Program
- 20 • Nimbus Fish Hatchery Fish Passage Project
- 21 • Folsom Dam Water Control Manual Update
- 22 • FERC Relicensing for Middle Fork of the American River Project
- 23 • Lower Mokelumne River Spawning Habitat Improvement Project
- 24 • Dutch Slough Tidal Marsh Restoration
- 25 • Suisun Marsh Habitat Management, Preservation, and Restoration Plan  
26 Implementation
- 27 • Tidal Wetland Restoration in the Delta and Suisun Marsh
- 28 • San Joaquin River Restoration Program
- 29 • Stockton Deep Water Ship Channel Dissolved Oxygen Project
- 30 • Grassland Bypass Project
- 31 • Central Valley Salinity Alternatives for Long-term Sustainability (CV-Salts)
- 32 • Long-term Water Transfers
- 33 • Municipal Water Supply Projects that are being implemented (including City  
34 of Stockton Delta Water Supply Project, Woodland-Davis Water Supply  
35 Project, water recycling programs, San Diego County Water Authority

- 1 Carlsbad Seawater Desalination Facility, groundwater bank and wellfield
- 2 expansions)
- 3 • Yolo Bypass Salmonid Habitat Restoration and Fish Passage Implementation
- 4 Plan
- 5 • Bay-Delta Water Quality Control Plan Update
- 6 • California WaterFix (Bay Delta Conservation Plan)
- 7 • California EcoRestore
- 8 • Shasta Lake Water Resources Investigation
- 9 • North of Delta Offstream Storage Investigation
- 10 • Federal Energy Regulatory Commission (FERC) License Renewal Projects
- 11 (including SWP Oroville Project, Yuba-Bear and Drum Spaulding Projects,
- 12 Turlock Irrigation District and Modesto Irrigation District Don Pedro Project,
- 13 and Merced Irrigation District Merced River Hydroelectric Project)
- 14 • El Dorado Water and Power Authority Supplemental Water Rights Project
- 15 • Northeastern San Joaquin County Groundwater Banking Authority
- 16 • Semitropic Water Storage District Delta Wetlands
- 17 • North Bay Aqueduct Alternative Intake
- 18 • Los Vaqueros Reservoir Expansion Phase 2
- 19 • Upper San Joaquin River Basin Storage Investigation
- 20 • Central Valley Regional Water Quality Control Board Irrigated Lands
- 21 Regulatory Program
- 22 • San Luis Reservoir Low Point Improvement Project
- 23 • Future Water Supply Projects (including groundwater storage and recovery
- 24 projects; major conveyance projects, including Sacramento River Water
- 25 Reliability Project, water recycling, and desalination projects)
- 26 • Contra Loma Reservoir and Recreation Resource Management Plan
- 27 • San Luis Reservoir State Recreation Area Resource Management
- 28 Plan/General Plan
- 29 • *Westlands Water District v. United States Settlement*
- 30 • Mill Creek Riparian Assessment
- 31 • Yolo County Habitat/Natural Community Conservation Plan
- 32 • North Delta Flood Control and Ecosystem Restoration Project
- 33 • Franks Tract Project
- 34 • Future Water Supply Projects (including groundwater storage and recovery,
- 35 conveyance, water recycling, desalination, and water transfers).

## 1.10 Organization of the Environmental Impact Statement

The Final EIS was prepared by incorporating changes identified during the public review of the Draft EIS. Chapters 1 through 25 and the Executive Summary have been revised and included in the Final EIS in response to comments received on the Draft EIS. Changes to the Appendices 3A through 19B have been included in the Final EIS as Errata sheets placed in front of each appendix. Appendices 1A through 1E include the comments on the Draft EIS and their corresponding responses. Three additional appendices have been added to the Final EIS to provide more detailed information requested by several commenters (Appendices 5E, 9O, and 9P).

This EIS is organized as follows:

- The **Executive Summary** presents the purpose and intended uses of this EIS and summarizes the project background, need to prepare this EIS, project area and study period, an overview of the alternatives, and major conclusions of the environmental analysis. A table summarizing the environmental consequences, mitigation measures, and significant impacts for the alternatives is included.
- **Chapter 1, Introduction**, summarizes the project background, need to prepare this EIS, use of this EIS, project area and study period, stakeholder and public involvement in the preparation of the EIS, and related projects and activities.
- **Chapter 2, Purpose and Need for the Action**, summarizes the underlying purpose and need to which Reclamation is responding in proposing the alternatives for the action.
- **Chapter 3, Description of Alternatives**, summarizes the methods used for developing the alternatives considered in the EIS, describes the alternatives, and discusses the alternatives considered but eliminated from detailed analysis.
- **Chapter 4, Approach to Environmental Analyses**, describes the approach and terms used in the description of the regulatory setting, affected environment, environmental consequences, cumulative effects, and mitigation measures, if appropriate, for the resource topics identified in Chapters 5 through 21.
- **Chapters 5 through 21** include the regulatory setting, affected environment, and environmental consequences for 17 resource topics and discuss methods of analysis, environmental impacts, and mitigation measures for potential direct and indirect impacts. References for each resource are included within each of these chapters, as follows:
  - Chapter 5 – Surface Water Resources and Water Supplies
  - Chapter 6 – Surface Water Quality

- 1 – Chapter 7 – Groundwater Resources and Groundwater Quality
- 2 – Chapter 8 – Energy
- 3 – Chapter 9 – Fisheries and Aquatic Resources
- 4 – Chapter 10 – Terrestrial Biological Resources
- 5 – Chapter 11 – Geology and Soils
- 6 – Chapter 12 – Agricultural Resources
- 7 – Chapter 13 – Land Use
- 8 – Chapter 14 – Visual Resources
- 9 – Chapter 15 – Recreation Resources
- 10 – Chapter 16 – Air Quality and Greenhouse Gas Emissions
- 11 – Chapter 17 – Cultural Resources
- 12 – Chapter 18 – Public Health
- 13 – Chapter 19 – Socioeconomics
- 14 – Chapter 20 – Indian Trust Assets
- 15 – Chapter 21 – Environmental Justice
- 16 • **Chapter 22, Other NEPA Considerations**, summarizes the environmental  
17 effects of implementation of the alternatives related to growth-inducing  
18 indirect impacts, the relationship between short-term and long-term  
19 productivity, irreversible and irretrievable commitments of resources, and  
20 impacts on other Federal and non-federal projects and plans.
- 21 • **Chapter 23, Consultation, Coordination, and Cooperation**, summarizes  
22 public and stakeholder involvement activities under NEPA; Native American  
23 consultation; consultation with other Federal, state, regional, and local  
24 agencies; consultation with other entities and organizations; and  
25 unresolved issues.
- 26 • **Chapter 24, Distribution List for Draft EIS and Final EIS**, provides  
27 locations where the Draft EIS was available for review and provides an  
28 overview of governmental entities, organizations, and interested parties that  
29 received a copy of the Draft EIS. The Final EIS was distributed to the same  
30 distribution list.
- 31 • **Chapter 25, List of Preparers**, provides a list of individuals who participated  
32 in the preparation of the EIS.
- 33 • **Chapter 26, Index**, provides an index of key topics in Chapters 1 through 23.
- 34 • **Appendices** contain background information including modeling  
35 methodologies, assumptions, and results; and lists and statuses of species  
36 federally listed as threatened and endangered evaluated in this EIS.



1

2 **Figure 1.1 Study Area**



**Chapter 2**

1 **Purpose and Need for the Action**

2 **2.1 Introduction**

3 National Environmental Policy Act (NEPA) regulations require a statement of  
4 “the underlying purpose and need to which the agency is responding in  
5 proposing the alternatives, including the proposed action” (40 Code of Federal  
6 Regulations 1502.13).

7 **2.2 Purpose of the Action**

8 The purpose of the action considered in this Environmental Impact Statement  
9 (EIS) is to continue the operation of the Central Valley Project (CVP), in  
10 coordination with operation of the State Water Project (SWP), for the authorized  
11 purposes, in a manner that:

- 12 • Is similar to historical operational parameters with certain modifications
- 13 • Is consistent with Federal Reclamation law; other Federal laws and  
14 regulations; Federal permits and licenses; and State of California water rights,  
15 permits, and licenses
- 16 • Enables the Bureau of Reclamation (Reclamation) and the California  
17 Department of Water Resources (DWR) to satisfy their contractual obligations  
18 to the fullest extent possible

19 **2.3 Need for the Action**

20 Continued operation of the CVP is needed to provide river regulation;  
21 improvement of navigation; flood control; water supply for irrigation and  
22 domestic uses; fish and wildlife mitigation, protection, and restoration; fish and  
23 wildlife enhancement; and power generation. The CVP and the SWP facilities  
24 also are operated to provide recreation benefits and in accordance with the water  
25 rights and water quality requirements adopted by the State Water Resources  
26 Control Board.

27 As described in Chapter 1, Introduction, the U.S. Fish and Wildlife Service  
28 (USFWS) and the National Marine Fisheries Service (NMFS) concluded in their  
29 2008 and 2009 Biological Opinions (BOs), respectively, that coordinated long-  
30 term operation of the CVP and SWP, as described in the 2008 Reclamation  
31 Biological Assessment, jeopardizes the continued existences of listed species and  
32 adversely modifies critical habitat. To remedy this, USFWS and NMFS provided  
33 Reasonable and Prudent Alternatives (RPAs) in their BOs.

## Chapter 2: Purpose and Need for the Action

1 The U.S. Court of Appeals for the Ninth Circuit confirmed the U.S. District Court  
2 for the Eastern District of California ruling that Reclamation must conduct a  
3 NEPA review to determine whether the RPA actions cause a significant impact on  
4 the human environment. Potential modifications to the coordinated operation of  
5 the CVP and SWP analyzed in the EIS process should be consistent with the  
6 intended purpose of the action, be within the scope of Reclamation's legal  
7 authority and jurisdiction, be economically and technologically feasible, and  
8 avoid the likelihood of jeopardizing listed species or resulting in the destruction or  
9 adverse modification of critical habitat in compliance with the requirements of  
10 Section 7(a)(2) of the Endangered Species Act.

## Chapter 3

# 1 Description of Alternatives

## 2 3.1 Introduction

3 This chapter describes the methodology used for development of all potential  
4 alternatives and the basis for selecting the reasonable range of alternatives which  
5 are evaluated in detail in this Environmental Impact Statement (EIS).

## 6 3.2 Approach to Identify Potential Alternatives

7 This EIS evaluates a range of alternatives to the No Action Alternative for the  
8 coordinated long-term operation of the Central Valley Project (CVP) and the State  
9 Water Project (SWP) in the Year 2030. The No-Action Alternative includes full  
10 implementation of the 2008 USFWS Biological Opinion (2008 USFWS BO) and  
11 the 2009 National Marine Fisheries Service (NMFS) Biological Opinion (2009  
12 NMFS BO) Reasonable and Prudent Alternatives (RPAs), in addition to other  
13 ongoing and future programs that are reasonably foreseeable to occur by 2030.

14 Identification of the No Action Alternative and the range of action alternatives for  
15 this EIS were developed in response to the purpose and need for the action as well  
16 as comments received during the scoping process and during preparation of the  
17 Draft EIS, as summarized below.

### 18 3.2.1 Scoping Process

19 The scoping process was initiated on March 28, 2012, with the publication of the  
20 Notice of Intent in the Federal Register (FR) and continued through June 28,  
21 2012. Five scoping meetings were held to inform the public and interested  
22 stakeholders about the project, and to solicit comments and input on the EIS. The  
23 scoping meetings were held in Madera, Diamond Bar, Sacramento, Marysville,  
24 and Los Banos, California, in April and May 2012. Many scoping comments  
25 addressed the definition and range of alternatives, as summarized below and in  
26 the Scoping Report (included as Appendix 23A of this EIS).

- 27 • Alternative South Delta operation criteria, including:
  - 28 – Changes to Old and Middle River (OMR) flow criteria from what was
  - 29 described in the 2008 USFWS BO and 2009 NMFS BO
  - 30 – Changes to operational criteria of CVP and SWP south Delta intakes
  - 31 relative to the ratio of San Joaquin River inflows to south Delta exports;
  - 32 – Changes to measurement methods for OMR flow criteria related to
  - 33 locations of measurements and inclusion of Contra Costa Water District
  - 34 intakes within the calculations of OMR flows.

- 1 • Measures to benefit the survival and recovery of listed aquatic species that do  
2 not involve modifications of long-term operation of the CVP and SWP, such  
3 as improved water quality, reduction of populations of predators of listed  
4 aquatic species in the Delta, regulation of small unscreened water diversions,  
5 restoration of floodplain habitat, and provisions for levee vegetation  
6 approaches.
- 7 • Measures to improve primary productivity and food supply for salmonids and  
8 smelts Smelt (both Delta Smelt and Longfin Smelt), including through  
9 increased spring outflow, reduced Delta diversions, and changes in Delta flow  
10 patterns resulting from channel modifications or changes in Delta exports that  
11 change Delta residence times for aquatic species.
- 12 • Measures to support federal and state fish population doubling mandates and  
13 goals.
- 14 • Measures to increase opportunities for transfer of water through the Delta.
- 15 • Measures to increase water supply availability from the CVP and SWP south  
16 Delta intakes.
- 17 • Measures to reduce reliance on Delta water supplies by reducing water supply  
18 availability from the CVP and SWP south Delta intakes.
- 19 • Complete cessation of long-term operation of the CVP and SWP, including  
20 benefits related to the operation of the CVP and SWP reservoirs, such as flood  
21 management and recreational benefits.
- 22 • Measures to prioritize CVP operations of the Trinity, Sacramento, American,  
23 and Stanislaus rivers to meet in-watershed water demands, not only in  
24 accordance with existing water rights and agreements, but also for CVP water  
25 contractors specifically located within the American and Stanislaus river  
26 watersheds.
- 27 • Measures to prioritize use of Central Valley Project Improvement Act  
28 (CVPIA) restoration funds within geographic locations collected from CVP  
29 water users in those locations.

### 30 **3.2.2 Concepts Identified during Preparation of the Draft EIS**

31 As described in Chapter 23, Consultation and Coordination, status meetings were  
32 held throughout preparation of the Draft EIS with stakeholders and interested  
33 parties between 2012 and 2015. Following the scoping process, the discussions  
34 were initially focused on identification of the No Action Alternative, other bases  
35 of comparisons, and alternative concepts to the RPAs. Based upon these  
36 discussions, the development of alternatives process initially focused on  
37 identification of the No Action Alternative, and subsequently, upon development  
38 of the range of alternatives to the No Action Alternative.

### 3.3 Identification of the Bases of Comparison

Council on Environmental Quality (CEQ) regulations require an EIS to include evaluation of a No Action Alternative (40 CFR 1502.14). The No Action Alternative is defined as the projections of current conditions and trends into the future without implementation of alternatives. These projected conditions are defined by CEQ as “no change” from current management direction or level of management intensity.” The No Action Alternative also can be defined as “no project” in cases where a new project is proposed for implementation. However, all of the alternatives evaluated in this EIS are to continue the coordinated long-term operation of the CVP and SWP. Therefore, the definition of the No Action Alternative used for this EIS is continuation of the current management direction and level of intensity.

For this EIS, the No Action Alternative is based upon the continued operation of the CVP and SWP in the same manner as was occurring at the time of the publication of the Notice of Intent in March 2012. Thus, the No Action Alternative consists of the coordinated long-term operation of the CVP and SWP, including full implementation of the RPAs in the 2008 USFWS BO and 2009 NMFS BO, because Reclamation provisionally accepted the BOs in 2008 and 2009, respectively, began implementing the RPAs, and continues to implement the RPAs to date. The No Action Alternative also includes changes not related to the long-term operation of the CVP and SWP or implementation of the RPAs in the 2008 USFWS BO and 2009 NMFS BO, as described in subsequent sections of this chapter.

Numerous scoping comments requested that the No Action Alternative not include the RPAs in the 2008 USFWS BO and 2009 NMFS BO because, at that time, the District Court had remanded the biological opinions (BOs) back to USFWS and NMFS. The comments indicated that the EIS should include a “basis of comparison” for the alternatives that was similar to conditions prior to implementation of the RPAs. Scoping comments also indicated that a “No Action Alternative scenario” without implementation of the RPAs in the 2008 USFWS BO and 2009 NMFS BO could be used to analyze the effects of implementing the RPAs.

Determining an appropriate baseline without the 2008 USFWS BO and 2009 NMFS BO actions and yet continuing to meet all of Reclamation’s statutory and regulatory requirements is a difficult task. Simply analyzing a No Action Alternative that is similar to the project description described in either the 2004 Biological Assessment or 2008 Biological Assessment is insufficient, as each was found to jeopardize listed species, the 2004 Biological Assessment by the District Court in 2007, and the 2008 Biological Assessment by USFWS and NMFS. Either of these operations would be inconsistent with Reclamation’s existing policy and management direction.

Because the RPAs were provisionally accepted and the No Action Alternative, represents a continuation of existing policy and management direction, the No Action Alternative includes the RPAs. However, in response to scoping

1 comments and subsequent comments from stakeholders and interest groups; and  
2 to provide a basis for comparison of the effects of implementation of the RPAs  
3 (per the District Court’s mandate), this EIS includes a “Second Basis of  
4 Comparison” that represents a condition in 2030 without implementation of the  
5 2008 USFWS BO and 2009 NMFS BO. All of the alternatives are compared to  
6 the No Action Alternative and to the Second Basis of Comparison to describe the  
7 effects that could occur by 2030 under both bases of comparison.

8 Several of the 2009 NMFS BO RPA actions had been initiated prior to issuance of  
9 the 2009 NMFS BO; and therefore, those actions are included in the Second Basis  
10 of Comparison, as described below. Reasonably foreseeable actions included in  
11 the No Action Alternative that are not related to the 2008 USFWS BO or 2009  
12 NMFS BO are also included in the Second Basis of Comparison.

### 13 **3.3.1 Conditions in Year 2030 without Implementation of** 14 **Alternatives 1 through 5**

15 Changes that would occur over the next 15 years without implementation of the  
16 alternatives are not analyzed in this EIS. However, the changes to environmental  
17 justice factors that are assumed to occur by 2030 under the No Action Alternative  
18 and the Second Basis of Comparison are summarized in this section, including:

- 19 • Continued long-term operation of the CVP and SWP in accordance with  
20 ongoing management policies, criteria, and regulations, including water right  
21 permits and licenses issued by the State Water Resources Control Board  
22 (SWRCB); and operational requirements of the 2008 USFWS BO and the  
23 2009 NMFS BO.
- 24 • Implementation of existing and future actions described in the 2008 USFWS  
25 BO and 2009 NMFS BO that would occur by 2030 without implementation of  
26 the BOs.
- 27 • Implementation of existing and future actions not described in the 2009  
28 NMFS BO that would occur by 2030 without implementation of any  
29 alternatives considered in this EIS.

#### 30 **3.3.1.1 Continued Long-Term Operation of the CVP and SWP Facilities**

31 The CVP and SWP are operated in a coordinated manner in accordance with  
32 Public Law 99-546 (October 27, 1986), directing the Secretary to execute the  
33 Coordinated Operation Agreement (COA). The CVP and SWP are also operated  
34 under State Water Resources Control Board (SWRCB) decisions and water right  
35 orders related to the CVP’s and SWP’s water right permits and licenses to  
36 appropriate water by diverting to storage, by directly diverting to use, or by re-  
37 diverting releases from storage later in the year or in subsequent years.

38 The CVP and SWP are permitted by SWRCB to store water, divert water and re-  
39 divert CVP and SWP water that has been stored in upstream reservoirs. The CVP  
40 and SWP have built water storage and water delivery facilities in the Central  
41 Valley to deliver water supplies to CVP and SWP contractors, including senior

1 water users. The CVP's and SWP's water rights are conditioned by the SWRCB  
2 to protect the beneficial uses of water within the watersheds.

3 As conditions of the water right permits and licenses, SWRCB requires the CVP  
4 and SWP to meet specific water quality objectives within the Delta. Reclamation  
5 and DWR coordinate operation of the CVP and SWP, pursuant to the COA, to  
6 meet these and other operating requirements. The COA is an agreement between  
7 the Federal government and the State of California for the coordinated operation  
8 of the CVP and SWP. The agreement suspended a 1960 agreement and  
9 superseded annual coordination agreements that had been implemented following  
10 construction of the SWP.

11 The COA established the operating framework for the CVP and SWP based upon  
12 conditions in the 1980s, by setting forth: (1) definitions of the CVP and SWP  
13 facilities and their water supplies, (2) procedures for coordination of operations,  
14 (3) formulas for sharing joint responsibilities for meeting Delta standards and  
15 ensuring no injury to other legal uses of water, (4) criteria for sharing unstored  
16 flow in the Delta, (5) a framework for exchange of water and services between the  
17 SWP and CVP, and (6) provisions for periodic reviews. Coordinated operation by  
18 agreed-on criteria can increase the efficiency of both the CVP and the SWP.

19 Implementation of the COA has evolved continually since 1986 as CVP and SWP  
20 facilities, operational criteria, and physical and regulatory environment have  
21 changed. For example, adoption of the CVPIA in 1992 changed purposes and  
22 operations of the CVP, and ESA responsibilities have affected operation of the  
23 CVP and SWP. Since 1986, facilities operations have been modified in response  
24 to statutory and regulatory requirements that were not part of the original COA  
25 assumptions or requirements. In addition, water quality objectives have been  
26 revised by the SWRCB since 1986 in the 1995 and 2006 Water Quality Control  
27 Plans and implemented through SWRCB Decision 1641. DWR and Reclamation  
28 have operational arrangements to accommodate new facilities, water quality  
29 objectives, the CVPIA, other SWRCB criteria, and the ESA, but the COA has not  
30 been formally modified to address these newer operating conditions.

31 The ongoing operational management policies of the CVP and SWP are  
32 anticipated to continue under the No Action Alternative and Second Basis of  
33 Comparison. These operational assumptions are described in Appendix 3A, No  
34 Action Alternative: Central Valley Project and State Water Project Operations,  
35 and summarized in Chapter 5, Surface Water Resources and Water Supplies.

36 **3.3.1.2 Actions included in the 2008 USFWS BO and 2009 NMFS BO that**  
37 **Would Have Occurred without Implementation of the Biological**  
38 **Opinions**

39 Several actions included in the 2008 USFWS BO RPA and 2009 NMFS BO RPA  
40 are ongoing and others have been completed, including the following actions.

- 41 • 2008 USFWS BO RPA Component 4, Habitat Restoration. In 2014,  
42 Reclamation, California Department of Fish and Wildlife (CDFW), and  
43 USFWS adopted and initiated implementation of the Suisun Marsh Habitat  
44 Management, Preservation, and Restoration Plan (Suisun Marsh Management

- 1 Plan). The No Action Alternative assumes that the Suisun Marsh  
2 Management Plan will provide up to 7,000 acres of intertidal and associated  
3 subtidal habitat in the Delta and Suisun Marsh with or without implementation  
4 of the 2000 USFWS BO. This would represent up to 87 percent (7,000 of  
5 8,000 acres of this habitat type referenced in the 2008 USFWS BO.
- 6 • 2009 NMFS BO RPA Action I.1.3, Clear Creek Spawning Gravel  
7 Augmentation. This effort was initiated in 1996 under the CVPIA Section  
8 3406(b)(12), and is assumed to continue under the No Action Alternative and  
9 Second Basis of Comparison. The Clear Creek fisheries habitat restoration  
10 program is being implemented by USFWS and Reclamation in accordance  
11 with CVPIA (Reclamation 2011a). By the year 2020 the overall goal is to  
12 provide 347,288 square feet of usable spawning habitat from Whiskeytown  
13 Dam downstream to the former McCormick-Saeltzer Dam, which is the  
14 amount that existed before construction of Whiskeytown Dam. Between 1996  
15 and 2009, a total of approximately 130,925 tons of spawning gravel was  
16 added to the creek. The interim annual spawning gravel addition target is  
17 25,000 tons per year, but due to a lack of funding, only an average of  
18 9,358 tons has been placed annually since 1996 (Reclamation 2013a). In  
19 2010, the first annual evaluation of spawning gravel implementation and  
20 monitoring was submitted to NMFS as required by the NMFS BO. In 2012,  
21 Reclamation placed 10,000 tons of spawning gravel at four locations:  
22 Guardian Rock/Below N.E.E.D. Camp, Placer Bridge, Clear Creek  
23 Crossing/Bridge, and Tule Backwater.
  - 24 • 2009 NMFS BO RPA Action I.1.4, Spring Creek Temperature Control  
25 Curtain Replacement. This action was completed when the temperature  
26 control curtain was replaced in 2011, as described in Appendix 3A, No Action  
27 Alternative: Central Valley Project and State Water Project Operations.
  - 28 • 2009 NMFS BO RPA Action I.2.6, Restore Battle Creek for Winter-Run,  
29 Spring-Run, and Central Valley Steelhead. The Battle Creek Salmon and  
30 Steelhead Restoration Projects under construction to reestablish  
31 approximately 42 miles of salmon and steelhead habitat on Battle Creek and  
32 an additional 6 miles of habitat on tributaries. The Project is a collaborative  
33 effort between Reclamation, USFWS, NMFS, CDFW, Pacific Gas & Electric  
34 Company (PG&E), and other groups. Prior to 2030, elements of the project  
35 will be completed including removal of five dams, installation of new fish  
36 screens and fish ladders, provisions for increased instream flows in Battle  
37 Creek, improved access roads and trails, and decommissioned power plant  
38 canals that conveyed water between tributaries. The No Action Alternative  
39 assumes implementation of this project with or without implementation of the  
40 2009 NMFS BO.
  - 41 • 2009 NMFS BO RPA Action I.3.1, Operate Red Bluff Diversion Dam with  
42 Gates Out. This action was completed when the new Red Bluff Pumping  
43 Plant began operation in 2012, and the gates no longer block the flow of water



- 1 in the Sacramento River, as described in Appendix 3A, No Action  
 2 Alternative: Central Valley Project and State Water Project Operations.
- 3 • 2009 NMFS BO RPA Action I.5, Funding for CVPIA Anadromous Fish  
 4 Screen Program. This effort was initiated over 20 years ago under the CVPIA  
 5 Section 3406(b)(21), and is assumed to continue under the No Action  
 6 Alternative with or without implementation of the 2009 NMFS BO. The No  
 7 Action Alternative assumes continued implementation of the program to meet  
 8 the program objectives by 2030.
  - 9 • 2009 NMFS BO RPA Action I.6.1, Restoration of Floodplain Habitat; and  
 10 Action I.6.2, Near-Term Actions at Liberty Island/Lower Cache Slough and  
 11 Lower Yolo Bypass; Action I.6.3, Lower Putah Creek Enhancements;  
 12 Action I.6.4, Improvements to Lisbon Weir; and Action I.7, Reduce Migratory  
 13 Delays and Loss of Salmon, Steelhead, and Sturgeon at Fremont Weir and  
 14 Other Structures in the Yolo Bypass. These actions are addressed in the  
 15 ongoing Yolo Bypass Salmonid Habitat Restoration and Fish Passage  
 16 Implementation Plan (Implementation Plan) that has been initiated by  
 17 Reclamation and DWR. The No Action Alternative and Second Basis of  
 18 Comparison assume completion of this Implementation Plan by 2030 with or  
 19 without implementation of the 2009 NMFS BO. The Implementation Plan  
 20 includes an operable gate at or near the Fremont Weir and modification of the  
 21 Sacramento Weir to increase the frequency and extent of floodplain  
 22 inundation in the Yolo Bypass; restoration of at least 20,000 acres of  
 23 floodplain rearing habitat (excluding tidally-influenced areas); and habitat  
 24 enhancements in the Yolo Bypass, including measures to avoid stranding or  
 25 barriers to migration. The No Action Alternative and Second Basis of  
 26 Comparison assume that an operable gate would be installed in or near the  
 27 Fremont Weir that would allow for controlled flows from the Sacramento  
 28 River into the Yolo Bypass when Sacramento River water elevations exceed  
 29 approximately 17.5 feet (NAVD88). Other portions of Fremont Weir would  
 30 continue to block flows into the Yolo Bypass until the Sacramento River  
 31 water elevations exceed 32.8 feet (NAVD88).
  - 32 • 2009 NMFS BO RPA Action II.1, Lower American River Flow Management.  
 33 This effort was initiated in 2006 when Reclamation began operating in  
 34 accordance with the American River Flow Management Standard (FMS), as  
 35 described in Appendix 3A, No Action Alternative: Central Valley Project and  
 36 State Water Project Operations. The No Action Alternative and Second Basis  
 37 of Comparison assume continued operations under the FMS.

38 **3.3.1.3 Future Actions not included in the 2008 USFWS BO and 2009**  
 39 **NMFS BO that Would Have Occurred without Implementation of**  
 40 **the Biological Opinions**

41 The No Action Alternative and the Second Basis of Comparison include  
 42 assumptions unrelated to implementation of the 2008 USFWS BO RPA actions  
 43 and 2009 NMFS BO RPA actions, including: climate change and sea level rise;  
 44 continued implementation of ongoing federal, state, and local regulations and

1 policies; development of lands in accordance with general plans in areas served  
2 by CVP and SWP water supplies; and reasonable and foreseeable projects that  
3 have been approved and are anticipated to be implemented by 2030. The 2008  
4 USFWS BO and the 2009 NMFS BO included assumptions for climate change  
5 and sea level rise; continued implementation of ongoing federal, state, and local  
6 regulations and policies; development of lands in accordance with general plans  
7 in areas served by CVP and SWP water supplies; and reasonable and foreseeable  
8 projects. Subsequent to the publication of the BOs, the assumptions for these  
9 items have been updated and are included in the No Action Alternative and the  
10 Second Basis of Comparison. The assumptions used in this EIS for these items  
11 are discussed below.

### 12 **3.3.1.3.1 Climate Change and Sea Level Rise**

13 Under Section 9503 of the SECURE Water Act (Public Law 111-11, Subtitle F),  
14 Reclamation conducted a comprehensive assessment of current information on  
15 potential future climate change impacts and implications for long-term water  
16 management in the West, as described in Appendix 5A, Modeling Methodology.  
17 Projections of future climate in the Sacramento and San Joaquin River basins are  
18 summarized, with regard to temperature, precipitation, snowpack, and runoff.  
19 Results indicate that temperatures across both river basins may increase steadily,  
20 with the basin-average mean annual temperature projected to increase by roughly  
21 5° to 6° Fahrenheit (F) during the 21st century. Annual precipitation in the basins  
22 should remain geographically variable over the next century, with current  
23 projections suggesting that annual basin-wide precipitation may initially stay  
24 steady to slightly increasing, to an eventual slight decrease over the region. With  
25 regard to snowpack, increased warming is expected to diminish snow  
26 accumulation during the cool season and reduce the availability of snowmelt to  
27 sustain runoff during the warm season. Reductions in annual runoff are predicted  
28 to occur by the latter half of the century. Changes in runoff seasonality are  
29 generally projected, with warming leading to more rainfall and runoff in the cool  
30 season and less runoff during the spring, affecting seasonal water supplies. One  
31 difficulty that arises in taking climate change into account in long-term water  
32 resources planning is that the natural variability is often greater than the  
33 magnitude of change expected over several decades.

34 Global and regional sea levels have been increasing steadily over the past century  
35 and are expected to continue to increase throughout this century (BCDC 2011).  
36 The National Research Council recently released a study of sea level rise on the  
37 west coast. Key results indicate that global sea level has risen about 7 inches in  
38 the 20th century and the rate of sea level rise is accelerating (NRC 2012).  
39 Relative to year 2000 levels, global sea level is projected to rise 3 to 9 inches by  
40 2030, 7 to 19 inches by 2050, and 20 to 55 inches by 2100. Sea level rise along  
41 the California coast south of Cape Mendocino are projected to show even greater  
42 ranges of potential change. As a result, sea level rise associated with climate  
43 change will continue to threaten coastal lands and infrastructure, increase flooding  
44 at the mouths of rivers, place additional stress on levees and water resources in  
45 the Delta.

1 Additional information related to development of climate change and sea level  
 2 rise projections by 2030 are presented in Section 5A.A.5 of Appendix 5A,  
 3 Section A, CalSim II and DSM2 Modeling.

4 **3.3.1.3.2 Continued Implementation of Ongoing Federal, State, and Local**  
 5 **Water Resources Policies**

6 The No Action Alternative and Second Basis of Comparison assume continued  
 7 implementation of ongoing water resources policies and programs that are not  
 8 addressed in the 2008 USFWS BO and 2009 NMFS BO, including the following  
 9 programs.

- 10 • Federal Clean Water Act, including completion of Total Maximum Daily  
 11 Load programs, National Pollutant Discharge Elimination System permits,  
 12 and Waste Discharge Permits, as described in Chapter 6, Surface Water  
 13 Quality.
- 14 • SWRCB water rights and water quality policies and programs, as described in  
 15 Chapter 5, Surface Water Resources and Water Supplies.
- 16 • Federal Safe Drinking Water Act and California Safe Drinking Water Act  
 17 policies and programs related to drinking water treatment requirements, as  
 18 described in Chapter 6, Surface Water Quality.
- 19 • Federal Clean Air Act and California Clean Air Act, including completion of  
 20 the compliance programs in accordance with the State Implementation Plans,  
 21 as described in Chapter 16, Air Quality and Greenhouse Gas Emissions.
- 22 • Flood management policies and programs established by the U.S. Army Corps  
 23 of Engineers (USACE) except for removal of substantial vegetation from  
 24 levees per recent USACE requirements (USACE 2009, 2010), Federal  
 25 Emergency Management Agency, DWR, Central Valley Flood Protection  
 26 Board, and local flood management agencies, as described in Chapter 5,  
 27 Surface Water Resources and Water Supplies.

28 **3.3.1.3.3 General Plan Development in CVP and SWP Service Areas**

29 Counties and cities throughout California have adopted general plans which  
 30 identify land use classifications including those for municipal and industrial uses  
 31 and those for agricultural uses. Preparation of general plans includes an  
 32 environmental evaluation under the California Environmental Quality Act to  
 33 identify adverse impacts to the physical environment and to provide mitigation  
 34 measures to reduce those impacts to a level of less than significance. Most of the  
 35 counties where CVP and SWP water supplies are delivered have adopted general  
 36 plans following the environmental review of the plans and appropriate  
 37 alternatives. Population projections from those general plan evaluations are  
 38 provided to the State Department of Finance and are used to project future water  
 39 needs and the potential for conversion of existing undeveloped lands and  
 40 agricultural lands. Many of the existing general plans for counties with municipal  
 41 areas recently have been modified to include land use and population projections  
 42 through 2030. The No Action Alternative and Second Basis of Comparison

1 assume that land uses, as described in Chapter 13, Land Use, will develop through  
2 2030 in accordance with existing general plans.

3 **3.3.1.3.4 Other Reasonable and Foreseeable Projects and Programs**

4 The No Action Alternative and Second Basis of Comparison assume continued  
5 implementation of existing projects and facilities, including water supply and  
6 wastewater management facilities, flood management facilities, and recreational  
7 facilities.

8 In addition, the No Action Alternative assumes implementation of the following  
9 ongoing projects by 2030. These project descriptions are organized  
10 geographically from north to south in the State of California.

11 *Trinity River Restoration Program*

12 The Trinity River Restoration Program is a conducted by eight partners that form  
13 the Trinity Management Council, including Reclamation, USFWS, NMFS, U.S.  
14 Forest Service, Hoopa Valley Tribe, Yurok Tribe, California Resources Agency,  
15 and Trinity County. The Trinity River Flow Evaluation Final Report was adopted  
16 in 1999 and the Trinity River Record of Decision (ROD) was signed in 2000 to  
17 implement restoration of the physical processes and rehabilitate the Trinity River  
18 as foundation for fisheries recovery. The ROD described four restoration  
19 methods (flow management through releases from Lewiston Dam, construction of  
20 channel rehabilitation sites, augmentation of gravels, and control of fine  
21 sediments); infrastructure improvements to accommodate high flow releases from  
22 Lewiston Dam; environmental compliance with improvements to riparian  
23 vegetation and wetlands, reduced turbidity, and improved water temperatures; and  
24 science-based adaptive management. The Trinity River Restoration Program  
25 2011 Annual Report indicated that about half of the projects described in the Flow  
26 Evaluation Study had been completed and intensive assessments of the physical  
27 responses of the Trinity River and geomorphic assessments of the 40-mile  
28 restoration reach had been initiated (TRRP 2012). This project will improve  
29 conditions for aquatic species in the Trinity River.

30 *Continued Implementation of the Central Valley Project Improvement Act*  
31 *Provisions*

32 In 1992, the CVPIA (Title 34 of Public Law 102-575) was adopted to include fish  
33 and wildlife protection, restoration, enhancement, and mitigation as purposes of  
34 the CVP having equal priority with irrigation and domestic water supply uses, and  
35 power generation. The purpose of the CVPIA is expressed in six broad  
36 statements found in Section 3402 of the Act:

- 37 • To protect, restore, and enhance fish, wildlife, and associated habitats in the  
38 Central Valley and Trinity River basins of California;
- 39 • To address impacts of the CVP on fish, wildlife, and associated habitats;
- 40 • To improve the CVP's operational flexibility;
- 41 • To increase water-related benefits provided by the CVP to the state through  
42 expanded use of voluntary water transfers and improved water conservation;

- 1 • To contribute to the state’s interim and long-term efforts to protect the San  
2 Francisco Bay/Sacramento-San Joaquin Delta Estuary;
- 3 • To achieve a reasonable balance among competing demands for use of CVP  
4 water, including the requirements of fish and wildlife, agricultural, municipal  
5 and industrial, and power contractors.

6 The Secretary of the Department of the Interior (DOI) assigned primary  
7 responsibility for implementing CVPIA’s many provisions to Reclamation and  
8 USFWS. Reclamation and USFWS coordinate with other federal agencies, tribes,  
9 the State of California, and numerous partners and stakeholders during each fiscal  
10 year to plan and implement activities.

11 The current focus of the CVPIA Program is on fish and wildlife restoration, water  
12 management, and conservation activities, authorized in Sections 3406 and 3408 of  
13 the Act. These goals fit within four broad resource areas: Fisheries, Water  
14 Operations, Refuges and Other Resources (Reclamation 2013c).

15 The Fisheries Resource Area includes actions to implement the CVPIA “fish-  
16 doubling goal” for Chinook Salmon, Rainbow Trout (steelhead), Striped Bass,  
17 American Shad, White Sturgeon and Green Sturgeon. The 2001 Final Restoration  
18 Plan to implement the CVPIA included 289 actions and evaluations that were  
19 determined to be reasonable given numerous technical, legal and implementation  
20 considerations. Reclamation and USFWS are implementing these and related  
21 actions (Reclamation 2013c). In 2008, the CVPIA Program conducted an  
22 independent review of the status of actions to achieve the fish-doubling goal.  
23 Following the review, a revised plan was developed to emphasize managing all of  
24 the fisheries programs as one program instead of individual actions; utilize a  
25 science-based management framework to address problems at a system level;  
26 report accomplishments by watershed; and improve transparency by  
27 communicating the coordination and decision-making that occurs within the  
28 program. The No Action Alternative assumes that the CVPIA Program will  
29 continue to be implemented in 2030.

30 The Water Operations Resource Area includes provisions to supply CVP water to  
31 resource locations in flow, quantity, velocity, and timing patterns that would  
32 contribute to the biological resources in accordance with Section 3406(b) of  
33 CVPIA (Reclamation 2013c). The No Action Alternative assumes that water  
34 operations will continue to include measures identified in Section 3406(b).

35 The Refuges Resources Area includes actions to contribute to the maintenance,  
36 restoration and enhancements of wetlands and waterfowl habitat either directly or  
37 through contractual agreements with other appropriate parties, firm water supplies  
38 of suitable quality to maintain and improve wetland habitat areas on 19 federal,  
39 state and private lands. The CVPIA requires Reclamation to provide CVP water  
40 to meet “Level 2” water demands and to obtain water supplies to meet “Level 4”  
41 water demands (Reclamation 2013c). In 2009, the CVPIA Program conducted an  
42 independent review of the refuge water supply program. The report indicated that  
43 Level 2 water supplies had become more reliable under CVPIA; however, Level 4  
44 water supplies were not fully obtained. In response, Reclamation entered into an

1 agreement with USFWS and the National Fish and Wildlife Foundation to explore  
2 avenues to improve the effectiveness of the water acquisitions, including those for  
3 Incremental Level 4; assessed ways to increase the priority for pumping,  
4 conveyance and storage of Incremental Level 4 water supplies in CVP facilities;  
5 and continued planning for external storage and conveyance facilities to meet  
6 refuge water supply needs. The No Action Alternative assumes that refuge water  
7 supplies will continue to be provided in 2030.

8 The Other Resource Area actions are related to terrestrial habitat and species; and  
9 water quality and conservation. One of the programs implemented in this  
10 resource area includes the Section 3406(b)(1) “other” Habitat Restoration  
11 Program, which focuses on protecting native habitats that have been directly and  
12 indirectly affected by the CVP’s construction and operation (Reclamation 2013c).  
13 This is accomplished through the purchase of fee title or conservation easements  
14 on lands where threats are significant and restoring lands to native habitat.  
15 Another program is the Land Retirement Program, Section 3408 (h), to purchase  
16 and retire land from agricultural production to improve water quality and provide  
17 for terrestrial habitat restoration. The No Action Alternative assumes that these  
18 actions will continue in a manner similar to ongoing operations.

19 The DOI is continuing to implement CVPIA using an improved science-based  
20 decision making process using a scientific framework that connects restoration  
21 actions to environmental and population responses across watersheds  
22 (Reclamation 2013c). A system-wide science-based approach with performance  
23 indices, monitoring, and scientific review of results is used to provide direction as  
24 the CVPIA adapts to changing conditions.

#### 25 *Clear Creek Mercury Abatement and Fisheries Restoration Project*

26 The Lower Clear Creek Aquatic Habitat and Waste Discharge Improvement  
27 Project was initiated to remove the long-term impacts of mercury contamination  
28 in Lower Clear Creek and to create over 5 acres of new wetlands. The mercury  
29 sources are dredge-mined tailings from more than 200 historic gold and gravel  
30 mines in the watershed. The tailings are located on the properties adjacent to  
31 Clear Creek and in gravels historically used for spawning gravel supplementation.  
32 This is being completed in accordance with CVPIA actions (WSRCD 2011). This  
33 project will improve conditions for aquatic species in Clear Creek and the upper  
34 Sacramento River.

#### 35 *Iron Mountain Mine Superfund Site*

36 The Iron Mountain Mine Superfund Site on Spring Creek had discharged acid  
37 mine drainage into several creeks that are tributary to Keswick Reservoir and the  
38 Sacramento River since the late 1890s. The interim remedies include source  
39 control, acid mine drainage collection and treatment, and water management,  
40 including water diversions and coordinated releases of contaminated surface  
41 water from Spring Creek Debris Dam with dilution flows released from the  
42 Spring Creek power plant and Shasta Lake. In 2008, the U.S. Environmental  
43 Protection Agency indicated that the interim remedies were operational and had  
44 reduced metal loading discharges by 95 percent as compared to pre-project

1 conditions. A final restoration plan for natural resources injured by Iron  
 2 Mountain Mine operation was adopted in 2002 by USFWS, CDFW, National  
 3 Oceanic and Atmospheric Administration, Bureau of Land Management, and  
 4 Reclamation and those programs are being implemented (USEPA 2008). This  
 5 project will improve water quality and conditions for aquatic species in Spring  
 6 Creek and the upper Sacramento River.

7 *Mainstem Sacramento River, American River, and Stanislaus River Gravel*  
 8 *Augmentation Programs*

9 The Mainstem Sacramento Gravel Augmentation Program is an ongoing  
 10 Reclamation project that helps meet requirements of Section 3406 (b)(13) of the  
 11 CVPIA to restore and replenish spawning gravel and rearing habitat for salmonid  
 12 species. Reclamation began placing salmonid spawning gravel in the Sacramento  
 13 River approximately 0.25 miles downstream of Keswick Dam in 1997 and  
 14 subsequently in Salt Creek. The project will place approximately 5,000 tons of  
 15 gravel into the river and implement riffle supplementation/side-channel  
 16 excavation to help improve spawning habitat for Chinook Salmon and steelhead  
 17 (Reclamation and USFWS 2012). This project will improve conditions for  
 18 aquatic species in the upper Sacramento River.

19 The Lower American River Salmonid Spawning Gravel Augmentation and Side-  
 20 Channel Habitat Establishment Program to increase and improve salmon and  
 21 steelhead spawning and rearing habitat by replenishing spawning gravel and  
 22 establishing additional side-channel habitat at new restoration sites along the  
 23 lower American River between Nimbus Dam and Upper Sunrise Recreation Area  
 24 and at Arden Rapids. Gravel augmentation, side channel excavation, and  
 25 incorporation of woody material into the main channel to improve Chinook  
 26 Salmon and steelhead spawning and rearing habitat (Reclamation 2008, 2014e).

27 Gravel restoration also has been implemented on the lower Stanislaus River since  
 28 2004 (Reclamation 2011c).

29 *Nimbus Fish Hatchery Fish Passage Project*

30 A fish passageway from the Nimbus Fish Hatchery to the stilling basin  
 31 downstream of the Nimbus Dam will be constructed and the diversion weir will  
 32 be removed. This project will create and maintain a reliable system for collecting  
 33 adult fish to allow Reclamation to mitigate for loss of access to spawning areas  
 34 following construction of Nimbus Dam and adequately protect Chinook Salmon  
 35 and Central Valley steelhead. The project is scheduled to start in 2018 if adequate  
 36 funding is appropriated. This project will improve conditions for aquatic species  
 37 in the lower American River and lower Sacramento River.

38 *Folsom Dam Water Control Manual Update*

39 The USACE is developing and evaluating alternatives to change flood  
 40 management operations of Folsom Dam and Folsom Lake to reduce flood risk to  
 41 the Sacramento area. Currently, the USACE is completing construction of the  
 42 new auxiliary spillway at Folsom Dam and is completing an in-depth analysis of  
 43 recent hydrologic data for the American River watershed upstream of Folsom  
 44 Dam. The study will result in an updated Water Control Manual following

1 completion of an EIS and an engineering report (USACE et al. 2012). This  
2 project could change flow patterns in the American and Sacramento rivers and the  
3 Delta.

4 *Federal Energy Regulatory Commission Relicensing for Middle Fork of the*  
5 *American River Project*

6 The Federal Energy Regulatory Commission (FERC) completed a final EIS for  
7 the relicensing of the Placer County Water Agency existing 223,753 kilowatt  
8 Middle Fork American River Hydroelectric Project. The project is located on the  
9 Middle Fork of the American River, Rubicon River, and Duncan and North and  
10 South Fork Long Canyon creeks in Placer and El Dorado counties. The re-  
11 licensing will provide for continued operation of the project with increased pulse  
12 and minimum instream flow releases, defined ramping rates, whitewater boating  
13 flow releases, protection of sensitive species, maintenance and enhancement of  
14 recreation opportunities, erosion and sedimentation reduction measures,  
15 vegetation improvement plans, and recreation management plans (FERC 2012).  
16 This project will change flow patterns in the American River and improve  
17 conditions for aquatic species in portions of the American River watershed.

18 *Lower Mokelumne River Spawning Habitat Improvement Project*

19 The Mokelumne River is tributary to the Delta and supports five species of  
20 anadromous fish. The proposed project will initially include placement of  
21 4,000 to 5,000 cubic yards of suitably sized salmonid spawning gravel annually  
22 for a 3-year period at two specific sites, and then provide annual supplementation  
23 of 600 to 1,000 cubic yards thereafter. Fall-run Chinook Salmon and steelhead  
24 are the primary management focus in the river. Availability of spawning gravel in  
25 this section of the Mokelumne River has been determined to be deficient because  
26 historic gold and aggregate mining operations removed gravel annually and  
27 upstream dams have reduced gravel transport to the area. This area was chosen  
28 because it is known to have supported fall-run Chinook Salmon and steelhead  
29 spawning in the past and because the substrate is suitable for habitat improvement  
30 (USFWS 2009).

31 This project will improve conditions for aquatic species in the Mokelumne and  
32 San Joaquin rivers.

33 *Dutch Slough Tidal Marsh Restoration*

34 The Dutch Slough Tidal Marsh Restoration Project, located near Oakley in  
35 Eastern Contra Costa County, will restore wetland and uplands, and provide  
36 public access to the 1,200-acre Dutch Slough property. The property is composed  
37 of three parcels separated by narrow man-made sloughs. The project is a  
38 cooperative partnership between DWR, State Coastal Conservancy, CDFW, City  
39 of Oakley, Ironhouse Sanitary District, Reclamation Districts 2137 and 799,  
40 Natural Heritage Institute, and landowners. The project will provide ecosystem  
41 benefits, including habitat for sensitive species, including winter-run Chinook  
42 Salmon Sacramento splittail, and many waterfowl species. It also will be  
43 designed and implemented to maximize opportunities to assess the development  
44 of those habitats and measure ecosystem responses so that future Delta restoration



1 projects will be more successful. DWR approved the Final Environmental Impact  
 2 Report (EIR) for the project in March 2010 (NMFS 2013). This project will  
 3 improve conditions for aquatic and terrestrial species in the Delta through tidal  
 4 marsh restoration.

5 *Suisun Marsh Habitat Management, Preservation, and Restoration Plan*  
 6 *Implementation*

7 On March 2, 1987, the Suisun Marsh Preservation Agreement (SMPA) was  
 8 signed by DWR, CDFW, Reclamation, and the Suisun Resource Conservation  
 9 District. The purpose of the agreement was to establish mitigation for impacts on  
 10 salinity from the SWP, CVP, and other upstream diversions. The SMPA contains  
 11 provisions for Reclamation and DWR to mitigate the adverse effects on Suisun  
 12 Marsh channel water salinity from operation of the CVP and SWP and other  
 13 upstream diversions. The Suisun Marsh Habitat Management, Preservation and  
 14 Restoration Plan (SMP) was completed in 2014 under the direction of  
 15 Reclamation, USFWS, CDFW, NMFS, Suisun Resource Conservation District,  
 16 and CALFED Bay-Delta Program (the Principal Agencies). This group was  
 17 assisted by regulatory agencies such as the USACE, Bay Conservation and  
 18 Development Commission, SWRCB, and the San Francisco Bay Regional Water  
 19 Quality Control Board. The following actions will be implemented under the plan  
 20 (Reclamation 2014a).

- 21 • Restoration of up to 7,000 acres of tidal marsh and protection and  
 22 enhancement of up to 46,000 acres of managed wetlands through dredging,  
 23 erosion protection, and installation of fish screens.
- 24 • Increased frequency of currently implemented managed wetlands activities.
- 25 • Implementation of the Preservation Agreement Implementation Fund (PAI  
 26 Fund) to improve managed wetland flood and drain capabilities to  
 27 accommodate high salinity water while maintaining functions and values of  
 28 managed wetland habitats.

29 The plan includes environmental commitments and mitigation measures, an  
 30 adaptive management program, and reporting through annual reports over the  
 31 30-year time frame of the plan. This project will improve conditions for aquatic  
 32 and terrestrial species in the Delta and Suisun Marsh.

33 *Tidal Wetland Restoration in the Delta and Suisun Marsh*

34 In addition to tidal wetlands restoration that would occur in the Suisun Marsh,  
 35 several programs are being implemented in the Cache Slough portion of the Delta.  
 36 The 2008 USFWS BO RPA required a program to create or restore a minimum of  
 37 8,000 acres of intertidal and associated subtidal habitat in the Delta and Suisun  
 38 Marsh. As described above, up to 7,000 acres of tidal marsh restoration would  
 39 occur under the SMP. Other programs have been initiated to restore or expand  
 40 tidal wetlands, and could provide an additional 3,000 acres of tidal wetlands in the  
 41 Delta and Suisun Marsh. This additional 3,000 acres could be completed in  
 42 accordance with the 2008 USFWS BO requirements. The No Action Alternative  
 43 includes the following restoration programs.

- 1 • Yolo Ranch (initial phase), Northwest Field Network 4, and Flyway Farms –  
2 941 and 405 acres, respectively, of tidal influenced lands (SFWCA 2011,  
3 2013).
- 4 • Northern Liberty Island Fish Restoration Project – 737 acres (RD 2093 2011).
- 5 • Prospect Island Restoration Project – 1,170 acres (based on maps included in  
6 CDFW and DWR 2013).
- 7 • Calhoun Cut/Lindsey Slough Tidal Habitat Restoration Project – 87 acres  
8 (CDFW 2015).

9 *San Joaquin River Restoration Program*

10 The San Joaquin River Restoration Program is a comprehensive long-term effort  
11 to restore flows to the San Joaquin River from Friant Dam to the confluence of  
12 Merced River and restore a self-sustaining Chinook Salmon fishery in the river  
13 while reducing or avoiding adverse water supply impacts from restoration flows.  
14 The restoration program is the product of more than 18 years of litigation, which  
15 culminated in a Stipulation of Settlement on the lawsuit known as *NRDC, et al.,*  
16 *v. Kirk Rodgers, et al.* The settling parties reached agreement on the terms and  
17 conditions of the settlement, which was subsequently approved by the District  
18 Court on October 23, 2006. The settling parties include the Natural Resources  
19 Defense Council, Friant Water Users Authority, and the U.S. Departments of the  
20 Interior and of Commerce. The settlement's two primary goals are to:

- 21 • Restore and maintain fish populations in "good condition" in the main stem of  
22 the San Joaquin River below Friant Dam to the confluence of the Merced  
23 River, including naturally reproducing and self-sustaining populations of  
24 salmon and other fish, and
- 25 • Reduce or avoid adverse water supply impacts to all of the Friant Division  
26 long-term contractors that may result from the Interim Flows and Restoration  
27 Flows provided for in the settlement.

28 The settlement requires specific releases of water from Friant Dam to the  
29 confluence of the Merced River, which are designed primarily to meet the various  
30 life stage needs for spring- and fall-run Chinook Salmon. The release schedule  
31 assumes continuation of the current average Friant Dam release of 116,741 acre-  
32 feet, annually, with specific flow requirements depending on the year type. The  
33 project was authorized and funded with the passage of San Joaquin River  
34 Restoration Settlement Act, part of the Omnibus Public Land Management Act of  
35 2009 (Public Law 111-11). Interim flows began in October, 2009. There are  
36 many physical improvements within and near the San Joaquin River that will be  
37 undertaken to fully achieve the river restoration goal. The improvements will  
38 occur in two separate phases that will focus on a combination of water releases  
39 from Friant Dam, as well as structural and channel improvements (Reclamation  
40 2012). This project will improve conditions for aquatic and terrestrial species in  
41 the San Joaquin River and the Delta.

1 This EIS does not address the CVP facilities associated with Millerton Lake,  
2 including the Madera and Friant-Kern canals and their service areas, and the San  
3 Joaquin River Restoration Program because these facilities are not considered in  
4 the consultations related to the 2008 USFWS BO and 2009 NMFS BO.

5 *Stockton Deep Water Ship Channel Demonstration Dissolved Oxygen Project*

6 The Stockton Deep Water Ship Channel Demonstration Dissolved Oxygen  
7 Project is a multiple-year study of the effectiveness of elevating dissolved oxygen  
8 (DO) concentrations in the channel. The DO concentrations drop as low as 2 to  
9 3 milligrams per liter (mg/L) during warmer and lower water flow periods in the  
10 San Joaquin River. The low DO levels can adversely affect aquatic life including  
11 the health and migration behavior of anadromous fish (e.g., salmon). The  
12 objective of the study is to maintain DO levels above the minimum recommended  
13 levels specified in the 2006 Water Quality Control Plan (Basin Plan) for the  
14 Sacramento River and San Joaquin River basins, as described in Chapter 6,  
15 Surface Water Quality.

16 The project's full-scale aeration system includes two 200-foot-deep u-tube  
17 aeration tubes; two vertical turbine pumps capable of pumping over  
18 11,000 gallons of water each; a liquid-to-gas oxygen supply system; and  
19 numerous pieces of ancillary equipment and control systems. The system has  
20 been sized to deliver approximately 10,000 pounds of oxygen per day into the  
21 Deep Water Ship Channel. The aeration system is anticipated to be operated only  
22 when channel DO levels are below the Basin Plan DO water quality objectives  
23 (approximately 100 days per year). The project study includes an on-going  
24 assessment of DO levels in the channel and vicinity and a study of potential  
25 adverse effects of low DO on salmon (DWR 2010a). This project will improve  
26 water quality in the central and south Delta as compared to historical conditions.

27 *Grasslands Bypass Project*

28 Reclamation is actively engaged with the Grassland Area Farmers who discharge  
29 subsurface agricultural drainage waters through the Grassland Bypass Project,  
30 which is a significant source of selenium to the San Joaquin River and to the  
31 Delta. Reclamation and the Grassland Area Farmers are continuing to reduce the  
32 amount of agricultural drainage water produced in the Grassland Drainage Area,  
33 preventing the discharge of this water into local Grassland wetland water supply  
34 channels, and improving the quality of water in the San Joaquin River. The  
35 Grassland Bypass Project is based upon an agreement between Reclamation and  
36 the San Luis and Delta-Mendota Water Authority to use a 28-mile segment of the  
37 San Luis Drain to convey agricultural subsurface drainage water from the  
38 Grassland Drainage Area to Mud Slough (North), a tributary of the San Joaquin  
39 River. An extensive monitoring program by the San Francisco Estuary Institute  
40 (2013) continues to document the effectiveness of actions such as source control  
41 and other measures being taken by the Grassland Area Farmers. These actions by  
42 the Grassland Area Farmers are described in Chapter 2 of SFEI (2013). Briefly,  
43 these activities have included the Grassland Bypass Project and the San Joaquin  
44 River Improvement Project, formation of a regional drainage entity, newsletters  
45 and other communication with the farmers, a monitoring program, using State

1 Revolving Fund loans for improved irrigation systems, installing and using  
2 drainage recycling systems to mix subsurface drainage water with irrigation  
3 supplies under strict limits, tiered water pricing and a tradable loads programs.

4 The purposes and objectives of the Grasslands Bypass Project, 2010–2019, are to:  
5 1) extend the San Luis Drain Use Agreement in order to allow the Grassland  
6 Basin Drainers time to acquire funds and develop feasible drainwater treatment  
7 technology to meet revised Basin Plan objectives and Waste Discharge  
8 Requirements by December 31, 2019; 2) continue the separation of unusable  
9 agricultural drainage water discharged from the Grassland Drainage Area from  
10 wetland water supply conveyance channels for the period 2010–2019; and  
11 3) facilitate drainage management that maintains the viability of agriculture in the  
12 project area and promotes continuous improvement in water quality in the San  
13 Joaquin River. All discharges of drainage water from the Grassland Drainage  
14 Area into wetlands and refuges have been eliminated. The selenium load  
15 discharged from the Grassland Drainage Area has been reduced by 61 percent  
16 (from 9,600 pounds to 3,700pounds) and the salt load has been reduced by  
17 39 percent (from 187,300 tons to 113,600 tons). Prior to the project, the monthly  
18 mean concentration of selenium in Salt Slough was 16 parts per billion. Since  
19 implementation of this project, the concentration has been less than the water  
20 quality objective of 2 parts per billion. The drainage water is conveyed to Mud  
21 Slough. Grasslands Water District and others are currently evaluating alternative  
22 plans to comply with Central Valley Regional Water Quality Control Board water  
23 quality objectives for selenium and salinity in the San Joaquin River at the end of  
24 this project in 2019. One of the alternatives could be zero discharge with  
25 complete recycle of the drainwater to salinity-tolerant crops (Reclamation 2009).  
26 This project will improve water quality in the San Joaquin River and the central  
27 and south Delta.

28 *Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS)*

29 In 2006, the Central Valley Regional Water Quality Control Board, the SWRCB,  
30 and stakeholders began a joint effort to address salinity and nitrate problems in  
31 California's Central Valley and adopt long-term solutions that will lead to  
32 enhanced water quality and economic sustainability. This effort is referred to as  
33 the Central Valley Salinity Alternatives for Long-term Sustainability (CV-  
34 SALTS) Initiative. The goal of CV-SALTS is to develop a comprehensive  
35 region-wide Salt and Nitrate Management Plan (SNMP) describing a water  
36 quality protection strategy that will be implemented through a mix of voluntary  
37 and regulatory efforts. The SNMP may include recommendations for numeric  
38 water quality objectives, beneficial use designation refinements, and/or other  
39 refinements, enhancements, or basin plan revisions.

40 The SNMP and will serve as the basis for amendments to the three Basin Plans  
41 that cover the Central Valley Region (Sacramento River and San Joaquin River  
42 Basin Plan, the Tulare Lake Basin Plan and the Sacramento/San Joaquin Rivers  
43 Bay-Delta Plan). The basin plan "amendments" will likely establish a  
44 comprehensive implementation plan to achieve water quality objectives for  
45 salinity (including nitrate) in the Region's surface waters and groundwater. The

1 SNMP may include recommendations for numeric water quality objectives,  
 2 beneficial use designation refinements, and/or other refinements, enhancements,  
 3 or basin plan revisions (CVRWQCB 2015). This project could change water  
 4 quality and flow patterns in the San Joaquin River.

5 *Municipal Water Supply Projects*

6 Municipal water users in California are required to prepare Urban Water  
 7 Management Plans (UWMPs) in accordance with the California Urban Water  
 8 Management Planning Act of 1983. The State Water Conservation Act of 2009  
 9 (also known as SBx7-7) required the UWMPs to identify the water demands and  
 10 water supplies for their service area through the year 2030, and to provide a plan  
 11 to reduce statewide per capita water use by 20 percent by the year 2020. All of  
 12 the UWMPs identify conservation measures to reduce water demands by 2020.  
 13 Many of the UWMPs identify projects that are being planned or implemented to  
 14 meet water demands in 2030. Water resources projects that have been approved  
 15 and are being implemented are assumed to be complete by 2030 under the No  
 16 Action Alternative. There are numerous projects considered in the study area to  
 17 be included in the No Action Alternative, as described in Appendix 5D,  
 18 Municipal and Industrial Water Demands and Supplies, including the following  
 19 major water supply projects.

- 20 • Cambria Emergency Water Supply Project desalination project (CCSD 2014).
- 21 • Carlsbad Metropolitan Water District water recycling project (Carlsbad MWD  
 22 2012)
- 23 • Central Basin Municipal Water District Southeast Water Reliability Project  
 24 (CBMWD 2011).
- 25 • City of Los Angeles Department of Water and Power groundwater recharge  
 26 projects (City of Los Angeles 2011, 2013a).
- 27 • City of Oxnard GREAT Program Desalter (City of Oxnard 2013).
- 28 • Eastern Municipal Water District water recycling programs (EMWD 2014a,  
 29 2014b).
- 30 • Fresno Irrigation District groundwater recharge projects (FID 2015).
- 31 • Inland Empire Utilities Agency groundwater recharge projects (IEUA 2015).
- 32 • Kern County and Antelope Valley-East Kern Water Agency (AVEK 2011).
- 33 • Los Angeles County Sanitation Districts expansion of water recycling  
 34 programs (LACSD 2005).
- 35 • San Benito County Water District expansion of water treatment plant to treat  
 36 CVP water (SBCWD 2014).
- 37 • San Diego County Water Authority Carlsbad Seawater Desalination Facility  
 38 (SDCWA 2014).
- 39 • Santa Barbara desalination water treatment plant (KEYT 2015).

- 1 • Santa Clara Valley Water District wastewater recycling projects (SCVWD  
2 2012).
- 3 • City of Stockton Delta Water Supply Project (City of Stockton 2005).
- 4 • Victor Valley Wastewater Reclamation Authority water recycling programs  
5 (VVWRA 2015).
- 6 • Water Replenishment District Groundwater Reliability Improvement Program  
7 and water recycling programs (WRD 2012, 2015).
- 8 • West Basin Municipal Water District recycling water programs (WBMWD  
9 2011).
- 10 • Western Development and Storage Antelope Valley Water Bank (Reclamation  
11 2010).
- 12 • Western Municipal Water District Arlington Desalter Expansion to use saline  
13 groundwater (WMD 2015).
- 14 • Woodland-Davis Clean Water Agency water treatment plant (WDCWA  
15 2013).

16 *Water Transfer Projects*

17 Water transfer programs have been used historically throughout California,  
18 especially among CVP water users to meet both irrigation and municipal water  
19 demands either during drought or to replenish stored surface water or  
20 groundwater during wet periods (Reclamation 2013b).

21 Implementation of CVPIA in 1992 facilitated water transfers between CVP water  
22 users and between CVP water users and non-CVP water users. The water can be  
23 transferred through CVP facilities in a manner that does not harm the operation of  
24 the CVP for other users and beneficial uses. CVP facilities also can be used to  
25 convey non-CVP water under the Warren Act of 1911. In the first 10 years  
26 following adoption of CVPIA, more than 4.3 million acre-feet of water was  
27 transferred for agricultural and municipal water uses and more than 396,000 acre-  
28 feet was transferred to the DOI for Level 4 Refuge Water Supplies (Reclamation  
29 2004a). Water transfers also occur between the SWP water users and non-SWP  
30 water users. SWP facilities can be used to convey the transferred water, including  
31 non-SWP water, under DWR conveyance agreements.

32 Historically, water transfers primarily were in-basin transfers (e.g., Sacramento  
33 Valley water seller to Sacramento Valley water user) (Reclamation 2013b; DWR,  
34 Reclamation, USFWS and NMFS 2013). However, between 2001 and 2012,  
35 water transfers from the Sacramento Valley to the areas located south of the Delta  
36 of up to 298,806 acre-feet occurred (not including water transfers under the  
37 Environmental Water Account Program in the early 2000s) (DWR, Reclamation,  
38 USFWS and NMFS 2013). These transfers occurred in drier years. In 2012 and  
39 2013, the following types of water transfers occurred (DWR and SWRCB 2014).

- 1 • Water transfers involving CVP and SWP water:
  - 2 – 2012: 47,420 acre-feet of water transfers (43 percent were between
  - 3 agricultural water users, 36 percent were between municipal water users,
  - 4 and 21 percent were between agricultural and municipal water users).
  - 5 – 2013: 63,790 acre-feet of water transfers (28 percent were between
  - 6 agricultural water users, and 72 percent were between agricultural and
  - 7 municipal water users).
- 8 • Water transfers involving non-CVP and SWP water:
  - 9 – 2012: 188,074 acre-feet of water transfers (72 percent were between
  - 10 agricultural water users, 14 percent were from agricultural water users to
  - 11 wildlife refuges, and 14 percent were between agricultural and municipal
  - 12 water users).
  - 13 – 2013: 268,370 acre-feet of water transfers (72 percent were between
  - 14 agricultural water users, 1 percent were from agricultural water users to
  - 15 wildlife refuges, and 27 percent were between agricultural and municipal
  - 16 water users).

17 Until recently, most of the water transfers extended for one or two years. In 2008,  
 18 one of the first long-term water transfer agreements was approved by the SWRCB  
 19 for the Lower Yuba River Accord. The plan was designed to protect and enhance  
 20 fisheries resources in the Lower Yuba River, increase local water supply  
 21 reliability, provide DWR with increased operational flexibility for protection of  
 22 Delta fisheries resources, and provide added dry-year water supplies to CVP and  
 23 SWP water users, as described in Appendix 3A, No Action Alternative: Central  
 24 Valley Project and State Water Project Operations. In 2013, Reclamation  
 25 approved an overall program for a 25-year period (2014 to 2038) to transfer up to  
 26 150,000 acre-feet/year of water from the San Joaquin River Exchange Contractors  
 27 Water Authority to DOI for refuge water supplies or CVP and SWP water users  
 28 (Reclamation 2013b). Reclamation is currently evaluating a long-term water  
 29 transfer program (2015 to 2024) between water sellers in the Sacramento Valley  
 30 and water users located in the San Francisco Bay Area and south of the Delta  
 31 (Reclamation 2014b).

32 Transfer programs generally involve annual crop changes using temporary crop  
 33 idling or shifting, release of stored water in reservoirs on different patterns for the  
 34 purchasers' water demands, and/or groundwater substitution (DWR and  
 35 Reclamation 2014). The transfers must be approved by the CVP and/or SWP if  
 36 the transfer involves CVP or SWP water or utilizes CVP or SWP facilities.  
 37 Except for water transfers among CVP water users, water transfers also require  
 38 approval from the SWRCB. Environmental documentation is required for all  
 39 water transfers involving CVP and/or SWP water supplies or facilities. Under  
 40 State law, water transfers cannot result in injury to other legal users of water;  
 41 unreasonable impacts on fish and wildlife and instream uses; and unreasonable  
 42 economic or environmental impact on the county in which the transfer water  
 43 originates.

1 It is assumed that transfers would continue under the No Action Alternative in a  
2 similar manner as have occurred for the past 10 years. It is anticipated that the  
3 number of long-term transfer agreements could increase to facilitate annual  
4 decisions for water transfers. However, the conditions for each water transfer  
5 would be determined on a case-by-case basis.

### 6 **3.3.2 No Action Alternative**

7 In addition to the common conditions described above, the No Action Alternative  
8 also would include existing and future actions described in the 2008 USFWS BO  
9 and 2009 NMFS BO that would not occur by 2030 without implementation of the  
10 BOs and implementation of the USACE vegetation management operations along  
11 levees for flood management in accordance with policies issued by the USACE in  
12 2009 and 2010.

#### 13 **3.3.2.1 Continued Long-Term Operation of the CVP and SWP Facilities**

14 The actions related to the CVP and SWP operations are described in more detail  
15 in Appendix 3A, No Action Alternative: Central Valley Project and State Water  
16 Project Operations.

17 In addition to the operational actions, there are several actions that would not have  
18 been implemented by 2030 under the No Action Alternative without  
19 implementation of the 2008 USFWS BO and 2009 NMFS BO. These actions  
20 have not been fully defined at this time; and therefore, would require future  
21 engineering and environmental evaluation prior to implementation. These  
22 following actions are assumed to be completed under the No Action Alternative,  
23 and the objectives outlined in the 2008 USFWS BO and 2009 NMFS BO are  
24 assumed to be achieved by 2030.

- 25 • 2009 NMFS BO RPA Action I.2.5, Winter-Run Passage and Re-Introduction  
26 Program at Shasta Dam.
- 27 • 2009 NMFS BO RPA Action II.3, Structural Improvements for Temperature  
28 Management on the American River, including installation of a Folsom Dam  
29 temperature control device, methods to transport cold water through Lake  
30 Natoma, installation of a temperature control device on the El Dorado  
31 Irrigation District intake from Folsom Lake, and development of temperature  
32 management decision-support tools.
- 33 • 2009 NMFS BO RPA Action II.5, Fish Passage at Nimbus and Folsom Dams.
- 34 • 2009 NMFS BO RPA Action II.6, Implement Actions to Reduce Genetic  
35 Effects of Nimbus and Trinity River Fish Hatchery Operations.
- 36 • 2009 NMFS BO RPA Action III.2.1, Increase and Improve Quality of  
37 Spawning Habitat with Addition of 50,000 Cubic Yards of Gravel by 2014  
38 and with a Minimum Addition of 8,000 Cubic Yards per Year for the Duration  
39 of the Project Actions on Stanislaus River.



- 1 • 2009 NMFS BO RPA Action III.2.2, Conduct Floodplain Restoration and  
2 Inundation Flows in Winter or Spring to Inundate Steelhead Juvenile Rearing  
3 Habitat on One- to Three-Year Schedule on Stanislaus River.
- 4 • 2009 NMFS BO RPA Action III.2.3, Restore Freshwater Migratory Habitat  
5 for Juvenile Steelhead by Implementing Projects to Increase Floodplain  
6 Connectivity and to Reduce Predation Risk During Migration on Stanislaus  
7 River.
- 8 • 2009 NMFS BO RPA Action III.2.4, Fish Passage at New Melones, Tulloch,  
9 and Goodwin Dams.
- 10 • 2009 NMFS BO RPA Action IV.4, Tracy Fish Collection Facility  
11 Improvements to Reduce Pre-Screen Loss and Improve Screening Efficiency.
- 12 • 2009 NMFS BO RPA Action IV.4.2 Skinner Fish Collection Facility  
13 Improvements to Reduce Pre-Screen Loss and Improve Screening Efficiency.
- 14 • 2009 NMFS BO RPA Action IV.4.3 Tracy Fish Collection Facility and the  
15 Skinner Fish Collection Facility Actions to Improve Salvage Monitoring,  
16 Reporting and Release Survival Rates.

17 **3.3.2.2 Vegetation Management along Levees**

18 The No Action Alternative also would include vegetation management operations  
19 along levees for flood management in accordance with policies issued by the  
20 USACE in 2009 and 2010. Historically, the USACE has allowed brush and small  
21 trees to be located on the waterside of federal flood management project levees if  
22 the vegetation would preserve, protect, and/or enhance natural resources, and/or  
23 protect rights of Native Americans, while maintaining the safety, structural  
24 integrity, and functionality of the levee (DWR 2011b). After Hurricane Katrina in  
25 2005, the USACE issued a policy and draft policy guidance to remove substantial  
26 vegetation from these levees throughout the nation (USACE 2009). This policy  
27 requires federally authorized levee systems that have maintenance agreements  
28 with the USACE (including Delta levees along the Sacramento and San Joaquin  
29 rivers) and other levees that are eligible for the federal Rehabilitation and  
30 Inspection Program (Public Law 84-99) to remove vegetation in the following  
31 manner.

- 32 • Removal of all vegetation from the upper third of the waterside slope of the  
33 levee, the top of the levee, landside slope of the levee, or within 15 feet of the  
34 toe of the levee on the landside (“toe” is where the levee slope meets the  
35 ground surfaces).
- 36 • Removal of all vegetation over 2 inches in diameter on the lower two-thirds of  
37 the waterside slope of the levee and within 15 feet of the toe of the levee on  
38 the waterside along benches above the water surface.

39 In 2010, the USACE issued a draft policy guidance letter, *Draft Process for*  
40 *Requesting a Variance from Vegetation Standards for Levees and Floodwalls—*  
41 *75 Federal Register 6364-68* (USACE 2010) that included procedures for State  
42 and local agencies to request variances on a site-specific basis. DWR has been in

1 negotiations with USACE to remove vegetation on the upper third of the  
2 waterside slope, top, and landside of the levees, and continue to allow vegetation  
3 on the lower two-thirds of the waterside slope of the levee and along benches  
4 above the water surface (DSC 2011). By 2030, it is anticipated that much of the  
5 existing vegetation on the upper third of the waterside slopes, tops, landside  
6 slopes, and within 15 feet of the landside toe of the levees would be removed.

### 7 **3.3.3 Second Basis of Comparison**

8 Numerous comments received during the scoping process and subsequently  
9 during preparation of the Draft EIS requested that the No Action Alternative not  
10 include the 2008 USFWS BO RPA and 2009 NMFS BO RPA. The comments  
11 indicated that the EIS should include a “basis of comparison” for the alternatives  
12 that was similar to conditions prior to implementation of the RPAs. Scoping  
13 comments also indicated that a “No Action Alternative scenario” without  
14 implementation of the RPAs in the 2008 USFWS BO and 2009 NMFS BO could  
15 be used to analyze the effects of implementing the RPAs.

16 Determining an appropriate baseline without the 2008 USFWS BO and 2009  
17 NMFS BO actions and yet continuing to meet all of Reclamation’s statutory and  
18 regulatory requirements is a difficult task. Simply analyzing a No Action  
19 Alternative that is similar to the project description described in either the 2004  
20 Biological Assessment or 2008 Biological Assessment is insufficient, as each was  
21 found to jeopardize listed species (the 2004 Biological Assessment by the District  
22 Court in 2007, and the 2008 Biological Assessment by USFWS and NMFS).  
23 Either of these operations would be inconsistent with Reclamation’s existing  
24 policy and management direction.

25 Reclamation has provisionally accepted and implemented the 2008 USFWS BO  
26 and 2009 NMFS BO actions; therefore, the No Action Alternative, by definition,  
27 must include these actions because they represent a continuation of existing  
28 policy and management direction. In response to the comments and to provide a  
29 basis for comparison of the effects of implementation of the RPAs (per the  
30 District Court’s mandate), this EIS includes a “Second Basis of Comparison” that  
31 does not include implementation of the RPAs. The Second Basis of Comparison  
32 can be used as a basis of comparison for the alternatives that do not include the  
33 RPAs. In this way, the action alternatives can be compared against both the No  
34 Action Alternative and the Second Basis of Comparison.

#### 35 **3.3.3.1 Continued Long-Term Operation of the CVP and SWP Facilities**

36 The Second Basis of Comparison conditions assume that climate change  
37 conditions would have changed between 2015 and 2030. It is anticipated that by  
38 2030, there will be less snowfall over the long-term average conditions and higher  
39 mean sea level elevations.

40 The CVP and SWP operations would be in accordance with water rights permits  
41 and licenses issued by the SWRCB and biological opinions issued by the USFWS  
42 and NMFS in the early 2000s. The CVP and SWP operations would be closely  
43 coordinated through the COA. The ongoing operational management policies of

1 the CVP and SWP under the Second Basis of Comparison would be similar to the  
 2 operational assumptions described in Appendix 3A, No Action Alternative:  
 3 Central Valley Project and State Water Project Operations, except for the sections  
 4 identified as “Implementation of the 2008 USFWS BO [and/or 2009 NMFS BO]”  
 5 (see Section 3A.4.3.4.8) and New Melones Reservoir operations.

6 The Second Basis of Comparison includes implementation of existing and future  
 7 actions described in the 2008 USFWS BO and 2009 NMFS BO that would occur  
 8 by 2030 without implementation of the biological opinions (as described in  
 9 Section 3.3.1.2). The Second Basis of Comparison also includes implementation  
 10 of future actions not described in the 2009 NMFS BO that would occur by 2030  
 11 without implementation of any alternatives considered in this EIS (as described in  
 12 Section 3.3.1.3).

13 The Second Basis of Comparison would not include implementation of future  
 14 actions described in the 2008 USFWS BO and 2009 NMFS BO that would not  
 15 occur by 2030 without implementation of the biological opinions, as described  
 16 below, including operations RPA actions and the following actions.

- 17 • 2009 NMFS BO RPA Action I.2.5, Winter-Run Passage and Re-Introduction  
 18 Program at Shasta Dam.
- 19 • 2009 NMFS BO RPA Action II.3, Structural Improvements for Temperature  
 20 Management on the American River, including installation of a Folsom Dam  
 21 temperature control device, methods to transport cold water through Lake  
 22 Natoma, installation of a temperature control device on the El Dorado  
 23 Irrigation District intake from Folsom Lake, and development of temperature  
 24 management decision-support tools.
- 25 • 2009 NMFS BO RPA Action II.5, Fish Passage at Nimbus and Folsom Dams.
- 26 • 2009 NMFS BO RPA Action II.6, Implement Actions to Reduce Genetic  
 27 Effects of Nimbus and Trinity River Fish Hatchery Operations.
- 28 • 2009 NMFS BO RPA Action III.2.1, Increase and Improve Quality of  
 29 Spawning Habitat with Addition of 50,000 Cubic Yards of Gravel by 2014  
 30 and with a Minimum Addition of 8,000 Cubic Yards per Year for the Duration  
 31 of the Project Actions on Stanislaus River.
- 32 • 2009 NMFS BO RPA Action III.2.2, Conduct Floodplain Restoration and  
 33 Inundation Flows in Winter or Spring to Inundate Steelhead Juvenile Rearing  
 34 Habitat on One- to Three-Year Schedule on Stanislaus River.
- 35 • 2009 NMFS BO RPA Action III.2.3, Restore Freshwater Migratory Habitat  
 36 for Juvenile Steelhead by Implementing Projects to Increase Floodplain  
 37 Connectivity and to Reduce Predation Risk During Migration on Stanislaus  
 38 River.
- 39 • 2009 NMFS BO RPA Action III.2.4, Fish Passage at New Melones, Tulloch,  
 40 and Goodwin Dams.

- 1 • 2009 NMFS BO RPA Action IV.4, Tracy Fish Collection Facility  
2 Improvements to Reduce Pre-Screen Loss and Improve Screening Efficiency.
- 3 • 2009 NMFS BO RPA Action IV.4.2 Skinner Fish Collection Facility  
4 Improvements to Reduce Pre-Screen Loss and Improve Screening Efficiency.
- 5 • 2009 NMFS BO RPA Action IV.4.3 Tracy Fish Collection Facility and the  
6 Skinner Fish Collection Facility Actions to Improve Salvage Monitoring,  
7 Reporting and Release Survival Rates.

### 8 **3.3.3.2 Vegetation Management Along Levees**

9 The Second Basis of Comparison includes vegetation management operations  
10 along levees for flood management in accordance with policies issued by the  
11 USACE in 2009 and 2010.

### 12 **3.3.3.3 New Melones Reservoir Operations**

13 Under the Second Basis of Comparison, operations of New Melones Reservoir  
14 would be the same as under the No Action Alternative for flood management,  
15 water quality, San Joaquin River base flows and pulse flows at Vernalis, and  
16 water supply. Because the Second Basis of Comparison represents regulatory  
17 environment without the 2008 USFWS and 2009 NMFS BOs, fishery flows  
18 would be consistent with the 1997 New Melones Interim Plan of Operations (IPO)  
19 without implementation of the Vernalis Adaptive Management Program (VAMP),  
20 as described in Appendix 3A, No Action Alternative: Central Valley Project and  
21 State Water Project Operations.

## 22 **3.4 Development of Reasonable Alternatives**

23 The National Environmental Policy Act (NEPA) regulations and DOI NEPA  
24 regulations (43 CFR Section 46.415(b)) require an EIS to include a range of  
25 reasonable alternatives that meet the purpose and need of the proposed action, and  
26 address one or more significant issues related to the proposed action.

27 The DOI NEPA regulations also state that the lead agencies should include a  
28 consensus-based alternatives consistent with the purpose and need of the proposed  
29 project that are proposed by participating persons, organizations, or communities  
30 who may be interested in or affected by the proposed project when one exists. No  
31 alternatives or alternative concepts submitted to Reclamation during preparation  
32 of this EIS were identified as consensus-based.

33 The range of alternatives was developed for this EIS through the identification of  
34 screening criteria based upon the purpose of the action; comparison of alternative  
35 concepts identified by Reclamation, stakeholders, and agencies to the screening  
36 criteria; and review of the identified range of alternatives to determine if the range  
37 of alternatives addresses the significant issues.

**3.4.1 Application of Screening Criteria to the Range of Alternative Concepts**

The screening criteria developed for this EIS is based upon the purpose of the action, as described in Chapter 2, Purpose and Need for the Action. The purpose of the action is:

- To continue the operation of the CVP, in coordination with operation of the SWP, for the authorized purposes, in a manner that:
  - Is similar to historic operational parameters with certain modifications;
  - Is consistent with Federal Reclamation law; other Federal laws; Federal permits and licenses; State of California water rights, permits, and licenses; and
  - Enables Reclamation and DWR to satisfy their contractual obligations to the fullest extent possible.

A number of alternative concepts were identified during the scoping process and through meetings with stakeholders and agencies during preparation of this EIS. These concepts were compared to the purpose of the action, as summarized in Table 3.1. Most of the concepts were incorporated into alternatives to be evaluated in detail in this EIS. Further discussion of concepts not included in the alternatives evaluated in detail in this EIS is presented in Section 3.4.8, Alternatives Considered but Not Evaluated in Detail.

**Table 3.1 Application of Screening Criteria to Alternative Concepts Identified for Consideration in the EIS**

<b>Alternative Concept</b>	<b>Consistent with Purpose for the Action</b>	<b>Addresses One or More Significant Issues</b>	<b>Include in One or More of the Alternatives Evaluated in the Draft EIS</b>
<b>Concept 1.</b> CVP and SWP Operations without actions defined in the 2008 USFWS BO RPA and 2009 NMFS BO RPA	Possibly	Yes	Yes, included in Alternatives 1, 3, and 4
<b>Concept 2.</b> Modify actions defined in the 2008 USFWS BO RPA and 2009 NMFS BO RPA in a manner that would increase CVP and SWP deliveries	Possibly	Yes	Yes, included in Alternatives 1, 3, and 4
<b>Concept 3.</b> Modify actions defined in the 2008 USFWS BO RPA and 2009 NMFS BO RPA in a manner that would reduce reverse flows and increase Delta outflow in the spring.	Possibly	Yes	Yes, included in Alternative 5

Alternative Concept	Consistent with Purpose for the Action	Addresses One or More Significant Issues	Include in One or More of the Alternatives Evaluated in the Draft EIS
<p><b>Concept 4.</b> Modify actions defined in the 2008 USFWS BO RPA and 2009 NMFS BO RPA in a manner that would increase primary productivity and flood supply for aquatic resources</p>	Possibly	Yes	Yes, included in Alternatives 1, 3, 4, and 5
<p><b>Concept 5.</b> Modify actions defined in the 2008 USFWS BO RPA and 2009 NMFS BO RPA in a manner that would modify the triggers for OMR criteria to protect Delta Smelt as follows:</p> <p>a) Reduce OMR criteria to a level between -5,000 cfs and -3,500 cfs only when appropriate based on analysis of turbidity levels and normalized salvage data in the south Delta</p> <p>b) Reduce OMR to no more negative than -5,000 cfs when more than 25 percent of the Delta Smelt collected in the spring kodiak or 20 mm trawl are located in the south Delta or the adult cumulative salvage index immediately preceding spawning is high; lift this restriction if Qwest is &gt;12,000 cfs and/or secchi depth in the south Delta is &gt;85 cm</p> <p>Do not implement RPA actions in the 2008 USFWS BO or 2009 NMFS BO</p>	Possibly	Yes	Yes, included in Alternative 3

Alternative Concept	Consistent with Purpose for the Action	Addresses One or More Significant Issues	Include in One or More of the Alternatives Evaluated in the Draft EIS
<p><b>Concept 6.</b> Modify actions defined in the 2009 NMFS BO RPA related to the Interim Criteria for the San Joaquin River Inflow:Export ratio as follows for April 1 through May 30:</p> <p>Flows in San Joaquin River at Vernalis (7-day running average shall not be less than 7 percent of the target requirement) shall be based on the New Melones Index (as described in 2009 NMFS BO RPA Action IV.2.1) as follows for January 1 through June 15:</p> <p>a) If the Index is 999 TAF or less - no minimum flow requirement</p> <p>b) If the Index is 1000-1399 TAF - minimum flow is the greater of the SWRCB D-1641 requirement or 1500 cfs</p> <p>c) If the Index is 1400-1999 TAF - minimum flow is the greater of the SWRCB D-1641 requirement or 3000 cfs</p> <p>d) If the Index is 2000-2499 TAF - minimum flow is 4500 cfs</p> <p>e) If the Index is above 2499 TAF - minimum flow is 6000 cfs</p> <p>Do not implement RPA actions in the 2008 USFWS BO or 2009 NMFS BO</p>	<p>Possibly</p>	<p>Yes</p>	<p>No, this criteria is not implementable following the completion of the Vernalis Adaptive Management Program. Other flow criteria for the San Joaquin River at Vernalis are included in the range of alternatives, however this concept is informed the development of other alternative concepts evaluated in this EIS.</p>

Alternative Concept	Consistent with Purpose for the Action	Addresses One or More Significant Issues	Include in One or More of the Alternatives Evaluated in the Draft EIS
<p><b>Concept 7.</b> Implement predator control programs for Black Bass, Striped Bass, and Pikeminnow to protect salmonids and Delta Smelt as follows:</p> <p>a) Black Bass catch limit changed to allow catch of 12-inch fish with a bag limit of 10</p> <p>b) Striped Bass catch limit changed to allow catch of 12-inch fish with a bag limit of 5</p> <p>c) Establish a Pikeminnow sport-fishing reward program with a 8-inch limit at \$2/fish</p>	Yes	Yes	Yes, included in Alternatives 3 and 4
<p><b>Concept 8.</b> Restore or create at least 10,000 acres of tidally influenced seasonal or perennial wetlands.</p> <p>Do not implement other wetlands restoration RPA actions in the 2008 USFWS BO or 2009 NMFS BO</p>	Yes	Yes	Yes, included in Alternatives 3 and 4



Alternative Concept	Consistent with Purpose for the Action	Addresses One or More Significant Issues	Include in One or More of the Alternatives Evaluated in the Draft EIS
<p><b>Concept 9.</b> Establish a trap and haul program for juvenile salmonids entering the Delta from the San Joaquin River in March through June as follows:</p> <ul style="list-style-type: none"> <li>a) Begin operation of downstream migrant fish traps upstream of the Head of Old River on the San Joaquin River</li> <li>b) “Barge” all captured juvenile salmonids through the Delta, release at Chipps Island.</li> <li>c) Tag subset of fish in order to quantify effectiveness of the program</li> <li>d) Attempt to capture 10 percent to 20 percent of outmigrating juvenile salmonids</li> </ul>	<p>Yes</p>	<p>Yes</p>	<p>Yes, included in Alternatives 3 and 4</p>
<p><b>Concept 10.</b> Work with Pacific Fisheries Management Council, CDFW, and NMFS to minimize harvest mortality of natural origin Central Valley Chinook Salmon, including fall-run Chinook Salmon, by evaluating and modifying ocean harvest for consistency with Viable Salmonid Population Standards; including harvest management plan to show that abundance, productivity, and diversity (age-composition) are not appreciably reduced</p>	<p>Maybe</p>	<p>Yes</p>	<p>Yes, included in Alternative 3</p>

<b>Alternative Concept</b>	<b>Consistent with Purpose for the Action</b>	<b>Addresses One or More Significant Issues</b>	<b>Include in One or More of the Alternatives Evaluated in the Draft EIS</b>
<p><b>Concept 11.</b> Work with Pacific Fisheries Management Council, CDFW, and NMFS to impose salmon harvest restrictions to reduce by-catch of winter-run and spring-run Chinook Salmon to less than 10 percent of age-3 cohort in all years</p>	<p>Maybe</p>	<p>Yes</p>	<p>Yes, included in Alternative 4</p>
<p><b>Concept 12.</b> Limiting floodplain development to protect salmonids and Delta Smelt by implementing the following actions:</p> <ul style="list-style-type: none"> <li>a) Incorporate guidance into flood hazard mapping to help communities comply with the ESA</li> <li>b) Require communities to demonstrate ESA compliance for all flood plain map revisions</li> <li>c) Prioritize consideration of ESA listed species and critical habitat when selecting flood insurance studies</li> <li>d) Develop and implement floodplain management criteria</li> <li>e) Refine community rating system to provide credits for natural and beneficial functions</li> <li>f) Prohibit new development and substantial improvements to existing development within any designated floodway or within 170 feet of the ordinary high water line of any floodway</li> </ul>	<p>Possibly</p>	<p>Yes</p>	<p>Yes, included in Alternative 4</p>

Alternative Concept	Consistent with Purpose for the Action	Addresses One or More Significant Issues	Include in One or More of the Alternatives Evaluated in the Draft EIS
<p><b>Concept 13.</b> Do not implement USACE requirements for vegetation on levees, and instead bar removal of vegetation from levees, require planting of trees and shrubs on levees, and armor levees with vegetation, woody material, and root reinforcement material instead of riprap</p>	Possibly	Yes	Yes, included in Alternative 4
<p><b>Concept 14.</b> Advance the timing of upgrades at the Sacramento Regional Wastewater Treatment Plant to 2017; and implement advanced treatment technologies at the Fairfield-Suisun Sewer District treatment plant to reduce nutrients in the effluent</p>	Yes	Yes	No, these actions are under construction and will be complete by 2030, per the requirements of the SWRCB and the related Regional Water Quality Control Boards
<p><b>Concept 15.</b> Expand the current period of time for water transfers addressed in the operations consulted on in the 2008 USFWS BO and 2009 NMFS BO from July through September to year-round</p>	Possibly	Yes	Yes, included in Alternative 4
<p><b>Concept 16.</b> Include measures to support Federal and state fish-doubling goals, including the goals of CVPIA</p>	Yes	Yes	Yes, included in Alternatives 1, 2, 3, 4, and 5 as part of ongoing implementation of CVPIA
<p><b>Concept 17.</b> Operate the CVP and SWP to avoid “dead-pool” conditions in Shasta Lake, Folsom Lake, and Lake Oroville</p>	Possibly	Yes	Yes, included in Alternatives 1, 2, 3, 4, and 5 as part of overall CVP and SWP operations

Alternative Concept	Consistent with Purpose for the Action	Addresses One or More Significant Issues	Include in One or More of the Alternatives Evaluated in the Draft EIS
<b>Concept 18.</b> Change CVP water operations to meet all in-basin water demands for the Trinity, Sacramento, American, and Stanislaus rivers watersheds before meeting other CVP water demands	No	Yes	No, this concept would not be consistent with the purpose for the action
<b>Concept 19.</b> Implement operations of the New Melones Reservoir in accordance with the 2012 Oakdale Irrigation District and South San Joaquin Irrigation District Operations Plan	Possibly	Yes	Yes, included in Alternative 3
<b>Concept 20.</b> Reduce reliance of the CVP and SWP water users on water exported from the Delta through development of regional and local water supplies	Possibly	Yes	Yes, included in Alternatives 1, 2, 3, 4, and 5 as part of overall statewide water operations
<b>Concept 21.</b> Changes to methods used to monitor and predict OMR flow criteria, including exclusion of Contra Costa Water District diversions from the calculations	Possibly	Maybe	No, this EIS analyzes overall operational concepts for the CVP and SWP. Specific methods to monitor and predict operations will be developed under separate efforts by Reclamation
<b>Concept 22.</b> Prioritize use of CVPIA restoration funds within watersheds in accordance with the amount of restoration funds collected in each watershed (e.g., the most funds would be highest in the watershed that generates the highest CVPIA restoration fund based upon water sales)	No	No	No, would not be consistent with CVPIA

Alternative Concept	Consistent with Purpose for the Action	Addresses One or More Significant Issues	Include in One or More of the Alternatives Evaluated in the Draft EIS
<b>Concept 23.</b> Completely cease operations of the CVP and SWP facilities	No	No	No, this concept would not be consistent with the purpose for the action

1 Note:  
 2 Concepts identified as “possibly consistent with the purpose of the action” would require  
 3 development of additional details and evaluation to determine if the concept is consistent  
 4 with the stated purpose for the action, as described in Chapter 2, Purpose and Need for  
 5 the Action. Concepts identified as “possibly consistent with the purpose of the action”  
 6 were integrated into one or more of the alternatives evaluated in this EIS.

7 Based upon the comparison of screening criteria to the alternative concepts  
 8 developed by Reclamation 17 of the 23 alternative concepts would be included in  
 9 one or more of the alternatives evaluated in this EIS. The next step in the  
 10 development of the alternatives is to combine the alternative concepts into  
 11 specific alternatives and determine if the range of alternatives is adequate to  
 12 address the significant issues in implementing a program that supports the  
 13 purpose of the action.

14 **3.4.2 Identification of Alternatives**

15 The 17 alternative concepts were compiled into five alternatives. Development of  
 16 the alternatives was informed by comments received about the alternative  
 17 concepts. For example, numerous comments were received to evaluate an  
 18 alternative that included assumptions identical to the Second Basis of Comparison  
 19 assumptions in which the 2008 USFWS BO and 2009 NMFS BO would not be  
 20 implemented. One of the scoping comments identified specific alternatives that  
 21 included several alternative concepts included in Table 3.1; however, some of the  
 22 specified alternative concepts were not consistent with assumptions for the Year  
 23 2030 and were modified to reflect implementable concepts.

24 Several of the alternative concepts are consistent with the No Action Alternative  
 25 assumptions related to actions that would have occurred with or without  
 26 implementation of the 2008 USFWS BO and 2009 NMFS BO. Therefore, the  
 27 following alternative concepts are included under the No Action Alternative,  
 28 Second Basis of Comparison, and all other alternatives.

- 29 • Alternative Concept 8 to restore or create at least 10,000 acres of tidally-  
 30 influenced seasonal or perennial wetlands.
- 31 • Alternative Concept 16 to support the fish-doubling goals under CVPIA and  
 32 state ecosystem restoration programs.
- 33 • Alternative Concept 17 to operate the CVP and SWP to avoid dead-pool  
 34 conditions in the CVP and SWP reservoirs, to the extent possible based upon  
 35 hydrologic conditions.

- 1 • Alternative Concept 20 to increase regional and local water supplies that  
2 could be used when CVP and SWP water supplies are reduced due to  
3 hydrologic and regulatory restrictions.
- 4 Using these concepts, the alternative concepts were combined into Alternatives 1  
5 through 5 in a manner to avoid conflicts between concepts within an alternative.
- 6 The range of alternatives in the EIS includes the No Action Alternative and  
7 Alternatives 1 through 5, as described below.

### 8 **3.4.3 No Action Alternative**

9 The No Action Alternative, the Preferred Alternative, is described in Section  
10 3.3.2, of this chapter.

### 11 **3.4.4 Alternative 1**

12 Alternative 1 was created because many comments requested an alternative that  
13 reflected conditions without implementation of the 2008 USFWS BO and the  
14 2009 NMFS BO. Since the Second Basis of Comparison is not a true alternative,  
15 in accordance with NEPA guidelines, Reclamation could not select Second Basis  
16 of Comparison as a preferred alternative. Therefore, Alternative 1 was defined as  
17 being identical to the Second Basis of Comparison, as defined in Section 3.3.2.

### 18 **3.4.5 Alternative 2**

19 Alternative 2 was first included in the Notice of Intent and identified as an initial  
20 proposed action that included the operational actions of the 2008 USFWS BO and  
21 2009 NMFS BO. Alternative 2 does not include RPA actions that would require  
22 future studies and environmental documentation to define recommended actions  
23 (generally, structural actions).

24 The definition of Alternative 2 is based upon the following assumptions that are  
25 briefly described below.

- 26 • Continued long-term operation of the CVP and SWP in accordance with  
27 ongoing management policies, criteria, and regulations, including water right  
28 permits and licenses issued by the SWRCB and implementation of the 2008  
29 USFWS BO and 2009 NMFS BO, as described under the No Action  
30 Alternative.
- 31 • Implementation of existing and future actions described in the 2008 USFWS  
32 BO and 2009 NMFS BO that would occur by 2030 without implementation of  
33 the BOs, as described above for the No Action Alternative in Sections 3.4.1.2  
34 and 3.4.1.3.
- 35 • Implementation of future actions not described in the 2009 NMFS BO that  
36 would occur by 2030 without implementation of any alternatives considered  
37 in this EIS.

38 Alternative 2 conditions assume that climate change conditions would have  
39 changed between 2015 and 2030. It is anticipated that by 2030, there will be less

1 snowfall over the long-term average conditions and higher mean sea level  
2 elevations.

3 Alternative 2 would not include actions in the 2008 USFWS BO and 2009 NMFS  
4 BO that have not been fully defined at this time; and therefore, would require  
5 future engineering and environmental evaluation prior to implementation. These  
6 following actions are not included in Alternative 2.

- 7 • 2009 NMFS BO RPA Action I.2.5, Winter-Run Passage and Re-Introduction  
8 Program at Shasta Dam.
- 9 • 2009 NMFS BO RPA Action II.3, Structural Improvements for Temperature  
10 Management on the American River.
- 11 • 2009 NMFS BO RPA Action II.5, Fish Passage at Nimbus and Folsom Dams.
- 12 • 2009 NMFS BO RPA Action II.6, Implement Actions to Reduce Genetic  
13 Effects of Nimbus and Trinity River Fish Hatchery Operations.
- 14 • 2009 NMFS BO RPA Action III.2.1, Increase and Improve Quality of  
15 Spawning Habitat with Addition of Gravel.
- 16 • 2009 NMFS BO RPA Action III.2.2, Conduct Floodplain Restoration and  
17 Inundation Flows in Winter or Spring to Inundate Steelhead Juvenile Rearing  
18 Habitat on Stanislaus River.
- 19 • 2009 NMFS BO RPA Action III.2.3, Restore Freshwater Migratory Habitat  
20 for Juvenile Steelhead on Stanislaus River.
- 21 • 2009 NMFS BO RPA Action III.2.4, Fish Passage at New Melones, Tulloch,  
22 and Goodwin Dams.
- 23 • 2009 NMFS BO RPA Action IV.4, Tracy Fish Collection Facility  
24 Improvements to Reduce Pre-Screen Loss and Improve Screening Efficiency.
- 25 • 2009 NMFS BO RPA Action IV.4.2 Skinner Fish Collection Facility  
26 Improvements to Reduce Pre-Screen Loss and Improve Screening Efficiency.
- 27 • 2009 NMFS BO RPA Action IV.4.3 Tracy Fish Collection Facility and the  
28 Skinner Fish Collection Facility Actions to Improve Salvage Monitoring,  
29 Reporting and Release Survival Rates.

#### 30 **3.4.5.1 Continued Long-Term Operation of the CVP and SWP Facilities**

31 The CVP and SWP operations and ongoing operational management policies of  
32 the CVP and SWP under Alternative 2 would be identical to the operational  
33 assumptions described in Appendix 3A, No Action Alternative: Central Valley  
34 Project and State Water Project Operations.

1 **3.4.5.2 Actions in the 2008 USFWS BO and 2009 NMFS BO that Would**  
2 **Have Occurred without Implementation of the Biological**  
3 **Opinions**

4 Actions included in the 2008 USFWS BO and 2009 NMFS BO that would have  
5 occurred with or without the BOs, would be identical under Alternative 2 as under  
6 the No Action Alternative and the Second Basis of Comparison.

7 **3.4.5.3 Future Actions not included in the 2008 USFWS BO and 2009**  
8 **NMFS BO that Would Have Occurred without Implementation of**  
9 **the Biological Opinions**

10 Alternative 2 also includes assumptions unrelated to implementation of the 2008  
11 USFWS BO and 2009 NMFS BO, including: climate change and sea level rise;  
12 development of lands in accordance with general plans in areas served by CVP  
13 and SWP water supplies; and reasonable and foreseeable projects that have been  
14 approved and are anticipated to be implemented by 2030. These items included in  
15 Alternative 2 are identical as under the No Action Alternative and the Second  
16 Basis of Comparison.

17 **3.4.5.4 Vegetation Management Along Levees**

18 Alternative 2 includes vegetation management operations along levees for flood  
19 management in accordance with policies issued by the USACE in 2009 and 2010.

20 **3.4.6 Alternative 3**

21 Alternative 3 was developed based upon a scoping comment from the Coalition  
22 for a Sustainable Delta which identified “RPA Alternative 1,” and a scoping  
23 comment received from Oakdale Irrigation District (OID) and South San Joaquin  
24 Irrigation District (SSJID) (included in the Scoping Report in Appendix 23A of  
25 this EIS). The definition of Alternative 3 is based upon the following  
26 assumptions that are briefly described below.

- 27 • Continued long-term operation of the CVP and SWP in accordance with  
28 ongoing management policies, criteria, and regulations, including water right  
29 permits and licenses issued by the SWRCB; without the operational  
30 requirements of the 2008 USFWS BO and the 2009 NMFS BO; plus  
31 implementation of the 2012 operations plan for New Melones Reservoir  
32 proposed by OID and SSJID.
- 33 • Implementation of actions described in the Coalition for a Sustainable Delta  
34 scoping comment letter related to “RPA Alternative 1.”
- 35 • Implementation of existing and future actions described in the 2008 USFWS  
36 BO and 2009 NMFS BO that would occur by 2030 without implementation of  
37 the BOs, as described above for the No Action Alternative in Sections 3.4.1.2  
38 and 3.4.1.3.
- 39 • Implementation of future actions not described in the 2009 NMFS BO that  
40 would occur by 2030 without implementation of any alternatives considered  
41 in this EIS.



1 Alternative 3 would not include implementation of actions described in the 2008  
 2 USFWS BO and 2009 NMFS BO that would not occur by 2030 without  
 3 implementation of the BOs.

4 Alternative 3 conditions assume that climate change conditions would have  
 5 changed between 2015 and 2030. It is anticipated that by 2030, there will be less  
 6 snowfall over the long-term average conditions and higher mean sea level  
 7 elevations.

#### 8 **3.4.6.1 Continued Long-Term Operation of the CVP and SWP Facilities**

9 The CVP and SWP operations and ongoing operational management policies of  
 10 the CVP and SWP under Alternative 3 would be similar to the operational  
 11 assumptions under the Second Basis of Comparison with the following changes to  
 12 water demand assumptions, OMR criteria, and operations of New Melones  
 13 Reservoir to meet SWRCB D-1641 flow requirements on the San Joaquin River at  
 14 Vernalis.

15 Alternative 3 would include additional demands for American River water  
 16 supplies as compared to the No Action Alternative or Second Basis of  
 17 Comparison. The additional demands would provide water supplies of up to  
 18 17 TAF/year under a Warren Act Contract for El Dorado Irrigation District and  
 19 15 TAF/year under a long-term CVP water service contract with El Dorado  
 20 County Water Agency. During the review of the numerical modeling analyses  
 21 used in this EIS, it was discovered that the demands for these El Dorado Irrigation  
 22 District and the El Dorado County Water Agency contracts were not included in  
 23 the CalSim II modeling analysis for Alternative 3 as presented in Chapters 5  
 24 through 21. A sensitivity analysis using the CalSim II model to compare the  
 25 results of the analysis with and without these demands is presented in Appendix  
 26 5B of this EIS for Alternative 3. The results of the sensitivity analysis have been  
 27 used in conjunction with the results presented in Chapters 5 through 21 to analyze  
 28 the effects of including the CVP water service contract for El Dorado County  
 29 Water Agency in Alternative 3.

##### 30 **3.4.6.1.1 Old and Middle River Criteria**

31 The OMR flow criteria under Alternative 3 are based on concepts addressed in the  
 32 2008 USFWS BO and 2009 NMFS BO related to adaptive restrictions for  
 33 temperature, turbidity, salinity, and presence of Delta Smelt. The OMR flow  
 34 criteria in the Alternative 3 are similar to those of the No Action Alternative, as  
 35 described in Appendix 3A, No Action Alternative: Central Valley Project and  
 36 State Water Project Operations, with the exception of the following changes:

- 37 • Reduce OMR criteria to a level between -5,000 cfs and -3,500 cfs only when  
 38 appropriate based on analysis of turbidity levels and normalized salvage data  
 39 in the south Delta
- 40 • Reduce OMR to no more negative than -5,000 cfs when more than 25 percent  
 41 of the Delta Smelt collected in the spring kodiak or 20 mm trawl are located in  
 42 the south Delta or the adult cumulative salvage index immediately preceding

1 spawning is high; lift this restriction if Qwest is >12,000 cfs and/or secchi  
2 depth in the south Delta is >85 cm

3 For the purpose of quantitative analysis in this EIS, the numerical model  
4 represented this concept with the following assumptions.

- 5 • Action 1 that protects the pre-spawning adult Delta Smelt from entrainment is  
6 modified to limit exports such that the average daily OMR flow is no more  
7 negative than -3,500 cfs for a total duration of 14 days, with a 5-day running  
8 average no more negative than -4,375 cfs (within 25 percent of the monthly  
9 criteria).
- 10 • Action 2 that protects adult Delta Smelt within the Delta from entrainment is  
11 modified to limit exports so that the average daily OMR flow is no more  
12 negative than -3,500 or -7,500 cfs depending on the previous month's ending  
13 X2 location (-3,500 cfs if X2 is east of Roe Island, or -7,500 cfs if X2 is west  
14 of Roe Island), with a 5-day running average within 25 percent of the monthly  
15 criteria (no more negative than -4,375 cfs if X2 is east of Roe Island, or  
16 -9,375 cfs if X2 is west of Roe Island).
- 17 • Action 3 that protects larval and juvenile Delta Smelt from entrainment is  
18 modified to limit exports so that the average daily OMR flow is no more  
19 negative than -1,250, -3,500, or -7,500 cfs, depending on the previous  
20 month's ending X2 location (-1,250 cfs if X2 is east of Chipps Island,  
21 -7,500 cfs if X2 is west of Roe Island, or -3,500 cfs if X2 is between Chipps  
22 and Roe Island, inclusively), with a 5-day running average within 25 percent  
23 of the monthly criteria (no more negative than -1,562 cfs if X2 is east of  
24 Chipps Island, -9,375 cfs if X2 is west of Roe Island, or -4,375 cfs if X2 is  
25 between Chipps and Roe Island).
- 26 • Temporal off-ramp for Action 3 is assumed to occur no later than June 15  
27 (changed from June 30).
- 28 • An off-ramp based on QWest (westerly flow on the San Joaquin River past  
29 Jersey Point calculated as a combination of San Joaquin River at Blind Point,  
30 Three Mile Slough and Dutch Slough) is assumed. If Qwest is greater than  
31 12,000 cfs, then the Action 3 is discontinued. Because Action 2 is defined to  
32 occur between Actions 1 and 3, the Qwest off-ramp also results in  
33 discontinuation of Action 2 if it happens before Action 3 is triggered. In  
34 monthly CalSim II modeling, previous month's QWest value is used for  
35 determining the off-ramp, therefore if the off-ramp occurs within the previous  
36 month, actions in that previous month are assumed to continue until the end of  
37 the month.

#### 38 **3.4.6.1.2 New Melones Operations Criteria**

39 Alternative 3 assumes that the flood control operations for the New Melones  
40 Reservoir would be the same as under the No Action Alternative. However, New  
41 Melones Reservoir would be operated for different fishery flows, water quality  
42 flows, and San Joaquin River base flows and pulse flows at Vernalis.

1 *Fishery*

2 In the Alternative 3 simulation, fishery flows are modeled per the OID and SSJID  
 3 2012 operations proposal, as summarized in Tables 3.2 through 3.4. These flows  
 4 include an outmigration pulse flow from April 1 through May 15. Total annual  
 5 volume dedicated to fishery flows vary from 174 to 318 TAF depending on the  
 6 hydrologic conditions defined by the New Melones water supply forecast (the  
 7 end-of-February New Melones Storage, plus the March - September forecast of  
 8 inflow to the reservoir).

9 **Table 3.2 Annual Fishery Flow Allocation in New Melones**

Melones Water Supply Forecast (TAF)	Fishery Base Flows (TAF)
0 to 1,800	174
1,801 to 2,500	235
>2,500	318

10 **Table 3.3 Monthly “Base” Flows for Fisheries Purposes Based on the Annual**  
 11 **Fishery Volume**

Annual Fishery Flow Volume (TAF)	Monthly Fishery Base Flows (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
235	252	300	300	150	173	200	200	200	200	200	200	200
318	300	300	300	300	300	300	1,500	850	200	200	200	200

12 **Table 3.4 April 1 through May 31 “Pulse” Flows for Fisheries Purposes Based on**  
 13 **the Annual Fishery Volume**

Melones Water Supply Forecast (TAF)	Fishery Pulse Flows (CFS) April 1 –May 31
0 to 1,800	750
1,801 to 2,500	1,500
>2,500	1,500

14 *Water Quality*

15 Alternative 3 assumes that no water is released from New Melones Reservoir to  
 16 meet the SWRCB D-1641 water quality criteria in the San Joaquin River. Water  
 17 is released to meet the SWRCB D-1422 DO criteria; however, the compliance  
 18 point is moved from Ripon to the Orange Blossom Bridge under the Alternative 3.

1 *Bay-Delta Flows*

2 Alternative 3 assumes that no water is released from New Melones Reservoir to  
3 meet the SWRCB D-1641 Bay-Delta flow requirements on the San Joaquin River  
4 at Vernalis for base flows or pulse flows.

5 **3.4.6.2 Actions Related to Predation Control, Wetlands Restoration,**  
6 **Juvenile Salmonid Trap and Haul Program, and Chinook Salmon**  
7 **Ocean Harvest**

8 Alternative 3 includes the following actions as described in “RPA Alternative 1”  
9 in the Coalition for a Sustainable Delta scoping comment.

- 10 • Implement predator control programs for Black Bass, Striped Bass, and  
11 Pikeminnow to protect salmonids and Delta Smelt as follows:
  - 12 – Black Bass catch limit changed to allow catch of 12-inch fish with a bag  
13 limit of 10
  - 14 – Striped Bass catch limit changed to allow catch of 12-inch fish with a bag  
15 limit of 5
  - 16 – Establish a Pikeminnow sport-fishing reward program with a 8-inch limit  
17 at \$2/fish
- 18 • Restore or create at least 10,000 acres of tidally influenced seasonal or  
19 perennial wetlands. These conditions are the same as under the No Action  
20 Alternative and Second Basis of Comparison.
- 21 • Establish a trap and haul program for juvenile salmonids entering the Delta  
22 from the San Joaquin River in March through June as follows:
  - 23 – Begin operation of downstream migrant fish traps upstream of the Head of  
24 Old River on the San Joaquin River
  - 25 – “Barge” all captured juvenile salmonids through the Delta, release at  
26 Chipps Island.
  - 27 – Tag subset of fish in order to quantify effectiveness of the program
  - 28 – Attempt to capture 10 percent to 20 percent of out-migrating juvenile  
29 salmonids
- 30 • Work with Pacific Fisheries Management Council, CDFW, and NMFS to  
31 minimize harvest mortality of natural origin Central Valley Chinook Salmon,  
32 including fall-run Chinook Salmon, by evaluating and modifying ocean  
33 harvest for consistency with Viable Salmonid Population Standards; including  
34 harvest management plan to show that abundance, productivity, and diversity  
35 (age-composition) are not appreciably reduced.

36 Any changes in harvest limitations would require review and approval from the  
37 California Fish and Game Commission; and for some species, the Pacific  
38 Fisheries Management Council.

1    **3.4.6.3    *Actions in the 2008 USFWS BO and 2009 NMFS BO that Would***  
 2    ***Have Occurred without Implementation of the Biological***  
 3    ***Opinions***

4    Actions included in the 2008 USFWS BO and 2009 NMFS BO that would have  
 5    occurred with or without the BOs, would be identical under Alternative 3 as under  
 6    the No Action Alternative and the Second Basis of Comparison.

7    **3.4.6.4    *Future Actions not included in the 2008 USFWS BO and 2009***  
 8    ***NMFS BO that Would Have Occurred without Implementation of***  
 9    ***the Biological Opinions***

10   Alternative 3 also includes assumptions unrelated to implementation of the 2008  
 11   USFWS BO and 2009 NMFS BO, including: climate change and sea level rise;  
 12   development of lands in accordance with general plans in areas served by CVP  
 13   and SWP water supplies; and reasonable and foreseeable projects that have been  
 14   approved and are anticipated to be implemented by 2030. These items included in  
 15   Alternative 3 are identical as under the No Action Alternative and the Second  
 16   Basis of Comparison.

17   **3.4.6.5    *Vegetation Management Along Levees***

18   Alternative 3 includes vegetation management operations along levees for flood  
 19   management in accordance with policies issued by the USACE in 2009 and 2010.

20   **3.4.7        Alternative 4**

21   Alternative 4 was developed based upon a scoping comment from the Coalition  
 22   for a Sustainable Delta which identified “RPA Alternative 2” (included in the  
 23   Scoping Report in Appendix 23A of this EIS). The definition of Alternative 4 is  
 24   based upon the following assumptions that are briefly described below.

- 25   • Continued long-term operation of the CVP and SWP in accordance with  
 26   ongoing management policies, criteria, and regulations, including water right  
 27   permits and licenses issued by the SWRCB; without the operational  
 28   requirements of the 2008 USFWS BO and the 2009 NMFS BO, as described  
 29   under Second Basis of Comparison.
- 30   • Implementation of actions described in the Coalition for a Sustainable Delta  
 31   scoping comment letter related to “RPA Alternative 2.”
- 32   • Implementation of existing and future actions described in the 2008 USFWS  
 33   BO and 2009 NMFS BO that would occur by 2030 without implementation of  
 34   the BOs, as described above for the No Action Alternative in Sections 3.4.1.2  
 35   and 3.4.1.3.
- 36   • Implementation of future actions not described in the 2009 NMFS BO that  
 37   would occur by 2030 without implementation of any alternatives considered  
 38   in this EIS.

39   Alternative 4 would not include implementation of actions described in the 2008  
 40   USFWS BO and 2009 NMFS BO that would not occur by 2030 without  
 41   implementation of the BOs.

1 The “RPA Alternative 2” also included a provision to “Advance the timing of  
2 upgrades at the Sacramento Regional Wastewater Treatment Plant to 2017; and  
3 implement advanced treatment technologies at the Fairfield-Suisun Sewer District  
4 treatment plant to reduce nutrients in the effluent.” However, both of these  
5 actions would be complete by 2030, the study period considered in this EIS. The  
6 Sacramento Regional Wastewater Treatment Plant must comply with the National  
7 Pollutant Discharge Elimination System permit issued on December 9, 2010 by  
8 the Central Valley Regional Water Quality Control Board to reduce nutrients in  
9 the effluent discharged to the Sacramento River by 2020 (SRCSD 2012). The  
10 Fairfield Suisun Sewer District must comply with similar permit conditions issued  
11 by the San Francisco Bay Regional Water Quality Control Board in March 2015  
12 (SFRRWQCB 2015). Because the Environmental Consequences analysis in this  
13 EIS is conducted as a “snapshot” in time at 2030, inclusion of a provision to  
14 require compliance with the discharge requirements prior to 2020 could not be  
15 evaluated.

16 Alternative 4 conditions assume that climate change conditions would have  
17 changed between 2015 and 2030. It is anticipated that by 2030, there will be less  
18 snowfall over the long-term average conditions and higher mean sea level  
19 elevations.

20 **3.4.7.1 Continued Long-Term Operation of the CVP and SWP Facilities**

21 The ongoing operational management policies of the CVP and SWP under  
22 Alternative 4 would be identical to operations described under the Second Basis  
23 of Comparison.

24 **3.4.7.2 Actions Related to Floodplain Protection, Levee Vegetation,  
25 Predation Control, Wetlands Restoration, Juvenile Salmonid Trap  
26 and Haul Program, and Chinook Salmon Ocean Harvest**

27 Alternative 4 includes the following actions as described in “RPA Alternative 1”  
28 in the Coalition for a Sustainable Delta scoping comment.

- 29 • Limiting floodplain development to protect salmonids and Delta Smelt by  
30 implementing the following actions:
- 31 – Incorporate guidance into flood hazard mapping to help communities  
32 comply with the ESA
  - 33 – Require communities to demonstrate ESA compliance for all flood plain  
34 map revisions
  - 35 – Prioritize consideration of ESA listed species and critical habitat when  
36 selecting flood insurance studies
  - 37 – Develop and implement floodplain management criteria
  - 38 – Refine community rating system to provide credits for natural and  
39 beneficial functions

- 1       – Prohibit new development and substantial improvements to existing  
 2       development within any designated floodway or within 170 feet of the  
 3       ordinary high water line of any floodway
- 4       • Modify the requirements of the USACE related to removal of vegetation on  
 5       levees. USACE requires removal of vegetation on levees. DWR and USACE  
 6       have been working to develop a plan that would allow for the continuation of  
 7       existing vegetation on levees until levee maintenance or repairs requires  
 8       removal of the vegetation. Under Alternative 4, trees and shrubs would be  
 9       planted along the levees; and vegetation, woody material, and root re-  
 10      enforcement material would be installed on the levees instead of riprap for  
 11      erosion protection.
- 12      • Implement predator control programs for Black Bass, Striped Bass, and  
 13      Pikeminnow to protect salmonids and Delta Smelt as follows:
- 14      – Black Bass catch limit changed to allow catch of 12-inch fish with a bag  
 15      limit of 10
- 16      – Striped Bass catch limit changed to allow catch of 12-inch fish with a bag  
 17      limit of 5
- 18      – Establish a Pikeminnow sport-fishing reward program with a 8-inch limit  
 19      at \$2/fish
- 20      • Restore or create at least 10,000 acres of tidally influenced seasonal or  
 21      perennial wetlands. These conditions are the same as under the No Action  
 22      Alternative and Second Basis of Comparison.
- 23      • Establish a trap and haul program for juvenile salmonids entering the Delta  
 24      from the San Joaquin River in March through June as follows:
- 25      – Begin operation of downstream migrant fish traps upstream of the Head of  
 26      Old River on the San Joaquin River
- 27      – “Barge” all captured juvenile salmonids through the Delta, release at  
 28      Chipps Island.
- 29      – Tag subset of fish in order to quantify effectiveness of the program
- 30      – Attempt to capture 10 percent to 20 percent of outmigrating juvenile  
 31      salmonids
- 32      • Work with Pacific Fisheries Management Council, CDFW, and NMFS to  
 33      impose salmon harvest restrictions to reduce by-catch of winter-run and  
 34      spring-run Chinook Salmon to less than 10 percent of age-3 cohort in all  
 35      years.
- 36      Any changes in harvest limitations would require review and approval from the  
 37      California Fish and Game Commission; and for some species, the Pacific  
 38      Fisheries Management Council.

1    **3.4.7.3    *Actions in the 2008 USFWS BO and 2009 NMFS BO that Would***  
2                    ***Have Occurred without Implementation of the Biological***  
3                    ***Opinions***

4    Actions included in the 2008 USFWS BO and 2009 NMFS BO that would have  
5    occurred with or without the BOs, would be identical under Alternative 4 as under  
6    the No Action Alternative and the Second Basis of Comparison.

7    **3.4.7.4    *Future Actions not included in the 2008 USFWS BO and 2009***  
8                    ***NMFS BO that Would Have Occurred without Implementation of***  
9                    ***the Biological Opinions***

10   Alternative 4 also includes assumptions unrelated to implementation of the 2008  
11   USFWS BO and 2009 NMFS BO, including: climate change and sea level rise;  
12   development of lands in accordance with general plans in areas served by CVP  
13   and SWP water supplies; and reasonable and foreseeable projects that have been  
14   approved and are anticipated to be implemented by 2030. These items included in  
15   Alternative 4 are identical as under the No Action Alternative and the Second  
16   Basis of Comparison.

17   **3.4.8        Alternative 5**

18   Alternative 5 is similar to the No Action Alternative with positive OMR criteria in  
19   April and May which causes increased Delta outflow; and use of the SWRCB D-  
20   1641 pulse flow at Vernalis. Alternative 5 was developed considering comments  
21   from environmental interest groups during the scoping process. Alternative 5 also  
22   provides another method to operate the New Melones Reservoir as compared to  
23   the other alternatives.

24   The definition of Alternative 5 is based upon the following assumptions that are  
25   briefly described below.

- 26   • Continued long-term operation of the CVP and SWP in accordance with  
27   ongoing management policies, criteria, and regulations, including water right  
28   permits and licenses issued by the SWRCB; and the operational requirements  
29   of the 2008 USFWS BO and the 2009 NMFS BO.
- 30   • Implementation of existing and future actions described in the 2008 USFWS  
31   BO and 2009 NMFS BO that would occur by 2030 without implementation of  
32   the BOs, as described above for the No Action Alternative in Sections 3.4.1.2  
33   and 3.4.1.3.
- 34   • Implementation of actions described in the 2008 USFWS BO and 2009 NMFS  
35   BO that would not occur by 2030 without implementation of the BOs.
- 36   • Implementation of future actions not described in the 2009 NMFS BO that  
37   would occur by 2030 without implementation of any alternatives considered  
38   in this EIS.

39   Alternative 5 conditions assume that climate change conditions would have  
40   changed between 2015 and 2030. It is anticipated that by 2030, there will be less  
41   snowfall over the long-term average conditions and higher mean sea level  
42   elevations.



**3.4.8.1 Continued Long-Term Operation of the CVP and SWP Facilities**

The CVP and SWP operations and ongoing operational management policies of the CVP and SWP under Alternative 5 would be similar to the operational assumptions under the No Action Alternative with the following changes to water demand assumptions, OMR criteria, and operations of New Melones Reservoir to meet SWRCB D-1641 flow requirements on the San Joaquin River at Vernalis.

**3.4.8.1.1 Water Demands**

Alternative 5 would include additional water demands for users of water from the American River watershed as compared to the No Action Alternative or Second Basis of Comparison. Under Alternative 5, up to 17 TAF/year would be provided to the El Dorado Irrigation District under a Warren Act Contract to allow water to be conveyed through Folsom Lake; and up to 15 TAF/year would be provided to El Dorado County Water Agency under a separate long-term CVP water service contract. During the review of the numerical modeling analyses used in this EIS, it was discovered that the demands for these El Dorado Irrigation District and the El Dorado County Water Agency contracts were not included in the CalSim II modeling analysis for Alternative 3 as presented in Chapters 5 through 21. A sensitivity analysis using the CalSim II model to compare the results of the analysis with and without these demands is presented in Appendix 5B of this EIS for Alternative 3. The results of the sensitivity analysis have been used in conjunction with the results presented in Chapters 5 through 21 to analyze the effects of including the CVP water service contract for El Dorado County Water Agency in Alternative 3.

**3.4.8.1.2 Old and Middle River Criteria**

The OMR flow criteria under Alternative 5 is similar to the assumptions under the No Action Alternative and based on concepts addressed in the 2008 USFWS BO and 2009 NMFS BO plus a requirement for positive OMR (no reverse flows) in April and May of all water year types.

**3.4.8.1.3 New Melones Operations Criteria**

Alternative 5 assumptions for New Melones Reservoir operations are similar to assumptions under the No Action Alternative except for SWRCB D-1641 requirements for the San Joaquin River pulse flows at Vernalis, as summarized in Table 3.5.

**Table 3.5 Bay-Delta Vernalis Flow Objectives (average monthly cfs)**

<b>60-20-20 Index</b>	<b>Pulse Flow Required if X2 is West of Chipps Island</b>	<b>Pulse Flow required if X2 is East of Chipps Island</b>
Wet	8,620	7,330
Above Normal	7,020	5,730
Below Normal	5,480	4,620
Dry	4,880	4,020
Critical	3,540	3,110

1     **3.4.8.2     *Actions in the 2008 USFWS BO and 2009 NMFS BO that Would***  
2                   ***Have Occurred without Implementation of the Biological***  
3                   ***Opinions***

4     Actions included in the 2008 USFWS BO and 2009 NMFS BO that would have  
5     occurred with or without the BOs, would be identical under Alternative 5 as under  
6     the No Action Alternative and the Second Basis of Comparison.

7     **3.4.8.3     *Actions in the 2009 NMFS BO that Would Not Have Occurred***  
8                   ***without Implementation of the Biological Opinions***

9     Actions included in the 2008 USFWS BO and 2009 NMFS BO that would not  
10    have occurred without the BOs, would be identical under Alternative 5 as under  
11    the No Action Alternative.

12    **3.4.8.4     *Future Actions not included in the 2008 USFWS BO and 2009***  
13                   ***NMFS BO that Would Have Occurred without Implementation of***  
14                   ***the Biological Opinions***

15    Alternative 5 also includes assumptions unrelated to implementation of the 2008  
16    USFWS BO and 2009 NMFS BO, including: climate change and sea level rise;  
17    development of lands in accordance with general plans in areas served by CVP  
18    and SWP water supplies; and reasonable and foreseeable projects that have been  
19    approved and are anticipated to be implemented by 2030. These items included in  
20    Alternative 5 are identical as under the No Action Alternative and the Second  
21    Basis of Comparison.

22    **3.4.8.5     *Vegetation Management Along Levees***

23    Alternative 5 includes vegetation management operations along levees for flood  
24    management in accordance with policies issued by the USACE in 2009 and 2010.

25    **3.4.9        *Alternatives Considered but Not Evaluated in Detail***

26    As described above, 6 of the 23 alternative concepts identified for inclusion in the  
27    alternatives to be evaluated in this EIS were eliminated for further evaluation for  
28    several reasons, as described below.

29    **3.4.9.1     *Alternative Concept 6: Modify Flows in San Joaquin River at***  
30                   ***Vernalis***

31    The 2009 NMFS BO included two phases related to implementation of the San  
32    Joaquin River Inflow to Export Ratio. The first phase, to be implemented in 2010  
33    and 2011, assumed CVP and SWP operations under the Vernalis Adaptive  
34    Management Plan (VAMP) which provided for Reclamation to purchase water  
35    from non-CVP water users in the San Joaquin River watershed. The second phase  
36    was designed to be implemented following the completion of VAMP when  
37    Reclamation could no longer purchase water to meet flow requirements of the  
38    SWRCB D-1641 in the Delta.

39    Alternative Concept 6 recommended an operations that CVP could not meet  
40    without VAMP authorizations. Therefore, Alternative Concept 6 did not meet the  
41    provision in the purpose of the action to be “consistent with Federal Reclamation  
42    law; other Federal laws; Federal permits and licenses; State of California water

1 rights, permits, and licenses.” Alternative Concept 6 was not retained for analysis  
2 in the EIS.

3 **3.4.9.2 Alternative Concept 14: Advance the Timing of Upgrades at**  
4 **Wastewater Treatment Plants**

5 Alternative Concept 14 would advance the timing of upgrades at the Sacramento  
6 Regional Wastewater Treatment Plant to 2017; and implement advanced  
7 treatment technologies at the Fairfield-Suisun Sewer District treatment plant to  
8 reduce nutrients in the effluent.” However, both of these actions would be  
9 complete by 2030, the study period considered in this EIS. The Sacramento  
10 Regional Wastewater Treatment Plant must comply with the National Pollutant  
11 Discharge Elimination System permit issued on December 9, 2010 by the Central  
12 Valley Regional Water Quality Control Board to reduce nutrients in the effluent  
13 discharged to the Sacramento River by 2020 (SRCSD 2012). The Fairfield  
14 Suisun Sewer District must comply with similar permit conditions issued by the  
15 San Francisco Bay Regional Water Quality Control Board in March 2015  
16 (SFRRWQCB 2015).

17 Because the Environmental Consequences analysis in this EIS is conducted as a  
18 “snapshot” in time at 2030, inclusion of a provision to require compliance with  
19 the discharge requirements prior to 2020 would not be evaluated. Therefore,  
20 Alternative Concept 14 was not retained for analysis in the EIS.

21 **3.4.9.3 Alternative Concept 18: Change to CVP Operations to Meet In-**  
22 **Basin Water Demands prior to Meeting other CVP Water**  
23 **Demands**

24 Alternative Concept 18 would require operations of the CVP to meet in-basin  
25 water demands in the Trinity, Sacramento, American, and Stanislaus rivers  
26 watersheds prior to use of the CVP water in other portions of the service area.  
27 However, the CVP is operated as integrated system to satisfy statutory,  
28 regulatory, and contractual obligations to the fullest extent possible, in accordance  
29 with the purpose of the action. Therefore, Alternative Concept 18 was not  
30 retained for analysis in the EIS.

31 **3.4.9.4 Alternative Concept 21: Change methods used to monitor and**  
32 **predict OMR criteria**

33 Alternative Concept 21 addresses an item that is related to methods to implement  
34 OMR monitoring and projections. The alternatives considered in this EIS address  
35 approaches to continued operation of the CVP and SWP. Methods to monitor and  
36 predict criteria used in CVP and SWP operations are considered by Reclamation  
37 as part of the operations of the CVP. Changes in methods used to monitor and  
38 predict OMR values can be applied to any of the alternatives considered in this  
39 EIS; and would not result in differentiations between alternatives. Therefore,  
40 Alternative Concept 21 was not retained for analysis in the EIS.

1    **3.4.9.5    Alternative 22: Prioritize Use of CVPIA Restoration Funds in the**  
2    **Watersheds that Generated the Funds**

3    As described above, the locations of CVPIA restoration activities are determined  
4    based upon scientific framework throughout the CVP service area that connects  
5    restoration actions to environmental and population responses across watersheds  
6    (Reclamation 2013c). A system-wide science-based approach with performance  
7    indices, monitoring, and scientific review of results is used to provide direction as  
8    the CVPIA adapts to changing conditions. Changing the approach from the  
9    current CVPIA implementation plan could be considered to be inconsistent with  
10   Federal law. Therefore, Alternative Concept 22 was not retained for analysis in  
11   the EIS.

12   **3.4.9.6    Alternative 23: Completely Cease Operations of the CVP and**  
13   **SWP**

14   Complete cessation of CVP and SWP operations would not be consistent with the  
15   requirement of the purpose of the action to operate the CVP and SWP in a manner  
16   that is similar to historic operational parameters with certain modifications; and it  
17   would not be consistent with Federal Reclamation law; other Federal laws;  
18   Federal permits and licenses; State of California water rights, permits, and  
19   licenses related to delivery of water by CVP and SWP to water rights holder and  
20   related to flood management operations at the CVP and SWP reservoirs.  
21   Therefore, Alternative Concept 23 was not retained for analysis in the EIS.

22   **3.5        Assumptions for Cumulative Effects Analysis**

23   The CEQ regulations define cumulative effects as the impact on environmental,  
24   human, and community resources that results from the incremental impact of the  
25   proposed project when added to other past, present, and reasonably foreseeable  
26   future actions regardless of what agency (Federal or non-Federal) or persons  
27   undertakes such actions. Cumulative effects can result from individually minor  
28   but collectively significant actions taking place over time (40 CFR 1508.7,  
29   1508.25.) Future cumulative impacts should not be speculative but should be  
30   based upon known or reasonably foreseeable long-range plans, regulations,  
31   operating agreements, or other information that establishes them as reasonably  
32   foreseeable.

33   The reasonably foreseeable future actions included in the cumulative effects  
34   analysis are summarized below. The projects and actions are organized into:

- 35   • Water Supply and Water Quality Projects and Actions potentially affected by  
36    long-term operation of the SWP and CVP (organized geographically from  
37    north to south)
- 38   • Ecosystem Improvement Projects and Actions potentially affected by long-  
39    term operation of the SWP and CVP or potentially affecting resources  
40    analyzed in this EIS (organized geographically from north to south)

### 1 **3.5.1 Water Supply and Water Quality Projects and Actions**

2 There are numerous water supply and water quality projects and actions that could  
3 be potentially affected by changes in the coordinated long-term operation of the  
4 CVP and SWP, or could affect the CVP and SWP operations. Major future water  
5 supply and water quality projects and actions are discussed below.

#### 6 **3.5.1.1 Bay-Delta Water Quality Control Plan Update**

7 In accordance with the federal Clean Water Act and the Porter-Cologne Water  
8 Quality Control Act, basin plans must be developed for each hydrologic area.  
9 Each basin plan must contain water quality objectives to ensure the reasonable  
10 protection of beneficial uses, as well as a program of implementation for  
11 achieving those objectives. Federal regulations require each state to adopt water  
12 quality standards to protect the public health or welfare, enhance the quality of  
13 water, and serve the purposes of the Clean Water Act. In California, the  
14 beneficial uses and water quality objectives form the basis of the water quality  
15 control standards. In the Sacramento-San Joaquin Bay Delta, water quality and  
16 flow objectives to meet water quality criteria are included in the Water Quality  
17 Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary  
18 (Bay-Delta WQCP) (SWRCB 2006). The SWRCB and the Central Valley and  
19 San Francisco Regional Water Quality Control Boards are in the process of  
20 updating the Bay-Delta WQCP. The updates, or amendments, are being prepared  
21 in two phases. Initially, the SWRCB and Regional Water Quality Control Boards  
22 are evaluating new flow objectives for the Lower San Joaquin River and the  
23 tributaries of Stanislaus, Tuolumne, and Merced rivers; and southern Delta  
24 salinity objectives. The second phase is evaluating changes to other portions of  
25 the Bay-Delta WQCP including Delta outflows, SWP and CVP export  
26 restrictions, and other requirements in the Bay-Delta to protect fish and wildlife  
27 beneficial uses. A third phase will consider and assign responsibility for  
28 implementing measures to achieve the water quality objectives established in the  
29 first two phases (SWRCB 2012).

30 Ongoing programs to adopt and implement total maximum daily loads are  
31 described in Chapter 6, Surface Water Quality.

#### 32 **3.5.1.2 Bay Delta Conservation Plan and the California Water Fix**

33 The Bay Delta Conservation Plan (BDCP) and the California WaterFix are being  
34 developed by Federal and State agencies and other stakeholders to achieve the  
35 dual goals of a reliable water supply for California and a healthy California Bay  
36 Delta ecosystem that supports the State's economy. The program would construct  
37 a new conveyance facility and modify operation of existing CVP and SWP Delta  
38 facilities; and reduce ecological stressors that impair the function or the use of the  
39 Delta by aquatic and terrestrial resources.

40 The Recirculated Draft EIR/Supplemental Draft EIS (RDEIR/SDEIS) was issued  
41 by DWR and Reclamation. The RDEIR/SDEIS evaluated new alternatives in  
42 addition to the alternatives included in the Public Draft EIR/EIS that combined  
43 ecosystem restoration approaches and Delta conveyance approaches. During the  
44 last 50 years, several broad conveyance approaches have been studied to address

1 urban water quality, water supply reliability, and environmental concerns in the  
2 Delta: physical barriers, hydraulic barriers, through-Delta facilities, and isolated  
3 facilities. Several alternative Delta conveyance facilities are being evaluated as  
4 part of the EIR/EIS process. These alternatives included use of an isolated facility  
5 that would convey water around or under the Delta for local supply and export  
6 through a hydraulically isolated channel or pipeline and with continual use of the  
7 existing south Delta intakes (dual conveyance alternatives); and continuation of  
8 the use of the through-Delta conveyance with channel modifications.

9 **3.5.1.3 Shasta Lake Water Resources Investigation**

10 The Shasta Lake Water Resources Investigation is currently being conducted by  
11 Reclamation to determine the type and extent of federal interest in a multiple  
12 purpose plan to modify Shasta Dam and Reservoir to increase the survival of  
13 anadromous fish populations in the upper Sacramento River; increase water  
14 supplies and water supply reliability for agricultural, municipal, industrial, and  
15 environmental purposes (Reclamation 2013d). To the extent possible through  
16 meeting these objectives, alternatives evaluated in the EIS included features to  
17 benefit other identified water and related resource needs including ecosystem  
18 conservation and enhancement, improve hydropower generation capability, flood  
19 damage reduction, maintain and increase recreation opportunities, and maintain or  
20 improve water quality conditions in the Sacramento River and the Delta  
21 consistent with the objectives of the CALFED Bay-Delta Program. Alternatives  
22 for expansion of Shasta Lake included, among other features, raising the dam  
23 from 6.5 to 18.5 feet above current elevation, which would result in additional  
24 storage capacity of 256,000 to 634,000 acre-feet, respectively. The increased  
25 capacity would improve water supply reliability and increase the cold water pool,  
26 which would provide improved water temperature conditions for anadromous fish  
27 in the Sacramento River downstream of the dam. The Final EIS, published in  
28 December 2014, identified the preferred alternative to include an 18.5 foot raise  
29 of Shasta Dam to provide an additional 634,000 acre-feet of storage with  
30 augmentation of spawning gravel programs and restoration of riparian, floodplain,  
31 and side channel habitat in the upper Sacramento River (Reclamation 2014g).

32 **3.5.1.4 North of Delta Offstream Storage Investigation**

33 The North-of-the-Delta Offstream Storage Investigation evaluates the feasibility  
34 of offstream storage in the northern Sacramento Valley for improved water supply  
35 and water supply reliability, improved water quality, and enhanced survival of  
36 anadromous fish and other aquatic species (DWR 2013). Specific primary  
37 planning objectives are to: 1) increase water supplies to meet existing contract  
38 requirements, including improved water supply reliability, and provide greater  
39 flexibility in water management for agricultural, environmental, and municipal  
40 and industrial users; 2) increase the survival of anadromous fish populations in the  
41 Sacramento River, as well as the survivability of other aquatic species; and  
42 3) improve drinking water quality in the Delta. To the extent possible through  
43 meeting these objectives, alternatives include ecosystem conservation and  
44 enhancement, provide ancillary hydropower generation capability to the statewide  
45 power grid, and create incremental flood damage reduction opportunities in

1 support of major northern California flood-control reservoirs consistent with the  
 2 objectives of the CALFED Bay Delta Program. All alternatives include  
 3 construction of a dam and reservoir near Sites, located to the west of Maxwell  
 4 (California), with various facilities and configurations for conveyance into and  
 5 out of the reservoir, which would result in additional storage capacity ranging  
 6 from 1200 to 1900 TAF.

7 **3.5.1.5 Federal Energy Regulatory Commission License Renewals**

8 There are 22 hydroelectric generation FERC permits that will expire prior to 2030  
 9 (FERC 2015). Fifteen projects in the Sacramento River watershed include one on  
 10 the Pit River (upstream of Shasta Lake), six on the Feather River, four on the  
 11 Yuba River, one on the Bear River, one on the American River, and one each on  
 12 Cow and Battle creeks. Projects in the San Joaquin River watershed include four  
 13 on the San Joaquin River, one on the Stanislaus River, two on the Merced River,  
 14 and one on the Tuolumne River. The FERC must complete analyses under NEPA  
 15 and ESA to consider the effects of the hydropower operations on the environment,  
 16 including flow regimes, water quality, fish passage, recreation, aquatic and  
 17 riparian habitat, and special status species.

18 **3.5.1.5.1 Federal Energy Regulatory Commission License Renewal for**  
 19 **SWP Oroville Project**

20 The Oroville Facilities, as part of SWP, are also operated for flood management,  
 21 power generation, water quality improvement in the Delta, recreation, and fish  
 22 and wildlife enhancement. The objective of the relicensing process was to  
 23 continue operation and maintenance of the Oroville Facilities for electric power  
 24 generation, along with implementation of any terms and conditions to be  
 25 considered for inclusion in a new FERC hydroelectric license. The initial FERC  
 26 license for the Oroville Facilities, issued on February 11, 1957, expired on  
 27 January 31, 2007. The Final EIR/EIS were completed in 2007 (FERC 2007). At  
 28 this time, the revised BOs and FERC license have not been issued.

29 **3.5.1.5.2 Federal Energy Regulatory Commission Relicensing for Yuba**  
 30 **River Watershed Hydroelectric Projects**

31 The Nevada Irrigation District is applying for a new license for the Yuba-Bear  
 32 Project (FERC Project No. 2266), and PG&E are applying for the Drum-  
 33 Spaulding Project (FERC Project No. 2310). The Yuba-Bear Project is located on  
 34 the Middle and South Yuba rivers, Bear River, and Jackson and Canyon creeks  
 35 (FERC 2013). Concurrently, PG&E is applying for a license renewal for the  
 36 Drum-Spaulding Project which is located on the Bear and Yuba rivers.  
 37 Operations of the two projects are coordinated in many factors. The FERC  
 38 relicensing processes for these two projects in underway.

1 **3.5.1.5.3 FERC Relicense Renewal for Turlock Irrigation District and**  
2 **Modesto Irrigation District Don Pedro Project**

3 The Don Pedro Project is located on the Tuolumne River in Tuolumne County.  
4 The initial license was issued for operations between 1971 and 1991 followed by  
5 requirements to evaluate fisheries water needs in the Tuolumne River.

6 In 1987, after the Turlock Irrigation District and Modesto Irrigation District  
7 applied to amend their license to add a fourth generating unit, FERC approved an  
8 amended fish study plan with possible changes in 1998. In 1996, FERC amended  
9 the license to implement amended minimum flow criteria and require fish  
10 monitoring studies for completion in 2005. In 2002, NMFS requested that FERC  
11 initiate formal consultation on the effects of the Don Pedro Project on Central  
12 Valley steelhead. The FERC approved the Summary Report on fisheries in 2008.  
13 In 2009, NMFS, USFWS, CDFW, and several environmental interest groups filed  
14 requests for rehearing on the license. FERC denied portions of the request but  
15 required instream flow studies to be conducted and required NMFS to be included  
16 for consultation on any authorized changes to minimum flow release schedules.

17 The FERC also directed the appointment of an administrative law judge to assist  
18 in assessing the need for and feasibility for interim measures prior to relicensing.  
19 A final report was completed in 2010. Following the completion of the report and  
20 a monitoring plan by the affected districts, FERC approved an order modifying  
21 and approving instream flow and monitoring study plans. A final license  
22 application, including an Environmental Report, was submitted to FERC in  
23 April 2014 (TID and MID 2014). The current license expires in 2016.

24 The objective of the relicensing process is to continue operation and maintenance  
25 of the Don Pedro Project facilities for electric power generation, along with  
26 implementation of any terms and conditions to be considered for inclusion in a  
27 new FERC hydroelectric license.

28 **3.5.1.5.4 FERC Relicense Renewal for Merced Irrigation District's Merced**  
29 **River Hydroelectric Project**

30 The Merced River Hydroelectric Project is located on the Merced River in  
31 Mariposa County and includes both Lake McClure and McSwain Reservoir, two  
32 powerhouses (New Exchequer and McSwain), and recreation facilities. The  
33 initial FERC license expires on February 28, 2014. The objective of the  
34 relicensing process is to continue operation and maintenance of the Merced River  
35 Hydroelectric Project facilities for electric power generation, along with  
36 implementation of any terms and conditions to be considered for inclusion in a  
37 new FERC hydroelectric license (Merced ID 2013).

38 **3.5.1.6 El Dorado Water and Power Authority Supplemental Water**  
39 **Rights Project**

40 The El Dorado Water and Power Authority (EDWPA) proposes to establish  
41 permitted water rights allowing diversion of water from the American River basin  
42 to meet planned future water demands in the El Dorado Irrigation District and  
43 Georgetown Divide Public Utility District service areas and other areas located



1 within El Dorado County that are outside of these service areas. The EDWPA  
 2 filed petitions with the SWRCB for partial assignment of State Filed Applications  
 3 5644 and 5645, and accompanying applications allowing for the total withdrawal  
 4 and use of 40,000 acre-feet per year, consistent with the diversion and storage  
 5 locations allowed under the El Dorado-Sacramento Municipal Utility District  
 6 Cooperation Agreement (EDWPA 2010).

### 7 **3.5.1.7 Semitropic Water Storage District Delta Wetlands**

8 In 1987, Delta Wetlands, a California Corporation, proposed a project for water  
 9 storage and wildlife habitat enhancement on four privately owned islands in the  
 10 Delta. The four islands were Bacon Island and Bouldin Island in San Joaquin  
 11 County and Holland Tract and Webb Tract in Contra Costa County,  
 12 encompassing approximately 23,000 acres. The Delta Wetlands Project would  
 13 store water on two Reservoir Islands (Bacon Island and Webb Tract) for  
 14 subsequent release into the Delta, and habitat enhancement to compensate for  
 15 wetland and wildlife effects of the water storage operations with a Habitat  
 16 Management Plan on two Habitat Islands (Bouldin Island and Holland Tract).

17 In 2007, the Delta Wetlands Project partnered with the Semitropic Water Storage  
 18 District (Semitropic WSD) to: 1) provide water to Semitropic WSD to augment its  
 19 water supply, and 2) bank water within the Semitropic Groundwater Storage Bank  
 20 and Antelope Valley Water Bank. The designated places of use for Delta  
 21 Wetlands Project water would include: Semitropic WSD; Member Agencies of  
 22 the Metropolitan Water District of Southern California, the Western Municipal  
 23 Water District of Riverside County, and select service areas of the Golden State  
 24 Water Company. The project would include improvements of 27 miles of levees  
 25 and screened diversions to divert water during high-flow periods in the winter  
 26 months of December through March into Webb Tract (100,000 acre-feet of  
 27 storage) and Bacon Island (115,000 acre-feet of storage). The water would not be  
 28 diverted in a manner that would adversely affect senior legal water rights holders,  
 29 including the SWP and CVP. Stored water would be discharged into False River  
 30 (from Webb Tract) and Middle River (from Bacon Island) for export when excess  
 31 SWP or CVP diversion capacity is available, in the summer and fall months of  
 32 July through November. Any water that could not be exported from the Delta in a  
 33 given year would be available to increase Delta outflow in the fall months of  
 34 September through November. Semitropic WSD issued a Draft EIR in 2010 and  
 35 a Final EIR in 2011 (SWSD 2011).

### 36 **3.5.1.8 North Bay Aqueduct Alternative Intake**

37 DWR is evaluating the implementation of an alternative intake on the Sacramento  
 38 River upstream of the Sacramento Regional Wastewater Treatment Plant, and  
 39 conveyance facility to connect the intake with the existing North Bay Aqueduct.  
 40 The proposed alternative intake would be operated in conjunction with the  
 41 existing North Bay Aqueduct intake at Barker Slough. The proposed project  
 42 would be designed to improve water quality and to provide reliable deliveries of  
 43 SWP supplies to its contractors, the Solano County Water Agency and the Napa  
 44 County Flood Control and Water Conservation District (DWR 2011a).

1 The proposed project would include construction and operation of a 240 cfs  
2 capacity intake with state-of-the-art positive barrier fish screens, pumping plant,  
3 sediment basins, and ancillary support facilities located on the west side of the  
4 Sacramento River near south Sacramento. The conveyance facility would include  
5 an approximately 30 mile long, 72 to 84-inch diameter underground steel and/or  
6 concrete pipeline to convey the water from the alternate intake to the existing  
7 North Bay Aqueduct. Two options are proposed for the location of the alternate  
8 intake facility. Alternate intake site 1 is located on the outside edge of Garcia  
9 Bend of the Sacramento River (on the west bank), approximately 500 feet south  
10 of the boundary of the City of West Sacramento. Alternate intake site 2 is located  
11 immediately south of the outside edge of Garcia Bend of the Sacramento River  
12 (on the west bank), approximately 2,500 feet south of the boundary of the City of  
13 West Sacramento. The intake and pumping plant facility would be constructed on  
14 the water side of the Sacramento River levee and the remaining components  
15 would be constructed on the land side of the levee. The intake would extend  
16 about 100 feet from the top of the levee into the river. The exact amount of this  
17 extension would depend on the site option selected. A fish screen would be  
18 installed on the face of the intake structure to prevent fish from swimming or  
19 being drawn into the intake and it would be designed to meet CDFW, NMFS, and  
20 USFWS criteria. The dimensions of the fish screen would be based on an  
21 anticipated approach velocity of 0.2 feet per second at the fish screen. Flow-  
22 control louvers behind the screen would control flow rates through the screen to  
23 assure uniform water velocity across the screen. Normal operation would keep  
24 the top of the screen below low water elevation. A reduction in pumping would  
25 occur any time the screens are not submerged or the water velocities increased.  
26 Above the screen would be concrete panels which extend to the 200 year flood  
27 elevation. A log boom would be installed in front of the fish screen to block large  
28 debris from blocking or damaging the intake. The intake would be equipped with  
29 an automatic fish screen cleaning system.

### 30 **3.5.1.9 Los Vaqueros Reservoir Expansion Phase 2**

31 Los Vaqueros Reservoir is an off-stream reservoir in the Kellogg Creek watershed  
32 to the west of the Delta. The Los Vaqueros Reservoir initial construction was  
33 completed in 1997 as a 100 TAF off-stream storage reservoir owned and operated  
34 by Contra Costa Water District to improve delivered water quality and emergency  
35 storage reliability to their customers. In 2012, the Los Vaqueros Reservoir was  
36 expanded to a total storage capacity of 160,000 acre-feet (Phase 1) to provide  
37 additional water quality and supply reliability benefits, and to adjust the timing of  
38 its Delta water diversions to accommodate the life cycles of Delta aquatic species,  
39 thus reducing species impact and providing a net benefit to the Delta  
40 environment. As part of the Storage Investigation Program described in the  
41 CALFED Bay Delta Program Record of Decision, additional expansion up to  
42 275 TAF (Phase 2) is being evaluated by Contra Costa Water District, DWR, and  
43 Reclamation. The alternatives considered in the evaluation also consider methods  
44 to convey water from Los Vaqueros Reservoir to the South Bay Aqueduct to  
45 provide water to Zone 7 Water Agency, Alameda County Water District, and  
46 Santa Clara Valley Water District (Reclamation, CCWD, and Western 2010).

1     **3.5.1.10   Upper San Joaquin River Basin Storage Investigation**

2     The Upper San Joaquin River Basin Storage Investigation is being conducted by  
3     Reclamation and DWR to evaluate alternative plans to increase Upper San  
4     Joaquin River Storage to enhance the San Joaquin River restoration efforts and  
5     improve water supply reliability for agricultural, municipal and industrial, and  
6     environmental uses in the Friant Division, the San Joaquin Valley, and other  
7     regions of the state. The investigation is evaluating integration of conjunctive  
8     management and water transfer concepts into plan formulations. Additional  
9     storage is also expected to provide incidental flood damage reduction benefits  
10    (Reclamation 2014c).

11    Reclamation is analyzing alternatives for a new dam and a 1,260 TAF reservoir  
12    along the San Joaquin upstream of Millerton Lake in an area known as  
13    Temperance Flat. Primary planning objectives are to: 1) increase water supply  
14    reliability, and 2) enhance flow and temperature conditions to support the San  
15    Joaquin River Restoration Program. Operation variables include reservoir  
16    carryover, new or shifting water supply beneficiaries, and alternative conveyance  
17    routes.

18    **3.5.1.11   Central Valley RWQCB Irrigated Lands Regulatory Program**

19    The Irrigated Lands Regulatory Program regulates discharges from irrigated  
20    agricultural lands. Its purpose is to prevent agricultural discharges from impairing  
21    the waters that receive the discharges. The California Water Code authorizes the  
22    SWRCB and Regional Water Quality Control Boards to conditionally waive  
23    waste discharge requirements if this is in the public interest. On this basis, the  
24    Los Angeles, Central Coast, Central Valley, and San Diego regional water quality  
25    control boards have issued conditional waivers of waste discharge requirements to  
26    growers that contain conditions requiring water quality monitoring of receiving  
27    waters. In 2010, the Central Valley Regional Water Quality Control Board  
28    proposed to expand the requirements to groundwater especially for regulation of  
29    discharges with higher concentrations of nutrients (CVRWQCB 2011).  
30    Participation in the waiver program is voluntary; however, non-participant  
31    dischargers must file a permit application as an individual discharger, stop  
32    discharging, or apply for coverage by joining an established coalition group. The  
33    waivers must include corrective actions when impairments are found.

34    **3.5.1.12   San Luis Reservoir Low Point Improvement Project**

35    The San Luis Reservoir Low Point Improvement Project is proposed by  
36    Reclamation, the Santa Clara Valley Water District, and the San Luis and Delta  
37    Mendota Water Authority. As part of this project, Reclamation is investigating  
38    three alternatives to address the water quality problems within the CVP's San  
39    Felipe Division (Santa Clara and San Benito counties) that arise when San Luis  
40    Reservoir levels drop below 300,000 acre-feet during late summer in dry water  
41    years, resulting in large algal blooms. The alternatives being considered are to  
42    1) expand the 6,000 acre-feet Pacheco Reservoir to 80,000 acre-feet or  
43    130,000 acre-feet, 2) lower the San Felipe Intake at San Luis Reservoir, or  
44    3) implement a combination comprehensive plan. The combination

1 comprehensive plan would involve increasing groundwater recharge and recovery  
2 capacity, implementing desalination measures, re-operating Santa Clara Valley  
3 Water District's raw- and treated-water systems, and implementing institutional  
4 measures. If Pacheco Reservoir were to be enlarged, the reservoir would be filled  
5 with Delta water; thus, additional impacts on Delta aquatic species (e.g., juvenile  
6 salmonids and Delta Smelt) could result from an increase in Delta exports. The  
7 environmental scoping report for the San Luis Reservoir Low Point Improvement  
8 Project was released in January 2009 and the plan formulation report was  
9 published in January 2011 (Reclamation et al. 2011).

10 **3.5.1.13 Westlands v. United States Settlement**

11 In August 2015, Westlands Water District and the United States agreed upon a  
12 settlement involving several litigations, as described below. The settlement is  
13 contingent upon Congressional authorization of enabling legislation (Reclamation  
14 2015). The following information provides a summary from the Reclamation  
15 news release in October 2015.

16 In 2000, the court in *Firebaugh Canal Co v. United States*, issued an Order  
17 requiring the Secretary of the Interior to provide drainage service to lands served  
18 by the San Luis Unit of the Central Valley Project. In 2007 Reclamation signed a  
19 Record of Decision selecting a drainage plan and finding that the cost of  
20 providing drainage for lands served by the San Luis Unit. Reclamation began  
21 implementing the selected drainage plan in a portion of Westlands Water District  
22 in 2010 on a court-ordered schedule.

23 In 2011, individual landowners within Westlands Water District filed a takings  
24 claim against the United States alleging that failure to provide drainage service  
25 has caused a physical taking of their lands without just compensation in violation  
26 of the Fifth Amendment (*Etchegoinberry v. United States*). The Court of Federal  
27 Claims denied the government's motion to dismiss the complaint.

28 In January 2012, Westlands filed a breach of contract case alleging that the  
29 government's failure to provide drainage service to the Westlands Water District  
30 service area constituted a breach of Westlands Water District 1963 Water Service  
31 and 1965 Repayment contracts (including the interim renewal of those contracts).  
32 The case is currently pending.

33 Under the proposed terms of the Settlement, Westlands Water District will:

- 34 • Permanently retire not less than 100,000 acres of land from production.  
35 Westlands Water District will agree to permanently retire a total of not less  
36 than 100,000 acres of lands within its boundaries utilizing those lands only for  
37 the following purposes:
  - 38 – Management of drain water, including irrigation of reuse areas;
  - 39 – Renewable energy projects;
  - 40 – Upland habitat restoration projects; or
  - 41 – Other uses subject to the consent of the United States.

- 1 • Cap contract deliveries at 75 percent of its CVP contact amount (from  
2 1.193 million acre-feet to 895 thousand acre-feet). Any water above this  
3 75 percent cap, that would have been delivered to Westlands Water District,  
4 would instead be available to the United States for other public purposes  
5 under the CVP.
- 6 • Assume all responsibility for drainage in accordance with all legal  
7 requirements under state and federal law. Westlands Water District would  
8 become legally responsible for the management of drainage water within its  
9 boundaries, in accordance with federal and California law.
- 10 • Indemnify the United States for any damages and pay compensation for  
11 claims arising out of the *Etchegoinberry litigation*. Under the Settlement  
12 Westlands Water District will indemnify the United States for any claims  
13 (past, present and future) arising out of a failure to provide drainage service  
14 with Westlands Water District. Westlands Water District would also  
15 intervene in the *Etchigoinberry* case for Settlement purposes and would pay  
16 compensation to individual landowners.
- 17 • Continue to wheel water to Lemoore Naval Air Station. As part of the overall  
18 Settlement, CVP water will be made available to Lemoore Naval Air Station  
19 and Westlands Water District would agree to wheel all CVP water made  
20 available to Lemoore under the same terms and conditions as Westlands  
21 Water District wheels water to other Westlands Water District's contractors.
- 22 • Be relieved from potential drainage repayment. If the United States were to  
23 expend significant funds to provide a drainage solution, Reclamation would  
24 seek repayment from Westlands Water District (over 50 years, with no  
25 interest, commencing after completion of each separable element). By taking  
26 responsibility for drainage, Westlands Water District would also eliminate  
27 responsibility for repayment.

28 Under the Terms of the Settlement, the United States will:

- 29 • Be relieved of all statutory obligations to provide drainage. The Settlement  
30 Agreement would relieve the Department of the Interior from all drainage  
31 obligations imposed by the San Luis Act, including implementation of the  
32 2007 ROD, which is estimated to cost approximately \$3.5 billion  
33 (\$513 million authorized). Westlands Water District will agree to dismiss  
34 with prejudice the *Westlands v. U.S.* breach of contract litigation and will join  
35 the U.S. in petitioning for vacatur of the 2000 Order Modifying Partial  
36 Judgment in the *Firebaugh* case directing implementation of drainage service  
37 and control schedules.
- 38 • Receive a waiver of claims for potential damages due to a failure to provide  
39 drainage service. Westlands Water District will agree to provide for the  
40 release, waiver and abandonment of all past, present and future claims arising  
41 from the government's failure to provide drainage service under the San Luis  
42 Act, including those by individual landowners within Westlands Water  
43 District's service area, and would further agree to indemnify the United States

- 1 for any and all claims relating to the provision of drainage service or lack  
2 thereof within the Westlands service area.
- 3 • Relieve Westlands Water District repayment obligation for CVP construction  
4 charges to date (approximately \$375 million). Westlands Water District will  
5 be relieved of its current, unpaid capitalized construction costs for the CVP,  
6 the present value of which is currently estimated to be \$375 million. Under  
7 the Settlement, Westlands Water District will still be responsible for  
8 Operation and Maintenance, the payment of restoration fund charges pursuant  
9 to the CVPIA, and for future CVP construction charges.
  - 10 • Convert Westlands Water District water service contract into a repayment  
11 contract. The Secretary will convert Westlands Water District’s current 9(e)  
12 water service contract to a 9(d) repayment contract consistent with existing  
13 key terms and conditions. As a “paid out” contractor, the benefit of this  
14 conversion is permanent right to a stated share of CVP water. However, the  
15 terms and conditions of the contract—including the so called “shortage  
16 clause” – will otherwise be the same as in the current 9(e) contract.
  - 17 • Retain the right to cease water deliveries if Westlands Water District fails to  
18 meet its drainage obligation. Language in the Settlement makes the United  
19 States’ obligation to provide water to Westlands under the 9(d) Repayment  
20 Contract conditional upon Westlands Water District’s fulfillment of its  
21 obligations to manage drainage water within its service area.
  - 22 • Issue a water service contract to Lemoore Naval Air Station. As part of the  
23 overall Settlement, the United States is authorized to enter into a water service  
24 contract with Lemoore Naval Air Station to provide a guaranteed quantity of  
25 CVP water to meet the needs of the Naval Air Station associated with air  
26 operations and Westlands Water District will agree to wheel all CVP water  
27 made available to Lemoore.

28 **3.5.1.14 Contra Loma Reservoir and Recreation Resource Management**  
29 **Plan**

30 The Contra Loma Recreation Resource Management Plan is a long-term plan to  
31 guide management of the resources on the federal lands within the 80-acre Contra  
32 Loma Reservoir and surrounding 661 acres of recreation areas in Contra Loma  
33 Regional Park and Antioch Community Park (Reclamation 2014f). The East Bay  
34 Regional Park District manages the federal lands and public recreation facilities  
35 under an agreement with Reclamation. The proposed plan is to expand  
36 recreational use and facilities to increase recreational demands, including  
37 establishment of an additional all-weather sports field, fishermen’s shelter,  
38 playground structure, a disc golf course, and expanded swim lagoon and trails.

39 **3.5.1.15 San Luis Reservoir State Recreation Area Resource Management**  
40 **Plan/General Plan**

41 The Resource Management Plan addressed recreational plans for the San Luis  
42 Reservoir State Recreation Area and adjacent lands in Merced County that are  
43 owned by Reclamation and managed by the California Department Parks and

1 Recreation, DWR, and CDFW (Reclamation and CDPR 2013). The plan would  
 2 focus on boating management, cultural resources management, vegetation  
 3 management, enhanced trails management, expanded visitor experiences and  
 4 education opportunities, and road and utility upgrades.

### 5 **3.5.1.16 Future Water Supply Projects**

6 Many of the future projects would directly increase regional and local water  
 7 supplies through groundwater storage and recovery programs, improved  
 8 conveyance that connects water supplies from different water agencies, recycled  
 9 water projects, and desalination projects. Water resources projects that have been  
 10 approved and are being implemented were previously described in this chapter  
 11 under the No Action Alternative. The following major water supply projects are  
 12 currently being evaluated and are considered under the Cumulative Effects  
 13 analysis.

- 14 • Future Groundwater Storage and Recovery Projects
  - 15 – City of Roseville (City of Roseville 2012)
  - 16 – Mokelumne River Water & Power Authority (MORE 2015)
  - 17 – Northeastern San Joaquin County Groundwater Banking Authority
  - 18 (NSJCGBA 2011)
  - 19 – Stockton East Water District (SEWD 2012)
  - 20 – Madera Irrigation District (Reclamation 2011b)
  - 21 – Kings River Conservation District (KRCD 2012b)
  - 22 – Buena Vista Water Storage District and Rosedale Rio Bravo Water
  - 23 Storage District (BVWSD 2015)
  - 24 – City of Los Angeles (City of Los Angeles 2010, 2013b)
  - 25 – Los Angeles County (Los Angeles County 2013b)
  - 26 – City of San Diego (City of San Diego 2009a, 2009b)
  - 27 – Rancho California Water District (RCWD 2011, 2012)
  - 28 – Eastern Municipal Water District (EMWD 2014c)
  - 29 – Jurupa Community Services District (JCSD et al. 2010)
- 30 • Major Conveyance Projects
  - 31 – Bay Area Regional Water Supply Reliability (CCWD 2014, EBMUD
  - 32 2014)
  - 33 – Friant-Kern Canal and Madera Canal Capacity Restoration Projects
  - 34 (SJRRP 2011, 2015)
  - 35 – Los Banos Creek Water Resources Management Plan (SJRECWA 2012)
  - 36 – Sacramento River Water Reliability Project (Reclamation 2004b)

- 1 • Major Recycle Water Projects (more than 10,000 acre-feet/year)
  - 2 – City of Fresno (City of Fresno 2011)
  - 3 – City of Los Angeles (City of Los Angeles 2005)
  - 4 – Central Basin Municipal Water District (CBMWD 2010)
  - 5 – Foothill Municipal Water District (MWDSC 2010)
  - 6 – Upper San Gabriel Valley Municipal Water District (USGVMWD 2013)
  - 7 – West Basin Municipal Water District (WBMWD 2011, 2015a)
  - 8 – Olivenhain Municipal Water District (OMWD 2015)
  - 9 – Eastern Municipal Water District (EMWD 2014c)
  - 10 – Inland Empire Utilities Agency (IEUA 2014)
  - 11 – Palmdale Water District (PWD 2010)
  - 12 – East Valley Water Reclamation Authority (Antelope Valley 2013)
- 13 • Major Future Coastal Desalination Water Projects
  - 14 – San Francisco Bay Area Regional Desalination Project (BARDP 2015)
  - 15 – City of Santa Barbara (City of Santa Barbara 2015)
  - 16 – Camrosa Water District (CWD 2015)
  - 17 – City of Long Beach (City of Long Beach 2015)
  - 18 – City of Huntington Beach (City of Huntington Beach 2010)
  - 19 – City of Oceanside (City of Oceanside 2012)
  - 20 – City of Carlsbad (City of Carlsbad 2006)
  - 21 – West Basin Municipal Water District (WBMWD 2015b)
  - 22 – Metropolitan Water District of Orange County (MWD OC 2015)
  - 23 – San Diego County Water Authority in the Southern California Region
  - 24 (SDCWA 2009, 2015)
- 25 • Long-term and short-term Water Transfers to provide water to municipal,
  - 26 agricultural, and ecosystem water users, including wildlife refuges including
  - 27 programs that transfer water from northern California to the San Joaquin
  - 28 Valley and southern California across the Delta (Reclamation and SLDMWA
  - 29 2015; BWGWD 2015).

### 30 **3.5.2 Ecosystem Improvement Projects and Actions**

31 There are numerous ecosystem improvement projects and actions that could be  
32 potentially affected by changes in the coordinated long-term operation of the CVP  
33 and SWP, or could affect the CVP and SWP operations. Major future water  
34 supply and water quality projects and actions are discussed below.

#### 35 **3.5.2.1 Mill Creek Riparian Assessment**

36 The need to restore and maintain riparian habitat in Mill Creek is identified in the  
37 Anadromous Fish Restoration Program and CALFED Bay-Delta Ecosystem  
38 Restoration Program goals, objectives, and targets. The AFRP is one of five  
39 CVPIA programs that have been integrated with the Ecosystem Restoration Plan.  
40 Both of these programs prioritize establishment, restoration, and maintenance of  
41 anadromous fish habitat on this stream, particularly in the arena of riparian habitat  
42 and flow enhancement. In response to this identified need, Reclamation and  
43 USFWS is implementing the Mill Creek Riparian Assessment. The project



1 includes: 1) riparian habitat and condition mapping and vegetation classification  
 2 of the Mill Creek watershed, 2) identifying and prioritizing areas that should be  
 3 restored, enhanced, and/or preserved in addition to existing conservation  
 4 easements, and 3) identifying the types of restoration actions that should occur at  
 5 the prioritized sites (USFWS 2010).

### 6 **3.5.2.2 Yolo County Habitat/Natural Community Conservation Plan**

7 The Yolo County Habitat Joint Powers Authority, consisting of five local public  
 8 agencies, launched the Yolo Natural Heritage Program in March 2007. This  
 9 effort includes the continuing preparation of a joint Habitat Conservation Plan/  
 10 Natural Community Conservation Plan (HCP/NCCP). Member agencies include  
 11 Yolo County and the cities of Davis, Woodland, West Sacramento, and Winters.

12 The HCP/NCCP describes the measures that local agencies will implement to  
 13 conserve biological resources, obtain permits for urban growth and public  
 14 infrastructure projects, and continue to maintain the agricultural heritage and  
 15 productivity of Yolo County. The nearly 653,820-acre planning area provides  
 16 habitat for covered species occurring within five dominant habitats/natural  
 17 communities. The plan proposes to address 63 covered species, including seven  
 18 state-listed species: palmate-bracted bird's-beak, Colusa grass, Crampton's  
 19 tuctoria, giant garter snake, Swainson's hawk, western yellow-billed cuckoo, and  
 20 bank swallow. Interim conservation activities include acquiring permanent  
 21 conservation easements for sensitive species habitat in the plan area  
 22 (YNHP 2015).

### 23 **3.5.2.3 California EcoRestore**

24 California EcoRestore is an initiative by the California Natural Resources Agency  
 25 to coordinate and advance habitat restoration for at least 30,000 acres by 2019  
 26 (CNRA 2015a, 2015b). This acreage includes 25,000 acres of habitat restoration  
 27 identified in the 2008 USFWS BO and 2009 NMFS BO, and 5,000 acres of  
 28 habitat enhancements. Some of these programs would be funded by federal and  
 29 state water agencies that are required to mitigate impacts of the CVP and SWP.  
 30 Other programs would be sponsored by a combination of funds from state bonds  
 31 (Proposition 1 and 1E), Assembly Bill 32 Greenhouse Gas Reduction Fund,  
 32 federal agencies, local agencies, and private investments. The California Delta  
 33 Conservancy will lead implementation of identified restoration projects in  
 34 collaboration with local governments and with a priority on using public lands in  
 35 the Delta.

36 Many of the programs to be implemented under California EcoRestore in Suisun  
 37 Marsh, Yolo Bypass, and Cache Slough are discussed separately under the No  
 38 Action Alternative and cumulative effects in this EIS.

### 39 **3.5.2.4 North Delta Flood Control and Ecosystem Restoration Project**

40 The North Delta Flood Control and Ecosystem Restoration Project is proposed  
 41 near the confluence of the Cosumnes and Mokelumne rivers by the DWR and  
 42 encompasses approximately 197 square miles. Consistent with objectives  
 43 contained in the CALFED Record of Decision, the project is intended to improve

1 flood management and provide ecosystem benefits in the North Delta area  
2 through actions such as construction of setback levees and configuration of flood  
3 bypass areas to create quality habitat for species of concern. These actions are  
4 focused on McCormack-Williamson Tract and Staten Island. The project would  
5 implement flood control improvements in a manner that benefits aquatic and  
6 terrestrial habitats, species, and ecological processes. Flood control  
7 improvements are needed to reduce damage to land uses, infrastructure, and the  
8 Bay-Delta ecosystem resulting from overflows caused by insufficient channel  
9 capacities and catastrophic levee failures in the 197 square-mile project study  
10 area. The proposed project as described in the Final EIR (DWR 2010b) included:  
11 portions of the levee system degraded to allow controlled flow across  
12 McCormack-Williamson Tract; levee modification to mitigate hydraulic impacts;  
13 channel dredging to increase flood conveyance capacity; an off-channel detention  
14 basin on Staten Island; ecosystem restoration where floodplain forests and  
15 marshes would be developed at McCormack-Williamson Tract and the Grizzly  
16 Slough property; setback levee on Staten Island to expand the floodway  
17 conveyance; and opening up the southern portion of McCormack-Williamson  
18 Tract to boating; improving Delta Meadows property; providing access and  
19 interpretive kiosks for wildlife viewing; and providing restroom, circulation,  
20 parking, and signage infrastructure to support such uses.

### 21 **3.5.2.5 Franks Tract Project**

22 Reclamation has conducted studies to evaluate the feasibility of modifying the  
23 hydrodynamic conditions near Franks Tract to improve Delta water quality and  
24 enhance the aquatic ecosystem. The results of these studies have indicated that  
25 modifying the hydrodynamic conditions near Franks Tract may substantially  
26 reduce salinity in the Delta and protect fishery resources, including populations of  
27 Delta Smelt. Reclamation evaluated installing operable gates to control the flow  
28 of water at key locations (Threemile Slough and/or West False River) to reduce  
29 sea water intrusion, and to positively influence movement of fish species of  
30 concern to areas that provide favorable habitat conditions. The project gates  
31 would be operated seasonally and during certain hours of the day, depending on  
32 fisheries and tidal conditions. Boat passage facilities would be included to allow  
33 for passing of watercraft when the gates are in operation. The Franks Tract  
34 Project is consistent with ongoing planning efforts for the Delta to help balance  
35 competing uses and create a more sustainable system for the future. By protecting  
36 fish resources, this project also could improve operational reliability of the CVP  
37 and SWP because curtailments in water exports (pumping restrictions) are likely  
38 to be less frequent. Franks Tract was previously evaluated as part of DWR's  
39 Flooded Island Pre-Feasibility Study Report (DWR 2007).

## 40 **3.6 Summary of Environmental Consequences**

41 Conditions in 2030 related to environmental and human resources that would  
42 occur with implementation of the No Action Alternative were compared to  
43 conditions under the Second Basis of Comparison; and conditions under

1 Alternatives 1 through 5 were compared to the conditions under the No Action  
2 Alternative and the Second Basis of Comparison, as described in Chapter 4,  
3 Approach to Environmental Analysis. The results of these analyses by alternative  
4 are described in Chapters 5 through 21 of this EIS and summarized in Tables 3.6  
5 and 3.7.

6 The tables present summarize the results of both quantitative and qualitative  
7 impact analyses. The tables include relative quantitative differences for adverse  
8 impacts to provide a basis for consideration of mitigation measures. Potential  
9 mitigation measures were considered related to the comparison of Alternatives 1  
10 through 5 to the No Action Alternative. Mitigation measures were not included to  
11 address adverse impacts of implementation of Alternatives 1 through 5 and the No  
12 Action Alternative as compared to the Second Basis of Comparison because this  
13 analysis was included in this EIS for information purposes only.

14 Changes in surface water conditions are provided as a basis for identifying the  
15 impacts as described in Aquatic, Terrestrial, and Recreation resources. Therefore,  
16 no mitigation measures are presented for Surface Water Resources.

17 Differences in the quantitative analyses of 5 percent or less are considered to be  
18 “similar” because the modeling analyses are based on CalSim II model output  
19 which operates with monthly time steps. Therefore, it was determined that  
20 changes in the model of 5 percent or less were related to the uncertainties in the  
21 model processing.

1 **Table 3.6 Comparison of Alternatives 1 through 5 to No Action Alternative**

	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
<b>SURFACE WATER</b>					
Trinity Lake	Water surface elevations similar. Storage similar or increased.	No change.	Water surface elevations similar. Storage similar or increased.	Water surface elevations similar. Storage similar or increased.	Water surface elevations similar. Storage similar or increased.
Trinity River at Lewiston Dam	Flows similar or increased.	No change.	Flows similar or increased.	Flows similar or increased.	Water surface elevations similar. Storage similar.
Shasta Lake	Water surface elevations similar. Storage similar or increased.	No change.	Water surface elevations similar. Storage similar or increased.	Water surface elevations similar. Storage similar or increased.	Water surface elevations similar. Storage similar.
Sacramento River at Keswick Dam	Flows similar or increased except reduced in September and November (up to 44%).	No change.	Flows similar or increased except reduced in September and November (up to 42%).	Flows similar or increased except reduced in September and November (up to 44%).	Flows similar.
Sacramento River at Freeport	Flows similar or increased except reduced in September and November (up to 47%).	No change.	Flows similar or increased except reduced in September and November (up to 48%).	Flows similar or increased except reduced in September and November (up to 47%).	Flows similar.
Clear Creek near Igo	Flows same except reduced in May (41%).	No change.	Flows same except reduced in May (29%).	Flows same except reduced in May (41%).	No change.
Lake Oroville	Water surface elevations similar. Storage reduced except in June (up to 22%).	No change.	Water surface elevations similar. Storage similar or increased.	Water surface elevations similar. Storage reduced except in June (up to 22%).	Water surface elevations similar. Storage similar.

	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
Feather River downstream of Thermalito Complex	Flows similar or increased except reduced in July-September and November-December (up to 65%).	No change.	Flows similar or increased except reduced in July-September and October-January (up to 70%).	Flows similar or increased except reduced in July-September and November-December (up to 65%).	Flows similar or increased except reduced in April-May (up to 27%).
Folsom Lake	Water surface elevations similar Storage similar or increased except reduced in June-August in above normal and below normal years (up to 15%).	No change.	Water surface elevations similar Storage similar or increased except reduced in July-August in above normal and August-September in below normal years (up to 10%).	Water surface elevations similar Storage similar or increased except in reduced June-August in above normal and below normal years (up to 15%).	Water surface elevations similar. Storage similar.
American River at Nimbus Dam	Flows similar or increased except reduced in September-November and June-July (up to 48%).	No change.	Flows similar or increased except reduced in August-November and June (up to 46%).	Flows similar or increased except reduced in September-November and June-July (up to 48%).	Flows similar or increased except reduced in September and April-May (up to 14%).
New Melones Reservoir	Water surface elevations similar Storage similar or increased.	No change.	Water surface elevations similar Storage similar or increased.	Water surface elevations similar Storage similar or increased.	Water surface elevations similar. Storage reduced in July-September in above normal years (up to 6%); and all months in below normal, dry, and critical dry years (up to 19 percent).
Stanislaus River at Goodwin Dam	Flows similar or increased except reduced in July-August, December, and March (up to 18%).	No change.	Flows similar or increased except reduced in October and February-July (up to 73%).	Flows similar or increased except reduced in July-August, December, and March (up to 18%).	Flows similar or increased except reduced in June-August (up to 18%).

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	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
San Joaquin River at Vernalis	Flows similar or increased except reduced in October and April (up to 19%).	No change.	Flows similar or increased except reduced in October and May-June (up to 21%).	Flows similar or increased except reduced in October and April (up to 19%).	Flows similar or increased.
San Luis Reservoir	Water surface elevations similar Storage similar or increased.	No change.	Water surface elevations similar Storage similar or increased.	Water surface elevations similar Storage similar or increased.	Water surface elevations similar Storage similar or increased except in below normal years in June-July (up to 9%); in dry years in April-September (up to 17%); and in critical dry years in April-January (up to 18%).
Flows into Yolo Bypass	Flows similar or increased except in October in wet years (20%).	No change.	Flows similar or increased except in October in wet years (25%).	Flows similar or increased except in October in wet years (20%).	Flows similar.
Delta Outflow	Reduced flows in many months. Increased flows in some months, including in December, February-March, and June in wet years (up to 1,492 cfs); and similar or increased flows in June and September in dry years (up to 385 cfs).	No change.	Reduced flows in many months. Increased flows in some months, including in December-March, in wet years (up to 3,307cfs); and increased flows in January-February and June-July in dry years (up to 277 cfs).	Reduced flows in many months. Increased flows in some months, including in December, February-March, and June in wet years (up to 1,492 cfs); and similar or increased flows in June and September in dry years (up to 385 cfs).	Flows would be similar or increased.
Reverse Flows in Old and Middle Rivers	Increased negative flows except in July-September.	No change.	Increased negative flows except in July-September.	Increased negative flows except in July-September.	Increased positive flows except in July-August.

	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
<b>Water Supplies</b>					
Non-CVP and Non-SWP Deliveries	Deliveries similar. No mitigation needed.	No change. No mitigation needed.	Deliveries similar. No mitigation needed.	Deliveries similar. No mitigation needed.	Deliveries similar. No mitigation needed.
CVP Water Deliveries (including CVP agricultural and municipal and industrial water service contracts; Sacramento River Settlement Contracts, San Joaquin River Exchange Contracts, and Eastside Division Contracts)	Deliveries similar or increased. No mitigation needed.	No change. No mitigation needed.	Deliveries similar or increased. No mitigation needed.	Deliveries similar or increased. No mitigation needed.	Deliveries similar or increased in wet to dry years. Reduced deliveries in the Eastside Division Contractors in critical dry years (8%). Potential Mitigation measure: Reclamation would support water transfers from other basin water rights holders.
SWP Water Deliveries (In accordance with Table A contracts without Article 21 water)	Deliveries similar or increased. No mitigation needed.	No change. No mitigation needed.	Deliveries similar or increased. No mitigation needed.	Deliveries similar or increased. No mitigation needed.	Deliveries similar or increased. No mitigation needed.

	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
<b>Surface Water Quality</b>					
Salinity in Northern Delta (near Emmaton)	Salinity increased in fall and winter months (up to 377%).  Reduced in June in wet to dry years (up to 30%).  Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	No change.  No mitigation needed.	Salinity increased in fall and winter months in wet and above normal years (up to 378%).  Reduced in June of above normal years and September of below normal years (up to 8%).  Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in the western Delta in fall and winter months (up to 377%).  Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in January-February in all years (up to 8%).  Reduced in April-June in critical dry years (up to 15%).  Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.
Salinity in Western Delta (near Port Chicago)	Salinity increased in Oct-March in below normal, dry, and critical dry years, and September wet and above normal years (up to 96%).  Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	No change.  No mitigation needed.	Salinity increased in October-January, April-May, June, and September in wet and above normal years (up to 95%).  Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in Oct-March in below normal, dry, and critical dry years, and September wet and above normal years (up to 96%).  Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity similar in most months except reduced in April-May in dry and critical dry years (up to 8%).  No mitigation needed.



	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
Salinity in Western Central Delta (near Antioch)	Salinity increased in fall and winter months (up to 265%).  Reduced in June in wet to below normal years (up to 14%).  Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	No change.  No mitigation needed.	Salinity increased in fall and winter months (up to 262%).  Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in fall and winter months (up to 265%).  Reduced in June in wet to below normal years (up to 14%).  Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in February in critical dry years (7%).  Reduced in April-May in below normal to critical dry years, and in June in critical dry years (up to 20%).  Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.
Salinity in Western Central Delta (near Contra Costa Water District Intakes)	Salinity increased in October-January and September in wet and above normal years (up to 65%).  Reduced in March-June in wet to below normal years (up to 32%).  Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	No change.  No mitigation needed.	Salinity increased in October-December in all year types, and January in above normal to dry years, and in September in wet and above normal years (up to 76%).  Reduced in April-June (up to 34%).  Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in October-January and September in wet and above normal years (up to 65%).  Reduced in March-June in wet to below normal years (up to 32%).  Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in April-June in below normal to critical dry years (up to 40%).  Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.

	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
Salinity in Southern Delta (near CVP and SWP intakes)	Salinity increased in fall and early winter months (up to 65%). Reduced in February-June (up to 22%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	No change. No mitigation needed.	Salinity increased in October-December (up to 29% at Jones Pumping Plant intake and up to 41% at Clifton Court intake). Reduced in June (up to 13% at Jones Pumping Plant intake and up to 19% at Clifton Court intake). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in fall and early winter months (up to 65%). Reduced in February-June (up to 22%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.	Salinity increased in June in dry and critical dry years (up to 12%). Potential Mitigation Measures: Continued coordination of CVP and SWP operations to reduce salinity to the extent possible. Other mitigation measures have not been identified at this time.
Mercury in Delta Fish	Mercury concentrations similar or reduced concentrations. No mitigation needed.	No change. No mitigation needed.	Mercury concentrations similar or reduced concentrations. No mitigation needed.	Mercury concentrations similar or reduced concentrations. No mitigation needed.	Mercury concentrations similar concentrations. No mitigation needed.
Selenium in Delta and Delta Fish	Selenium concentrations similar concentrations. No mitigation needed.	No change. No mitigation needed.	Selenium concentrations similar concentrations. No mitigation needed.	Selenium concentrations similar concentrations. No mitigation needed.	Selenium concentrations similar concentrations. No mitigation needed.
<b>Groundwater Resources</b>					
Trinity River Region	Similar groundwater conditions. No mitigation needed.	No change. No mitigation needed.	Similar groundwater conditions. No mitigation needed.	Similar groundwater conditions. No mitigation needed.	Similar groundwater conditions. No mitigation needed.
Central Valley Region: Sacramento Valley	Similar groundwater conditions. No mitigation needed.	No change. No mitigation needed.	Similar groundwater conditions. No mitigation needed.	Similar groundwater conditions. No mitigation needed.	Similar groundwater conditions. No mitigation needed.

	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
Central Valley Region: San Joaquin Valley	Reduced groundwater pumping (8%); and higher groundwater elevations (2-200 feet). Potentially improved groundwater quality. Reduced subsidence potential. No mitigation needed.	No change. No mitigation needed.	Reduced groundwater pumping (6%); and higher groundwater elevations (2-200 feet). Potentially improved groundwater quality. Reduced subsidence potential. No mitigation needed.	Reduced groundwater pumping (8%); and higher groundwater elevations (2-200 feet). Potentially improved groundwater quality. Reduced subsidence potential. No mitigation needed.	Similar groundwater pumping; and similar to higher groundwater elevations (2-25 feet). Similar groundwater quality. Similar subsidence potential. No mitigation needed.
San Francisco Bay Area, Central Coast, and Southern California Region	Potentially reduced groundwater pumping; and potentially higher groundwater elevations. Potentially improved groundwater quality. Less subsidence potential. No mitigation needed.	No change. No mitigation needed.	Potentially reduced groundwater pumping; and potentially higher groundwater elevations. Potentially improved groundwater quality. Less subsidence potential. No mitigation needed.	Potentially reduced groundwater pumping; and potentially higher groundwater elevations. Potentially improved groundwater quality. Less subsidence potential. No mitigation needed.	Similar groundwater pumping; and groundwater elevations. Potentially similar groundwater quality. Similar subsidence potential. No mitigation needed.
<b>CVP and SWP Energy Resources</b>					
Energy Generated and Used by CVP and SWP Water Users	Similar CVP net generation. Decreased SWP net generation over the long-term (41%). Potentially reduced energy use by CVP and SWP water users. No mitigation needed.	No change. No mitigation needed.	Similar CVP net generation. Decreased SWP net generation over the long-term (27%). Potentially reduced energy use by CVP and SWP water users. No mitigation needed.	Similar CVP net generation. Decreased SWP net generation over the long-term (41%). Potentially reduced energy use by CVP and SWP water users. No mitigation needed.	Similar CVP and SWP net generation. Similar reduced energy use. No mitigation needed.

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	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
<b>Aquatic Resources</b>					
Trinity River: Coho Salmon	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Trinity River: Spring-run Chinook Salmon	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Trinity River: Fall-run Chinook Salmon	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Trinity River: Steelhead	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Trinity River: Green Sturgeon	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Trinity Lake and Lewiston Reservoir: Reservoir Fish	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Trinity River: Pacific Lamprey	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Trinity River: Eulachon	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.

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Sacramento River System: Winter-run Chinook Salmon	<p>Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030.</p> <p>Potential mitigation measure: Implement fish passage around dams.</p>	<p>Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030; reduced pulse flows along lower Clear Creek; and lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants.</p> <p>Potential mitigation measure: Implement fish passage around dams to reduce temperature impacts.</p> <p>No mitigation measures have been identified for remaining impacts.</p>	<p>Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030.</p> <p>Improved conditions due to predator controls.</p> <p>Potential mitigation measure: Implement fish passage around dams.</p>	<p>Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030.</p> <p>Improved conditions due to predator controls.</p> <p>Potential mitigation measure: Implement fish passage around dams.</p>	<p>Similar conditions.</p> <p>No mitigation needed.</p>

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	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
Sacramento River System: Spring-run Chinook Salmon	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030.  Potential mitigation measure: Implement fish passage around dams.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030; reduced pulse flows along lower Clear Creek; and lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants.  Potential mitigation measure: Implement fish passage around dams to reduce temperature impacts. No mitigation measures have been identified for remaining impacts.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030.  Improved conditions due to predator controls.  Potential mitigation measure: Implement fish passage around dams.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030.  Improved conditions due to predator controls.  Potential mitigation measure: Implement fish passage around dams.	Similar conditions.  No mitigation needed.
Sacramento River System: Fall-run Chinook Salmon	Similar conditions.  No mitigation needed.	Reduced habitat conditions due to reduced pulse flows along lower Clear Creek; and lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants.  No mitigation measures have been identified for remaining impacts.	Similar conditions.  No mitigation needed.	Similar conditions.  No mitigation needed.	Similar conditions.  No mitigation needed.

	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
Sacramento River System: Late Fall-run Chinook Salmon	Similar conditions. No mitigation needed.	Reduced habitat conditions due to lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants. Potential mitigation measure: Implement fish passage around dams to reduce temperature impacts. No mitigation measures have been identified for remaining impacts.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Sacramento River System: Steelhead	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Potential mitigation measure: Implement fish passage around dams.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Potential mitigation measure: Implement fish passage around dams.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Potential mitigation measure: Implement fish passage around dams.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030. Potential mitigation measure: Implement fish passage around dams.	Similar conditions. No mitigation needed.
Sacramento River System: Green Sturgeon and White Sturgeon	Likely to result in improved conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Likely to result in improved conditions. No mitigation needed.	Likely to result in improved conditions. No mitigation needed.	Similar conditions. No mitigation needed.

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	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
Delta: Delta Smelt	Reduced habitat conditions due to increased potential for entrainment during larval and juvenile stages, and increased salinity in the fall in the western Delta.  No mitigation measures have been identified at this time.	Similar conditions. No mitigation needed.	Reduced habitat conditions due to increased potential for entrainment during larval and juvenile stages, and increased salinity in the fall in the western Delta.  No mitigation measures have been identified at this time.	Reduced habitat conditions due to increased potential for entrainment during larval and juvenile stages, and increased salinity in the fall in the western Delta.  No mitigation measures have been identified at this time.	Similar conditions. No mitigation needed.
Delta: Longfin Smelt	Reduced habitat conditions due to more negative Old and Middle River flows and other factors (as indicated by lower Longfin Smelt abundance indices).  No mitigation measures have been identified at this time.	Similar conditions. No mitigation needed.	Reduced habitat conditions due to more negative Old and Middle River flows and other factors (as indicated by lower Longfin Smelt abundance indices).  No mitigation measures have been identified at this time.	Reduced habitat conditions due to more negative Old and Middle River flows and other factors (as indicated by lower Longfin Smelt abundance indices).  No mitigation measures have been identified at this time.	Similar conditions. No mitigation needed.
Delta: Sacramento Splittail	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Sacramento River System: Reservoir Fish	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Sacramento River System: Pacific Lamprey	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.



	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
Sacramento River System: Striped Bass, American Shad, and Hardhead	Similar conditions for Hardhead. Reduced habitat conditions for Striped Bass and American Shad due to reduced survival in larval and juvenile stages and increased salinity in the spring in the western Delta. No mitigation measures have been identified at this time.	Similar conditions. No mitigation needed.	Similar conditions for Hardhead. Reduced habitat conditions for Striped Bass and American Shad due to reduced survival in larval and juvenile stages and increased salinity in the spring in the western Delta. Adverse conditions for Striped Bass due to changes in harvest limitations. No mitigation measures have been identified at this time.	Similar conditions for Hardhead. Reduced habitat conditions for Striped Bass and American Shad due to reduced survival in larval and juvenile stages and increased salinity in the spring in the western Delta. Adverse conditions for Striped Bass due to changes in harvest limitations. No mitigation measures have been identified at this time.	Similar conditions. No mitigation needed.
Stanislaus River: Fall-run Chinook Salmon	Similar conditions. No mitigation needed.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030; and lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants. Potential mitigation measure: Implement fish passage around dams to reduce temperature impacts. No mitigation measures have been identified for remaining impacts.	Potential improved habitat conditions due to predator controls, trap and haul operations, and harvest restrictions; however, the effectiveness of these measures is uncertain. No mitigation needed.	Potential improved habitat conditions due to predator controls, trap and haul operations, and harvest restrictions; however, the effectiveness of these measures is uncertain. No mitigation needed.	Similar conditions. No mitigation needed.

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	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
Stanislaus River: Steelhead	<p>Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030; and lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants.</p> <p>Potential mitigation measure: Implement fish passage around dams to reduce temperature impacts. No mitigation measures have been identified for remaining impacts.</p>	<p>Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030; and lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants.</p> <p>Potential mitigation measure: Implement fish passage around dams to reduce temperature impacts. No mitigation measures have been identified for remaining impacts.</p>	<p>Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030; and lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants.</p> <p>Potential improved habitat conditions due to predator controls and trap and haul operations; however, the effectiveness of these measures is uncertain.</p> <p>Potential mitigation measure: Implement fish passage around dams to reduce temperature impacts. No mitigation measures have been identified for remaining impacts.</p>	<p>Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030; and lack of measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants.</p> <p>Potential improved habitat conditions due to predator controls and trap and haul operations; however, the effectiveness of these measures is uncertain.</p> <p>Potential mitigation measure: Implement fish passage around dams to reduce temperature impacts. No mitigation measures have been identified for remaining impacts.</p>	<p>Similar conditions. No mitigation needed.</p>
Stanislaus River: White Sturgeon	<p>Conditions may be similar; however, adverse impacts could occur due to higher water temperatures.</p> <p>No mitigation measures have been identified at this time.</p>	<p>Similar conditions. No mitigation needed.</p>	<p>Conditions may be similar; however, adverse impacts could occur due to higher water temperatures.</p> <p>No mitigation measures have been identified at this time.</p>	<p>Conditions may be similar; however, adverse impacts could occur due to higher water temperatures.</p> <p>No mitigation measures have been identified at this time.</p>	<p>Similar conditions. No mitigation needed.</p>

	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
New Melones Reservoir; Reservoir Fish	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Stanislaus River: Other Fish	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions for lampreys and Hardheads.  Adverse conditions for Striped Bass due to changes in harvest limitations.  No mitigation needed for lamprey and Hardhead. No mitigation measures have been identified at this time for Striped Bass.	Similar conditions for lampreys and Hardheads.  Adverse conditions for Striped Bass due to changes in harvest limitations.  No mitigation needed for lamprey and Hardhead. No mitigation measures have been identified at this time for Striped Bass.	Similar conditions. No mitigation needed.
Pacific Ocean: Killer Whale	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
<b>Terrestrial Resources</b>					
Terrestrial Resources along Shoreline of CVP and SWP Reservoirs	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Terrestrial Resources along Rivers Downstream of CVP and SWP Reservoirs	Similar or improved conditions along Trinity, Sacramento, American, and Feather rivers.  Reduced conditions along Stanislaus River.  No mitigation measures identified at this time for changes along the Stanislaus River.	No change. No mitigation needed.	Similar or improved conditions along Trinity, Sacramento, American, and Feather rivers.  Reduced conditions along Stanislaus River.  No mitigation measures identified at this time for changes along the Stanislaus River.	Similar or improved conditions along Trinity, Sacramento, American, and Feather rivers.  Reduced conditions along Stanislaus River.  No mitigation measures identified at this time for changes along the Stanislaus River.	Similar or improved conditions along Trinity, Sacramento, American, and Feather rivers.  Improved conditions along Stanislaus River.  No mitigation needed.

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	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
Terrestrial Resources in Yolo Bypass	Similar conditions in Yolo Bypass. No mitigation needed.	No change. No mitigation needed.	Similar or improved conditions in Yolo Bypass. No mitigation needed.	Similar conditions in Yolo Bypass. No mitigation needed.	Similar conditions in Yolo Bypass. No mitigation needed.
Terrestrial Resources in Western Delta	Increased extent of salt water in the fall months of wet and above normal years in western Delta which could adversely affect terrestrial resources that use freshwater habitat. No mitigation measures identified at this time.	No change. No mitigation needed.	Increased extent of salt water in the fall months of wet and above normal years in western Delta which could adversely affect terrestrial resources that use freshwater habitat. No mitigation measures identified at this time.	Increased extent of salt water in the fall months of wet and above normal years in western Delta which could adversely affect terrestrial resources that use freshwater habitat. No mitigation measures identified at this time.	Similar habitat in western Delta. No mitigation needed.
<b>Geology and Soils Resources</b>					
Geology and Soils Resources	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
<b>Agricultural Resources</b>					
Agricultural Production and Employment	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
<b>Land Use</b>					
Municipal and Industrial Land Use	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
<b>Visual Resources</b>					
Visual Resources of Land Irrigated with CVP and SWP Water	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Visual Resources at Reservoirs that Store CVP and SWP Water	Similar or improved conditions. No mitigation needed.	No change. No mitigation needed.	Similar or improved conditions. No mitigation needed.	Similar or improved conditions. No mitigation needed.	Similar conditions. No mitigation needed.

	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
<b>Recreation Resources</b>					
Recreation Resources at Reservoirs that Store CVP and SWP Water	Similar or improved conditions. No mitigation needed.	No change. No mitigation needed.	Similar or improved conditions. No mitigation needed.	Similar or improved conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Recreation Resources in Rivers downstream of CVP and SWP Reservoirs	Similar or improved conditions. No mitigation needed.	No change. No mitigation needed.	Similar or improved conditions. Reduced opportunities for Striped Bass and sport ocean salmon fishing. No mitigation measures identified at this time.	Similar or improved conditions. Reduced opportunities for Striped Bass and sport ocean salmon fishing. No mitigation measures identified at this time.	Similar conditions. No mitigation needed.
<b>Air Quality and Greenhouse Gas Emissions</b>					
Emissions of Criteria Air Pollutants and Precursors and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants from Diesel Engines at Groundwater Wells	Similar air quality conditions in the Trinity River Region and Sacramento Valley. Improved air quality conditions in the San Joaquin Valley and the San Francisco Bay Area, Central Coast, and Southern California regions. No mitigation needed.	No change. No mitigation needed.	Similar air quality conditions in the Trinity River Region and Sacramento Valley. Reduced air quality conditions in the San Joaquin Valley and the San Francisco Bay Area, Central Coast, and Southern California regions. No mitigation needed.	Similar air quality conditions in the Trinity River Region and Sacramento Valley. Improved air quality conditions in the San Joaquin Valley and the San Francisco Bay Area, Central Coast, and Southern California regions. No mitigation needed.	Similar air quality conditions in the Trinity River Region and Sacramento Valley. Similar air quality conditions in the San Joaquin Valley and the San Francisco Bay Area, Central Coast, and Southern California regions. No mitigation needed.

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	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
Increased Greenhouse Gas Emissions (GHG) due to Changes in Energy Resources Related to CVP and SWP Water Use	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could increase in the San Francisco Bay Area, Central Coast, and Southern California regions.	No change.	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could increase in the San Francisco Bay Area, Central Coast, and Southern California regions.	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could increase in the San Francisco Bay Area, Central Coast, and Southern California regions.	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could increase in the San Francisco Bay Area, Central Coast, and Southern California regions.
<b>Cultural Resources</b>					
Potential for Disturbance of Cultural Resources	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
<b>Public Health</b>					
Water Supply Availability for Wildland Firefighting	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Potential Exposure to Mercury in Fish in Delta	Similar or reduced concentrations. No mitigation needed.	No change. No mitigation needed.	Similar or reduced concentrations. No mitigation needed.	Similar or reduced concentrations. No mitigation needed.	Similar concentrations. No mitigation needed.
<b>Socioeconomics</b>					
Agricultural and Municipal and Industrial Employment	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Municipal and Industrial Water Supply Operating Expenses	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.	Similar conditions. No mitigation needed.
Recreational Economics CVP and SWP Reservoirs	Similar or improved conditions. No mitigation needed.	No change. No mitigation needed.	Similar or improved conditions. No mitigation needed.	Similar or improved conditions. No mitigation needed.	Similar or improved conditions. No mitigation needed.

	<b>Alternative 1 Compared to the No Action Alternative</b>	<b>Alternative 2 Compared to the No Action Alternative</b>	<b>Alternative 3 Compared to the No Action Alternative</b>	<b>Alternative 4 Compared to the No Action Alternative</b>	<b>Alternative 5 Compared to the No Action Alternative</b>
Recreational Economics Related to Striped Bass Fishing in Delta	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Reduced recreational opportunities and associated economics. No mitigation identified at this time.	Reduced recreational opportunities and associated economics. No mitigation identified at this time.	Similar conditions. No mitigation needed.
Commercial and Sport Ocean Salmon Fishing	Similar conditions. No mitigation needed.	No change. No mitigation needed.	Reduced commercial and sport ocean salmon fishing and associated economics. No mitigation identified at this time.	Reduced commercial and sport ocean salmon fishing and associated economics. No mitigation identified at this time.	Similar conditions. No mitigation needed.
<b>Indian Trust Assets</b>					
Potential for Disturbance of Indian Trust Assets	No change. No mitigation needed.	No change. No mitigation needed.	No change. No mitigation needed.	No change. No mitigation needed.	No change. No mitigation needed.
<b>Environmental Justice</b>					
Emissions of Criteria Air Pollutants and Precursors and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants from Diesel Engines at Groundwater Wells	Improved air quality conditions. No mitigation needed.	No change. No mitigation needed.	Reduced air quality conditions. No mitigation needed.	Improved air quality conditions. No mitigation needed.	Similar air quality conditions. No mitigation needed.
Potential Exposure to Mercury in Fish in Delta	Similar or reduced concentrations. No mitigation needed.	No change. No mitigation needed.	Similar or reduced concentrations. No mitigation needed.	Similar or reduced concentrations. No mitigation needed.	Similar concentrations. No mitigation needed.

1 **Table 3.7 Comparison of No Action Alternative and Alternatives 1 through 5 to Second Basis of Comparison**

	<b>No Action Alternative Compared to Second Basis of Comparison</b>	<b>Alternative 1 Compared to the Second Basis of Comparison</b>	<b>Alternative 2 Compared to the Second Basis of Comparison</b>	<b>Alternative 3 Compared to the Second Basis of Comparison</b>	<b>Alternative 4 Compared to the Second Basis of Comparison</b>	<b>Alternative 5 Compared to the Second Basis of Comparison</b>
<b>SURFACE WATER CONDITIONS</b>						
Trinity Lake	Water surface elevations similar Storage would be similar in most months, except reduced in November-December in above normal years (up to 6%) and all months in critical dry years (up to 10%).	No change.	Water surface elevations similar Storage would be similar in most months, except reduced in November-December in above normal years (up to 6%) and all months in critical dry years (up to 10%).	Water surface elevations similar Storage similar or increased.	No change.	Water surface elevations similar Storage would be similar in most months, except reduced in all months in critical dry years (up to 10%).
Trinity River at Lewiston Dam	Flows similar or increased except reduced in December-February in wet to below normal years (up to 30%).	No change.	Flows similar or increased except reduced in December-February in wet to below normal years (up to 30%).	Flows similar or increased.	No change.	Flows similar or increased except reduced in December-February in wet to below normal years (up to 21%).
Shasta Lake	Water surface elevations similar Storage reduced in September-February in wet to dry years (up to 11%) and in all months in critical dry years (up to 14%).	No change.	Water surface elevations similar Storage reduced in September-February in wet to dry years (up to 11%) and in all months in critical dry years (up to 14%).	Water surface elevations similar Storage similar or increased.	No change.	Water surface elevations similar Storage reduced in September-February in most months of wet to dry years (up to 10%), and in all months in critical dry years (up to 17%).



	<b>No Action Alternative Compared to Second Basis of Comparison</b>	<b>Alternative 1 Compared to the Second Basis of Comparison</b>	<b>Alternative 2 Compared to the Second Basis of Comparison</b>	<b>Alternative 3 Compared to the Second Basis of Comparison</b>	<b>Alternative 4 Compared to the Second Basis of Comparison</b>	<b>Alternative 5 Compared to the Second Basis of Comparison</b>
Sacramento River at Keswick Dam	Flows reduced (up to 21%) except September and November.	No change.	Flows reduced (up to 21%) except September and November.	Flows similar or increased except reduced in August in below normal years (up to 6%).	No change.	Flows reduced (up to 16%) except September and November.
Sacramento River at Freeport	Flows similar or increased except reduced in May and June (up to 27%).	No change.	Flows similar or increased except reduced in May and June (up to 27%).	Flows similar or increased except reduced in June in below normal years (up to 13%).	No change.	Flows similar or increased except reduced in May and June (up to 28%).
Clear Creek near Igo	Flows similar or increased.	No change.	Flows similar or increased.	No change.	No change.	Flows similar or increased.
Lake Oroville	Water surface elevations similar. Similar in most months May-July in wet to dry years and in all months in critical dry years. Reduced in many months from September-February in all year types (up to 18%).	No change.	Water surface elevations similar. Similar in most months May-July in wet to dry years and in all months in critical dry years. Reduced in many months from September-February in all year types (up to 18%).	Water surface elevations similar. Storage similar.	No change.	Water surface elevations similar. Similar in most months May-July in wet to dry years and in all months in critical dry years. Reduced in many months from September-February in all year types (up to 18%).
Feather River downstream of Thermalito Complex	Flows similar or increased except reduced in August-June (up to 52%).	No change.	Flows similar or increased except reduced in August-June (up to 52%).	Flows similar or increased except reduced in August-June (up to 28%).	No change.	Flows similar or increased except reduced in August-June (up to 58%).

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	<b>No Action Alternative Compared to Second Basis of Comparison</b>	<b>Alternative 1 Compared to the Second Basis of Comparison</b>	<b>Alternative 2 Compared to the Second Basis of Comparison</b>	<b>Alternative 3 Compared to the Second Basis of Comparison</b>	<b>Alternative 4 Compared to the Second Basis of Comparison</b>	<b>Alternative 5 Compared to the Second Basis of Comparison</b>
Folsom Lake	Water surface elevations similar Storage similar in many months except reduced flows in September-January (up to 12%) in wet to below normal years and July-September in critical dry years (up to 11%).	No change.	Water surface elevations similar Storage similar in many months except reduced flows in September-January (up to 12%) in wet to below normal years and July-September in critical dry years (up to 11%).	Water surface elevations similar Storage similar.	No change.	Water surface elevations similar Storage similar in many months except reduced flows in August-January (up to 13%) in wet to below normal years and July in critical dry years (8%).
American River at Nimbus Dam	Flows similar or increased except reduced in June-August, December, February, and April (up to 25%).	No change.	Flows similar or increased except reduced in June-August, December, February, and April (up to 25%).	Flows similar or increased except reduced flows in June-August and April (up to 17%).	No change.	Flows similar or increased except reduced in December-February, April, June, and August (up to 25%).
New Melones Reservoir	Water surface elevations similar Storage similar in wet, below normal, and dry years, and in most months in above normal and critical dry years. Storage reduced in October in above normal water years (6%) and in October-January and April-June in critical dry years (up to 7%).	No change.	Water surface elevations similar Storage similar in wet, below normal, and dry years, and in most months in above normal and critical dry years. Storage reduced in October in above normal water years (6%) and in October-January and April-June in critical dry years (up to 7%).	Water surface elevations similar Storage similar or increased.	No change.	Water surface elevations similar Storage reduced in all months in all water year types (up to 23%).

	<b>No Action Alternative Compared to Second Basis of Comparison</b>	<b>Alternative 1 Compared to the Second Basis of Comparison</b>	<b>Alternative 2 Compared to the Second Basis of Comparison</b>	<b>Alternative 3 Compared to the Second Basis of Comparison</b>	<b>Alternative 4 Compared to the Second Basis of Comparison</b>	<b>Alternative 5 Compared to the Second Basis of Comparison</b>
Stanislaus River at Goodwin Dam	Flows similar or increased except reduced in November-March and May-June (up to 25%).	No change.	Flows similar or increased except reduced in November-March and May-June (up to 25%).	Flows reduced in all months (up to 79%) except April and August.	No change.	Flows reduced in all months (up to 25%) except October, April, and May.
San Joaquin River at Vernalis	Flows similar or increased except reduced in November and May-June (up to 9%).	No change.	Flows similar or increased except reduced in November and May-June (up to 9%).	Flows similar or increased except reduced in May-June (up to 27%).	No change.	Flows similar or increased except reduced in November and June (up to 10%).
San Luis Reservoir	Water surface elevations reduced in all months in wet to below normal water years and in February-September in dry and critical dry years (up to 16%). Storage reduced in October-June in most water years (up to 71%).	No change.	Water surface elevations reduced in all months in wet to below normal water years and in February-September in dry and critical dry years (up to 16%). Storage reduced in October-June in most water years (up to 71%).	Water surface elevations similar except reduced in January-February in above normal years (up to 6%) and February-August in critical dry years (up to 7%). Storage similar or increased in some months except in December-February and June in wet years (up to 16%), October-July in above normal and below normal years (up to 40%), January-September in dry years (up to 19%), and October-August in critical dry years (up to 29%).	No change.	Water surface elevations reduced in all months in all year types (up to 70%). Storage would be reduced in October-August in wet to below normal years (up to 17%), in January-September in dry years (up to 14%), and in all months in critical dry years (up to 14%).

	<b>No Action Alternative Compared to Second Basis of Comparison</b>	<b>Alternative 1 Compared to the Second Basis of Comparison</b>	<b>Alternative 2 Compared to the Second Basis of Comparison</b>	<b>Alternative 3 Compared to the Second Basis of Comparison</b>	<b>Alternative 4 Compared to the Second Basis of Comparison</b>	<b>Alternative 5 Compared to the Second Basis of Comparison</b>
Flows into Yolo Bypass	Flows similar or increased except reduced in November-December in wet years (up to 15%), January-March in above normal years (14%), December-March in below normal years (up to 25%), and December in dry years (6%).	No change.	Flows similar or increased except reduced in November-December in wet years (up to 15%), January-March in above normal years (14%), December-March in below normal years (up to 25%), and December in dry years (6%).	Flows similar except reduced in October of wet years (6%).	No change.	Flows similar or increased except reduced in November-January in wet years (up to 15%), January-March in above normal years (15%), December-March in below normal years (up to 24%), and December in dry years (7%).
Delta Outflow	Flows similar or increased in many months. Reduced flows in some months, including in December, February-March, and June in wet years (up to 1,590 cfs).	No change.	Flows similar or increased in many months. Reduced flows in some months, including in December, February-March, and June in wet years (up to 1,590 cfs).	Flows would increase in many months. Reduced flows in some months, including October and March-June in wet years (up to 1,127 cfs), and October and May-June in dry years (up to 373 cfs).	No change.	Flows similar or increased in many months. Reduced flows in some months, including in December, February-March, and June in wet years (up to 1,713 cfs), and June in dry years (526 cfs).
Reverse Flows in Old and Middle Rivers	Increased positive flows except in June-August in most years and March in wet years.	No change.	Increased positive flows except in June-August in most years and March in wet years.	Increased negative flows in June-August in most years and March in wet years.	No change.	Increased negative flows in July-August in most years and March and June in wet years.

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<b>Water Supplies</b>						
Non-CVP and Non-SWP Deliveries	Deliveries similar.	Deliveries similar.	Deliveries similar.	Deliveries similar.	Deliveries similar.	Deliveries similar.
North of Delta CVP Water Deliveries: Agricultural Water Contractors	Deliveries reduced up to 16% over the long-term to 34% in critical dry years.	No change.	Deliveries reduced up to 16% over the long-term to 34% in critical dry years.	Deliveries similar over the long-term. Reduced up to 9% in dry years to 11% in critical dry years.	No change.	Deliveries reduced up to 16% over the long-term to 31% in critical dry years.
North of Delta CVP Water Deliveries: Municipal and Industrial Water Contractors	Deliveries similar.	No change.	Deliveries similar.	Deliveries similar.	No change.	Deliveries similar.
South of Delta CVP Water Deliveries: Agricultural Water Contractors	Deliveries reduced up to 23% over the long-term to 33% in critical dry years.	No change.	Deliveries reduced up to 23% over the long-term to 33% in critical dry years.	Deliveries similar over the long-term. Reduced up to 8% in dry years to 14% in critical dry years.	No change.	Deliveries reduced up to 24% over the long-term to 33% in critical dry years.
South of Delta CVP Water Deliveries: Municipal and Industrial Water Contractors	Deliveries reduced up to 10% over the long-term to 5% in critical dry years.	No change.	Deliveries reduced up to 10% over the long-term to 5% in critical dry years.	Deliveries similar.	No change.	Deliveries reduced up to 10% over the long-term to 8% in critical dry years.
CVP Water Deliveries: Eastside Division Contractors	Deliveries reduced up to 19% in critical dry years.	No change.	Deliveries reduced up to 19% in critical dry years.	Deliveries similar.	No change.	Deliveries reduced up to 19% in critical dry years.
North of Delta: SWP Water Deliveries under Table A without Article 21 water	Deliveries reduced up to 13% over the long-term to 20% in critical dry years.	No change.	Deliveries reduced up to 13% over the long-term to 20% in critical dry years.	Deliveries similar over the long-term and in dry years. Reduced by 10% in critical dry years.	No change.	Deliveries reduced up to 19% over the long-term to 21% in critical dry years.

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North of Delta: SWP Water Deliveries under Table A without Article 21 water	Deliveries reduced up to 18% over the long-term to 22% in critical dry years.	No change.	Deliveries reduced up to 18% over the long-term to 22% in critical dry years.	Deliveries similar over the long-term and in dry years. Reduced by 11% in critical dry years.	No change.	Deliveries reduced up to 19% over the long-term to 23% in critical dry years.
<b>Surface Water Quality</b>						
Salinity in Northern Delta (near Emmaton)	Salinity increased in June in wet to dry years (up to 21%). Reduced in fall and winter months in wet and above normal years (up to 79%).	No change.	Salinity increased in June in wet to dry years (up to 21%). Reduced in fall and winter months in wet and above normal years (up to 79%).	Salinity increased in June in wet to dry years (up to 35%). Reduced in fall and winter months in wet and above normal years (up to 24%).	No change.	Salinity increased in June in wet to dry years (up to 21%). Reduced in fall and winter months in wet and above normal years (up to 79%).
Salinity in Western Delta (near Port Chicago)	Salinity reduced in September-May (up to 49%).	No change.	Salinity reduced in September-May (up to 49%).	Salinity increased in June in wet to below normal years (up to 9%). Reduced in January-March (up to 25%).	No change.	Salinity reduced in September-May (up to 49%).
Salinity in Western Central Delta (near Antioch)	Salinity increased in June in wet to below normal years (up to 16%). Reduced in fall and winter months (up to 73%).	No change.	Salinity increased in June in wet to below normal years (up to 16%). Reduced in fall and winter months (up to 73%).	Salinity increased in May in wet years and June in wet to dry years (up to 20%). Reduced in January-April (up to 40%).	No change.	Salinity increased in June in wet to below normal years (up to 14%). Reduced in fall and winter months (up to 73%).

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Salinity in Western Central Delta (near Contra Costa Water District Intakes)	Salinity increased in March-June (up to 47%). Reduced in October-January and September (up to 42%).	No change.	Salinity increased in March-June (up to 47%). Reduced in October-January and September (up to 42%).	Salinity increased in March-April in dry and critical dry years (up to 16%). Reduced in December-February in dry and critical dry years (up to 23%).	No change.	Salinity increased in March-June (up to 63%). Reduced in October-January and September (up to 41%).
Salinity in Southern Delta (near CVP and SWP intakes)	Salinity increased in February-June (up to 23%). Reduced in October-January (up to 28%).	No change.	Salinity increased in February-June (up to 23%). Reduced in October-January (up to 28%).	Salinity increased in February-May in dry and critical dry years (up to 23%).	No change.	Salinity increased in February-June (up to 26%). Reduced in October-January (up to 28%).
Mercury in Delta Fish	Mercury concentrations increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).	No change.	Mercury concentrations increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).	Similar conditions.	No change.	Mercury concentrations increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).
Selenium in Delta and Delta Fish	Selenium concentrations similar concentrations.	No change.	Selenium concentrations similar concentrations.	Selenium concentrations similar concentrations.	No change.	Selenium concentrations similar concentrations.
<b>Groundwater Resources</b>						
Trinity River Region	Similar groundwater conditions.	No change.	Similar groundwater conditions.	Similar groundwater conditions.	No change.	Similar groundwater conditions.

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Central Valley Region: Sacramento Valley	Similar groundwater conditions.	No change.	Similar groundwater conditions.	Similar groundwater conditions.	No change.	Similar groundwater conditions.
Central Valley Region: San Joaquin Valley	Increased groundwater pumping (8%); and lower groundwater elevations (2-200 feet).  Potentially reduced groundwater quality.  Increased subsidence potential.	No change.	Increased groundwater pumping (8%); and lower groundwater elevations (2-200 feet).  Potentially reduced groundwater quality.  Increased subsidence potential.	Similar groundwater pumping; and similar to lower groundwater elevations (2-25 feet).  Similar groundwater quality.  Similar subsidence potential.	No change.	Increased groundwater pumping (8%); and lower groundwater elevations (2-200 feet).  Potentially reduced groundwater quality.  Increased subsidence potential.
San Francisco Bay Area, Central Coast, and Southern California Region	Potentially increased groundwater pumping; and potentially lower groundwater elevations.  Potentially reduced groundwater quality.  Increased subsidence potential.	No change.	Potentially increased groundwater pumping; and potentially lower groundwater elevations.  Potentially reduced groundwater quality.  Increased subsidence potential.	Potentially increased groundwater pumping; and potentially lower groundwater elevations.  Potentially reduced groundwater quality.  Increased subsidence potential.	No change.	Potentially increased groundwater pumping; and potentially lower groundwater elevations.  Potentially reduced groundwater quality.  Increased subsidence potential.



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<b>CVP and SWP Energy Resources</b>						
Energy Generated and Used by CVP and SWP Water Users	Similar CVP net generation. Increased net generation over the long-term (29%). Potentially increased energy use by CVP and SWP water users.	No change.	Similar CVP net generation. Increased net generation over the long-term (29%). Potentially increased energy use by CVP and SWP water users.	Similar CVP net generation. Increased net generation over the long-term (10%). Potentially increased energy use by CVP and SWP water users.	No change.	Similar CVP net generation. Increased net generation over the long-term (30%). Potentially increased energy use by CVP and SWP water users.
<b>Aquatic Resources</b>						
Trinity River: Coho Salmon	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Trinity River: Spring-run Chinook Salmon	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Trinity River: Fall-run Chinook Salmon	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Trinity River: Steelhead	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Trinity River: Green Sturgeon	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Trinity Lake and Lewiston Reservoir: Reservoir Fish	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Trinity River: Pacific Lamprey	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Trinity River: Eulachon	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.

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Sacramento River System: Winter-run Chinook Salmon	Improved habitat conditions due to fish passage at dams and other actions to address high water temperatures caused by climate change by 2030.	No change.	Similar conditions.	Improved habitat conditions due to improved escapement potential and predator controls.	Similar conditions.	Improved habitat conditions due to fish passage at dams and other actions to address high water temperatures caused by climate change by 2030.
Sacramento River System: Spring-run Chinook Salmon	Improved habitat conditions due to fish passage at dams and other actions to address high water temperatures caused by climate change by 2030.	No change.	Similar conditions.	Improved habitat conditions due to harvest limitations and predator controls.	Similar conditions.	Improved habitat conditions due to fish passage at dams and other actions to address high water temperatures caused by climate change by 2030.
Sacramento River System: Fall-run Chinook Salmon	Similar conditions.	No change.	Similar conditions.	Similar conditions.	Similar conditions.	Similar conditions.
Sacramento River System: Late Fall-run Chinook Salmon	Improved habitat conditions due to measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants.	No change.	Similar conditions.	Similar conditions.	Similar conditions.	Improved habitat conditions due to measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants.

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Sacramento River System: Steelhead	Improved habitat conditions due to fish passage programs to address high water temperatures caused by climate change by 2030; and measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants.	No change.	Similar conditions.	Similar conditions.	Similar conditions.	Improved habitat conditions due to fish passage programs to address high water temperatures caused by climate change by 2030; and measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants.
Sacramento River System: Green Sturgeon and White Sturgeon	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030 that are not improved by other actions.	No change.	Similar conditions.	Improved habitat conditions due to lower water temperatures.	No change.	Reduced habitat conditions due to lack of measures to address high water temperatures caused by climate change by 2030 that are not improved by other actions.
Delta: Delta Smelt	Improved habitat conditions due to reduced potential for entrainment during larval and juvenile stages, and reduced salinity in the fall in the western Delta.	No change.	Similar conditions.	Similar conditions.	No change.	Improved habitat conditions due to reduced potential for entrainment during larval and juvenile stages, and reduced salinity in the fall in the western Delta.

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Delta: Longfin Smelt	Improved habitat conditions due to more positive Old and Middle River flows and other factors (as indicated by higher Longfin Smelt abundance indices).	No change.	Similar conditions.	Similar conditions.	No change.	Improved habitat conditions due to more positive Old and Middle River flows and other factors (as indicated by higher Longfin Smelt abundance indices).
Delta: Sacramento Splittail	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Sacramento River System: Reservoir Fish	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Sacramento River System: Pacific Lamprey	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Sacramento River System: Striped Bass, American Shad, and Hardhead	Similar conditions for Hardhead. Improved habitat conditions for Striped Bass and American Shad due to improved survival in larval and juvenile stages and reduced salinity in the spring in the western Delta.	No change.	Similar conditions.	Similar habitat conditions for Hardhead, Striped Bass, and American Shad. Adverse conditions for Striped Bass due to changes in harvest limitations.	No change in habitat conditions for Hardhead, Striped Bass, and American Shad. Adverse conditions for Striped Bass due to changes in harvest limitations.	Similar conditions for Hardhead. Improved habitat conditions for Striped Bass and American Shad due to improved survival in larval and juvenile stages and reduced salinity in the spring in the western Delta.

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Stanislaus River: Fall-run Chinook Salmon	Similar or improved conditions.	No change.	Similar conditions.	Potential improved habitat conditions due to predator controls, trap and haul operations, and harvest restrictions; however, the effectiveness of these measures is uncertain.	Potential improved habitat conditions due to predator controls, trap and haul operations, and harvest restrictions; however, the effectiveness of these measures is uncertain.	Similar or improved conditions.
Stanislaus River: Steelhead	Improved habitat conditions due to measures to address high water temperatures caused by climate change by 2030; and measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants.	No change.	Similar conditions.	Potential improved habitat conditions due to predator controls and trap and haul operations; however, the effectiveness of these measures is uncertain.	Potential improved habitat conditions due to predator controls and trap and haul operations; however, the effectiveness of these measures is uncertain.	Improved habitat conditions due to measures to address high water temperatures caused by climate change by 2030; and measures to increase efficiency of fish handling facilities at Banks and Jones pumping plants.
Stanislaus River: White Sturgeon	Conditions may be similar; however, improved conditions could occur due to lower water temperatures.	No change.	Similar conditions.	Similar conditions.	No change.	Conditions may be similar; however, improved conditions could occur due to lower water temperatures.
New Melones Reservoir; Reservoir Fish	Similar conditions.	No change.	Similar conditions.	Improved conditions for black bass nest survival.	No change.	Similar conditions.

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Stanislaus River: Other Fish	Similar conditions.	No change.	Similar conditions.	Similar conditions for lamprey and Hardhead. Adverse conditions for Striped Bass due to changes in harvest limitations.	Similar conditions for lamprey and Hardhead. Adverse conditions for Striped Bass due to changes in harvest limitations.	Similar conditions.
Pacific Ocean: Killer Whale	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
<b>Terrestrial Resources</b>						
Terrestrial Resources along Shoreline of CVP and SWP Reservoirs	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Terrestrial Resources along Rivers Downstream of CVP and SWP Reservoirs	Similar or improved conditions along Trinity, Sacramento, American, and Stanislaus rivers. Reduced conditions along Feather River. No mitigation measures identified at this time for changes along Feather River.	No change.	Similar or improved conditions along Trinity, Sacramento, American, and Stanislaus rivers. Reduced conditions along Feather River. No mitigation measures identified at this time for changes along Feather River.	Similar or improved conditions along Trinity, Sacramento, Feather, and American rivers. Reduced conditions along Stanislaus River. No mitigation measures identified at this time for changes along Stanislaus River.	No change.	Similar or improved conditions along Trinity, American, and Stanislaus rivers. Reduced conditions along Feather and Sacramento rivers. No mitigation measures identified at this time for changes along Feather and Sacramento rivers.
Terrestrial Resources in Yolo Bypass	Similar conditions in Yolo Bypass.	No change.	Similar conditions in Yolo Bypass.	Similar conditions in Yolo Bypass.	No change.	Similar or reduced conditions in Yolo Bypass.
Terrestrial Resources in Western Delta	Increased extent of freshwater habitat in western Delta.	No change.	Increased extent of freshwater habitat in western Delta.	Similar conditions.	No change.	Increased extent of freshwater habitat in western Delta.

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<b>Geology and Soils Resources</b>						
Geology and Soils Resources	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
<b>Agricultural Resources</b>						
Agricultural Production and Employment	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
<b>Land Use</b>						
Municipal and Industrial Land Use	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
<b>Visual Resources</b>						
Visual Resources of Land Irrigated with CVP and SWP Water	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.

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Visual Resources at Reservoirs that Store CVP and SWP Water	<p>Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, and New Melones Reservoir.</p> <p>Similar conditions at San Luis Reservoir in above normal to dry years.</p> <p>Reduced conditions at San Luis Reservoir in wet and critical dry years (up to 6%).</p> <p>Potentially reduced conditions in the San Francisco Bay Area, Central Coast, and Southern California regions (up to 18%).</p>	No change.	<p>Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, and New Melones Reservoir.</p> <p>Similar conditions at San Luis Reservoir in above normal to dry years.</p> <p>Reduced conditions at San Luis Reservoir in wet and critical dry years (up to 6%).</p> <p>Potentially reduced conditions in the San Francisco Bay Area, Central Coast, and Southern California regions (up to 18%).</p>	Similar conditions.	No change.	<p>Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, and New Melones Reservoir.</p> <p>Similar conditions at San Luis Reservoir in above normal to dry years.</p> <p>Reduced conditions at San Luis Reservoir in wet and critical dry years (up to 9%).</p> <p>Potentially reduced conditions in the San Francisco Bay Area, Central Coast, and Southern California regions (up to 18%).</p>



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<b>Recreation Resources</b>						
Recreation Resources at Reservoirs that Store CVP and SWP Water	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, and New Melones Reservoir. Similar conditions at San Luis Reservoir in above normal to dry years. Reduced conditions at San Luis Reservoir in wet and critical dry years (up to 6%). Potentially reduced conditions in the San Francisco Bay Area, Central Coast, and Southern California regions (up to 18%).	No change.	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, and New Melones Reservoir. Similar conditions at San Luis Reservoir in above normal to dry years. Reduced conditions at San Luis Reservoir in wet and critical dry years (up to 6%). Potentially reduced conditions in the San Francisco Bay Area, Central Coast, and Southern California regions (up to 18%).	Similar conditions.	No change.	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, and New Melones Reservoir. Similar conditions at San Luis Reservoir in above normal to dry years. Reduced conditions at San Luis Reservoir in wet and critical dry years (up to 9%). Potentially reduced conditions in the San Francisco Bay Area, Central Coast, and Southern California regions (up to 18%).
Recreation Resources in Rivers downstream of CVP and SWP Reservoirs	Similar or improved conditions; except reduced conditions in June and August along the Feather and American rivers, and in May along the Feather River and Sacramento River near Freeport.	No change.	Similar or improved conditions; except reduced conditions in June and August along the Feather and American rivers, and in May along the Feather River and Sacramento River near Freeport.	Similar or improved conditions along rivers. Reduced opportunities for Striped Bass and sport ocean salmon fishing.	No change along rivers. Reduced opportunities for Striped Bass and sport ocean salmon fishing.	Similar or improved conditions; except reduced conditions in May and June and August along the Sacramento and Feather rivers, in August along the American River; and in June-August along Stanislaus River.

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<b>Air Quality and Greenhouse Gas Emissions</b>						
Emissions of Criteria Air Pollutants and Precursors and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants from Diesel Engines at Groundwater Wells	Similar air quality conditions in the Trinity River Region and Sacramento Valley.  Potential increase in emissions (up to 18%) in the San Joaquin Valley and the San Francisco Bay Area, Central Coast, and Southern California regions.	No change.	Similar air quality conditions in the Trinity River Region and Sacramento Valley.  Potential increase in emissions (up to 18%) in the San Joaquin Valley and the San Francisco Bay Area, Central Coast, and Southern California regions.	Similar conditions.	No change.	Similar air quality conditions in the Trinity River Region and Sacramento Valley.  Potential increase in emissions (up to 18%) in the San Joaquin Valley and the San Francisco Bay Area, Central Coast, and Southern California regions.
Increased Greenhouse Gas Emissions due to Changes in Energy Resources Related to CVP and SWP Water Use	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could be reduced in the San Francisco Bay Area, Central Coast, and Southern California regions.	No change.	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could be reduced in the San Francisco Bay Area, Central Coast, and Southern California regions.	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could be reduced in the San Francisco Bay Area, Central Coast, and Southern California regions.	No change.	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could be reduced in the San Francisco Bay Area, Central Coast, and Southern California regions.

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<b>Cultural Resources</b>						
Potential for Disturbance of Cultural Resources	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
<b>Public Health</b>						
Water Supply Availability for Wildland Firefighting	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir. Reduced potential at San Luis Reservoir (6%).	No change.	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir. Reduced potential at San Luis Reservoir (6%).	Similar conditions.	No change.	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir. Reduced potential at San Luis Reservoir (9%).
Potential Exposure to Mercury in Fish in Delta	Increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).	No change.	Increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).	Similar conditions.	No change.	Increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).
<b>Socioeconomics</b>						
Agricultural and Municipal and Industrial Employment	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.
Municipal and Industrial Water Supply Operating Expenses	Similar conditions.	No change.	Similar conditions.	Similar conditions.	No change.	Similar conditions.

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Recreational Economics CVP and SWP Reservoirs	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir. Reduced potential at San Luis Reservoir and reservoirs that store CVP and SWP water in San Francisco Bay Area, Central Coast, and Southern California regions.	No change.	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir. Reduced potential at San Luis Reservoir and reservoirs that store CVP and SWP water in San Francisco Bay Area, Central Coast, and Southern California regions.	Similar conditions.	No change.	Similar conditions at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir. Reduced potential at San Luis Reservoir and reservoirs that store CVP and SWP water in San Francisco Bay Area, Central Coast, and Southern California regions.
Recreational Economics Related to Striped Bass Fishing in Delta	Similar conditions.	No change.	Similar conditions.	Reduced recreational opportunities and associated economics.	Reduced recreational opportunities and associated economics.	Similar conditions.
Commercial and Sport Ocean Salmon Fishing	Similar conditions.	No change.	Similar conditions.	Reduced commercial and sport ocean salmon fishing and associated economics.	Reduced commercial and sport ocean salmon fishing and associated economics.	Similar conditions.
<b>Indian Trust Assets</b>						
Potential for Disturbance of Indian Trust Assets	No change.	No change.	No change.	No change.	No change.	No change.

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<b>Environmental Justice</b>						
Emissions of Criteria Air Pollutants and Precursors and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants from Diesel Engines at Groundwater Wells	Potential increase in emissions (up to 18%).	No change.	Potential increase in emissions (up to 18%).	Similar conditions.	No change.	Potential increase in emissions (up to 18%).
Potential Exposure to Mercury in Fish in Delta	Increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).	No change.	Increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).	Similar conditions.	No change.	Increased near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough (up to 7%).

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**Chapter 4**

**1 Approach to Environmental Analysis**

2 This chapter describes the organization of the remaining chapters in the  
3 Environmental Impact Statement (EIS). It also defines the scope, extent, and  
4 framework of the environmental analysis, including a description of resources  
5 areas evaluated and not evaluated.

6 The resource chapters in this EIS (Chapters 5 through 21) describe the affected  
7 environment and the impact analysis for each resource associated with  
8 implementation of the No Action Alternative, Second Basis of Comparison, and  
9 Alternatives 1 through 5. Potential mitigation measures (if necessary and  
10 available) to avoid, reduce, or otherwise minimize potential adverse impacts to  
11 the environment due to implementation of Alternatives 1 through 5 as compared  
12 to conditions under the No Action Alternative are discussed within each resource  
13 section. Potential cumulative effects that would occur with implementation of the  
14 alternatives are described in each resource chapter.

**15 4.1 Basis of the Environmental Analysis**

16 The impact analysis is focused on the coordinated long-term operation of the  
17 Central Valley Project (CVP) and the State Water Project (SWP). This EIS  
18 addresses conditions that would result from the long-term operation of  
19 Alternatives 1 through 5 as compared to the long-term conditions that would  
20 occur under the No Action Alternative and the Second Basis of Comparison in the  
21 Year 2030. This EIS does not address interim changes that would occur between  
22 now and 2030.

23 This EIS does not address the impacts that could occur between now and 2030  
24 due to the construction of projects that are assumed to be implemented under the  
25 No Action Alternative, Second Basis of Comparison, and Alternatives 1  
26 through 5. As described in Chapter 3, Description of Alternatives, there are  
27 several ongoing projects that are assumed to be implemented in 2030, including  
28 facilities that require construction. The 2030 conditions assume the projected  
29 long-term conditions for each ongoing project as described in their respective  
30 environmental documents. This EIS does not address the construction activities  
31 of each ongoing project because those impacts are addressed in separate  
32 environmental documents for each project.

33 Implementation of the No Action Alternative and Alternatives 1, 3, 4, and 5 also  
34 could result in construction of facilities (e.g., fish passage facilities around dams  
35 or across the Delta under these alternatives). Because, at this time, it is not known  
36 if construction will be required to implement these provisions or the nature of  
37 future facilities, this EIS does not address the construction activities of the future  
38 facilities. Impacts of future facilities will be addressed in separate environmental

1 documents for each project. It is assumed that the provisions in the alternatives,  
2 including construction activities, would be implemented in 2030.

## 3 **4.2 Resources Considered for Environmental** 4 **Analysis**

5 The resources and issues included in Chapters 5 through 22 were identified  
6 through a review of scoping comments and subsequent comments received from  
7 agencies and the public during preparation of this EIS, as described in Chapter 3,  
8 Description of Alternatives. The resources and issues are described and analyzed  
9 in the following chapters of this EIS.

- 10 • Chapter 5 – Surface Water Resources and Water Supplies
- 11 • Chapter 6 – Surface Water Quality
- 12 • Chapter 7 – Groundwater Resources and Groundwater Quality
- 13 • Chapter 8 – Energy
- 14 • Chapter 9 – Fish and Aquatic Resources
- 15 • Chapter 10 – Terrestrial Biological Resources
- 16 • Chapter 11 – Geology and Soils Resources
- 17 • Chapter 12 – Agricultural Resources
- 18 • Chapter 13 – Land Use
- 19 • Chapter 14 – Visual Resources
- 20 • Chapter 15 – Recreation Resources
- 21 • Chapter 16 – Air Quality and Greenhouse Gas Emissions
- 22 • Chapter 17 – Cultural Resources
- 23 • Chapter 18 – Public Health
- 24 • Chapter 19 – Socioeconomics
- 25 • Chapter 20 – Indian Trust Assets
- 26 • Chapter 21 – Environmental Justice
- 27 • Chapter 22 – Other National Environmental Policy Act (NEPA)  
28 Considerations
- 29 • Chapter 23 – Consultation and Coordination
- 30 • Chapter 24 – Distribution of Draft EIS
- 31 • Chapter 25 – List of Preparers
- 32 • Chapter 26 – Index

1 As described above, this EIS only addresses long-term operational impacts. It is  
2 assumed that the coordinated long-term operation of the CVP and SWP would not  
3 result in substantial impacts to transportation, noise, hazards and hazardous  
4 materials, infrastructure related to public services and utilities, and  
5 paleontological resources because there would not be ongoing construction  
6 activities and the operation and maintenance activities would be similar to  
7 conditions under the No Action Alternative or the Second Basis of Comparison.

8 Scoping comments were received related to potential impacts to transportation on  
9 highways and airports due to dust generated from noncultivated agricultural lands.  
10 The potential for changes in dust generation is addressed in Chapter 16, Air  
11 Quality and Greenhouse Gas Emissions; based upon the impact assessment, it  
12 does not appear that the amount of noncultivated land would change substantially  
13 between the alternatives and result in substantial change in dust generation.

14 It is recognized that the ability to fund some public services and utilities could be  
15 affected through implementation of the alternatives evaluated in this EIS. These  
16 potential changes related to water supply costs are addressed in Chapter 19,  
17 Socioeconomics.

18 Chapter 23 includes a discussion of comments received during scoping and  
19 meetings that were held throughout preparation of the EIS with stakeholders.  
20 Chapter 24 includes a list of recipients of this Draft EIS. Chapter 25 includes a  
21 list of preparers of this Draft EIS.

## 22 **4.3 Methodology for the Environmental Analysis**

23 This EIS assesses the potential impacts of changes that could result on the  
24 resources identified above from implementation of each of the alternatives as  
25 compared to the No Action Alternative and the Second Basis of Comparison. The  
26 impact analysis includes an evaluation of potential direct, indirect, and cumulative  
27 effects by resource.

### 28 **4.3.1 Geographic Range of Analysis**

29 The project area that could be affected varies by resource. As described in  
30 Chapter 1, Introduction, the project area includes most of the CVP facilities and  
31 CVP service areas, and all of the SWP facilities and the SWP service areas. For  
32 the analysis purposes, the project area was divided into five regions, as shown in  
33 Figure 4.1 at the end of this chapter. The geographic extent for each resource is  
34 described by applicable regions in Chapters 5 through 21. The geographic range  
35 of the project area encompasses 35 counties. The locations of CVP and SWP  
36 water supply facilities, locations of CVP and SWP water users, and areas  
37 potentially affected by the long-term coordinated operation of the CVP and SWP,  
38 are summarized in Table 4.1.

1 **Table 4.1 Geographic Range of the EIS Analysis**

<b>Region</b>	<b>County</b>	<b>Reasons for Inclusion of County in Project Area</b>
Trinity River	Trinity	CVP Facilities: Trinity Lake, and Lewiston and Whiskeytown reservoirs Trinity River downstream of Lewiston Dam
	Humboldt	Trinity River to confluence of lower Klamath River Lower Klamath River from Trinity County border to Del Norte County border
	Del Norte	Lower Klamath River from Humboldt County border to Pacific Ocean
Central Valley	Shasta	CVP Facilities: Shasta Lake and Keswick Reservoir Sacramento River downstream of Keswick Dam to Tehama County border
		CVP Water Users: Anderson-Cottonwood Irrigation District Bella Vista Water District Centerville Community Services District City of Redding City of Shasta Lake Clear Creek Community Services District Mountain Gate Community Services District Redding Rancheria Tribe Shasta Community Services District Shasta County Service Area No. 25 Shasta County Water Agency U.S. Forest Service Multiple Contracts with Individuals and Businesses
	Plumas	SWP Facilities: Antelope Lake, Lake Davis, and Frenchman Lake
		SWP Water Users: Plumas County Flood Control and Water Conservation District
	Tehama	CVP Facilities: Portion of the Tehama Colusa Canal and Corning Canal Sacramento River within Tehama County
		CVP Water Users: Corning Water District Kirkwood Water District Thomes Creek Water District Proberta Water District Lake California Property Owners Association Multiple Contracts with Individuals and Businesses

Region	County	Reasons for Inclusion of County in Project Area
Central Valley (continued)	Glenn	CVP Facilities: Portion of the Tehama Colusa Canal Sacramento River within Glenn County
		CVP Water Users: 4-E Water District Elk Creek Community Services District Glenn-Colusa Irrigation District Glide Water District Kanawha Water District Orland-Artois Water District Provident Irrigation District Stony Creek Water District U.S. Forest Service Portion of Sacramento National Wildlife Refuge
	Colusa	CVP Facilities: Portion of the Tehama Colusa Canal Sacramento River within Colusa County
		CVP Water Users: 4-M Water District Cachil Dehe Band of Wintu Indians of the Colusa Indian Community Carter Mutual Water Company Colusa County Water District Colusa Drain Mutual Water Company Cortina Water District County of Colusa County of Colusa (Stonyford) Davis Water District Glenn Valley Water District Holthouse Water District La Grande Water District Maxwell Irrigation District Myers-Marsh Mutual Water Company Princeton-Codora-Glenn Irrigation District Reclamation District No. 1004 Reclamation District No. 108 Roberts Ditch Irrigation Company Sartain Mutual Water Company Westside Water District Colusa National Wildlife Refuge Delevan National Wildlife Refuge Portion of Sacramento National Wildlife Refuge Multiple Contracts with Individuals and Businesses
	Butte	SWP Facilities: Lake Oroville and Thermalito Reservoir Sacramento River within Butte County
		CVP Water User: Gray Lodge Wildlife Area  SWP Water User: Butte County Water and Resources Conservation District

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<b>Region</b>	<b>County</b>	<b>Reasons for Inclusion of County in Project Area</b>
Central Valley (continued)	Sutter	Sacramento River within Sutter County
		CVP Water Users: Feather Water District Meridian Farms Water Company Natomas Basin Conservancy Pleasant Grove Verona Mutual Water Company Sutter Mutual Water Company Tisdale Irrigation and Drainage Company Sutter National Wildlife Refuge
		SWP Water Users: City of Yuba City
	Yuba	Sacramento River within Yuba County
		Water Supplies from Yuba County Water Agency are available to CVP and SWP
	Nevada	Water Supplies from Nevada County flow in the Bear River into CVP facilities on the American River
	Placer	CVP Water Facilities: Portion of Folsom Lake
		CVP Water Users: Placer County Water Agency City of Roseville San Juan Water District
	El Dorado	CVP Water Facilities: Portion of Folsom Lake
		CVP Water Users: El Dorado Irrigation District El Dorado County Water Agency
	Sacramento	CVP Water Facilities: Portion of Folsom Lake, Lake Natoma, and Folsom South Canal American River downstream of Nimbus Dam to confluence with Sacramento River Sacramento River and Delta within Sacramento County
		CVP Water Users: City of Folsom City of Sacramento Natomas Central Mutual Water Company Reclamation District No. 1000 Regional Water Authority Sacramento County Sacramento County Water Agency Sacramento Municipal Utility District Sacramento Suburban Water District San Juan Water District Natomas Basin Conservancy

Region	County	Reasons for Inclusion of County in Project Area
Central Valley (continued)	Yolo	CVP Facilities: Portion of the Tehama Colusa Canal Sacramento River and Delta within Yolo County Yolo Bypass
		CVP Water Users: City of West Sacramento Conaway Preservation Group Dunnigan Water District Eastside Mutual Water Company Pelger Mutual Water Company Reclamation District No. 900 Multiple Contracts with Individuals and Businesses
	Solano (included in San Francisco Bay Area Region in some chapters)	SWP Facilities: Portion of the North Bay Aqueduct Sacramento River and Delta within Solano County Yolo Bypass
		SWP Water Users: Solano County Water Agency
	Stanislaus	CVP Facilities: New Melones Reservoir and portion of the Delta Mendota Canal Stanislaus River downstream of New Melones Dam to confluence with San Joaquin River San Joaquin River within Stanislaus County
		SWP Facilities: Portion of the California Aqueduct
		CVP Water Users: Del Puerto Water District Oakdale Irrigation District Patterson Irrigation District West Stanislaus Irrigation District Portion of San Luis National Wildlife Refuge
		SWP Water Users: Oak Flat Water District
	Merced	CVP Facilities: San Luis and O'Neill reservoirs, portions of Delta-Mendota Canal and San Luis Canal San Joaquin River within Merced County
		SWP Facilities: San Luis and O'Neill reservoirs and portion of California Aqueduct

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Region	County	Reasons for Inclusion of County in Project Area
Central Valley (continued)	Merced (continued)	CVP Water Users: Centinella Water District Central California Irrigation District City of Dos Palos Del Puerto Water District Eagle Field Water District Grasslands Water District Laguna Water District Oro Loma Water District San Luis Canal Company San Luis Water District Turner Island Water District U.S. Department of Veterans Affairs, San Joaquin Valley National Cemetery Widren Water District Merced National Wildlife Refuge Portion of San Luis National Wildlife Refuge Kesterson National Wildlife Refuge Los Banos and Volta Wildlife Areas, Grasslands Resources Conservation District
	Madera	CVP Facilities: Madera Canal
	San Joaquin	San Joaquin River and Delta within San Joaquin County
		CVP Water Users: Banta-Carbona Irrigation District Byron-Bethany Irrigation District Central San Joaquin Water Conservation District City of Tracy Del Puerto Water District South San Joaquin Irrigation District Stockton-East Water District The West Side Irrigation District West Stanislaus Irrigation District
Fresno	CVP Facilities: Portions of Delta-Mendota Canal and San Luis Canal, Friant Dam and Millerton Lake San Joaquin River within Fresno County	



Region	County	Reasons for Inclusion of County in Project Area
Central Valley (continued)	Fresno (continued)	CVP Water Users: Broadview Water District California Department of Fish and Wildlife Central California Irrigation District City of Avenal City of Coalinga City of Huron Coelho Family Trust Columbia Canal Company County of Fresno Eagle Field Water District Firebaugh Canal Company Fresno Slough Water District Hills Valley Irrigation District James Irrigation District Laguna Irrigation District Mercy Springs Water District Meyers Farm Pacheco Water District Panoche Water District Pleasant Valley Water District Reclamation District No. 1606 San Luis Water District Tranquility Irrigation District Tranquility Public Utility District Tri-Valley Water District Westlands Water District Widren Water District
		SWP Water Users: Dudley Ridge Water District
	Kings	SWP Facilities: Portion of the California Aqueduct
		CVP Water Users: Angiola Water District Atwell Island City of Avenal
		SWP Water Users: County of Kings Empire West Side Irrigation District Tulare Lake Basin Water Storage District
	Tulare	CVP Water Users: County of Tulare Tranquility Public Utility District Pixley National Wildlife Refuge
	Kern	CVP Facilities: Cross Valley Canal and portion of the California Aqueduct
		SWP Facilities: Portion of the California Aqueduct

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<b>Region</b>	<b>County</b>	<b>Reasons for Inclusion of County in Project Area</b>
Central Valley (continued)	Kern (continued)	CVP Water Users: Kern National Wildlife Refuge Kern Tulare Water District Pixley Irrigation District
		SWP Water Users: Kern County Water Agency
San Francisco Bay Area	Alameda	CVP Facilities: Jones Pumping Plant and northern reaches of Delta-Mendota Canal
		SWP Facilities: Banks Pumping Plant, Bethany Reservoir, Lake Del Valle, and portions of the South Bay Aqueduct and California Aqueduct
		CVP Water Users: East Bay Municipal Utility District
		SWP Water Users: Alameda County Water District Zone 7 Water Agency
	Contra Costa	CVP Facilities: Contra Costa Pumping Plant, Contra Loma Reservoir, and Contra Costa Canal Delta within Contra Costa County
		SWP Facilities: Clifton Court Forebay
		CVP Water Users: Byron-Bethany Irrigation District Contra Costa Water District
	Santa Clara	CVP Facilities: Santa Clara Conduit
		SWP Facilities: Portion of the South Bay Aqueduct
		CVP and SWP Water Users: Santa Clara Valley Water District
	San Benito	CVP Water Facilities: Pacheco Conduit, San Justo Reservoir, and Hollister Conduit
		CVP Water Users: San Benito County Water District
	Napa	SWP Facilities: Portion of the North Bay Aqueduct
		SWP Water Users: County of Napa
Central Coast	San Luis Obispo	SWP Facilities: Portion of Coastal Branch Aqueduct
		SWP Water Users: Central Coast Water Authority San Luis Obispo County Flood Control and Water Conservation District

Region	County	Reasons for Inclusion of County in Project Area
Central Coast (continued)	Santa Barbara	SWP Facilities: Portion of Coastal Branch Aqueduct
		SWP Water Users: Central Coast Water Authority Santa Barbara County Flood Control and Water Conservation District
Southern California	Ventura	SWP Water Users: Ventura County Watershed Protection District
	Los Angeles	SWP Facilities: Portion of California Aqueduct
		SWP Water Users: Antelope Valley-East Kern Water Agency Castaic Lake Water Agency Littlerock Creek Irrigation District Metropolitan Water District of Southern California Palmdale Water District San Gabriel Valley Municipal Water District
	Orange	SWP Water Users: Metropolitan Water District of Southern California
	San Diego	SWP Water Users: Metropolitan Water District of Southern California
	Riverside	SWP Facilities: Portion of California Aqueduct
		SWP Water Users: Desert Water Agency Coachella Valley Water District Metropolitan Water District of Southern California San Gorgonio Pass Water Agency
	San Bernardino	SWP Facilities: Portion of California Aqueduct
		SWP Water Users: Crestline Lake Arrowhead Water Agency Metropolitan Water District of Southern California Mojave Water Agency San Bernardino Valley Municipal Water District

1 **4.3.2 Regulatory Environment and Compliance Requirements**  
2 Potential actions that could be implemented under the alternatives evaluated in  
3 this EIS that are located on Federal or state lands, or actions that are implemented,  
4 funded, or approved by Federal and state agencies, need to be compliant with  
5 appropriate Federal and state agency policies and regulations. Federal and state  
6 policies and regulations that could be relevant to implementation of the  
7 alternatives evaluated in this EIS are summarized in Appendix 4A.

1 **4.3.3 Affected Environment**

2 The Affected Environment portions of Chapters 5 through 21 provide an adequate  
3 level of detail for the quantitative and qualitative impact analyses presented in this  
4 EIS. Changes in CVP and SWP operations could result in changes to:

- 5 • Water elevations in reservoirs that store CVP and SWP water supplies,  
6 including reservoirs owned by regional and local water agencies that use CVP  
7 and/or SWP water, and associated use of the reservoir or surrounding areas to  
8 support biological resources, visual resources, recreation, and cultural  
9 resources
- 10 • Flow rates and water quality in rivers downstream of CVP and SWP  
11 reservoirs, and associated use of the rivers to support biological resources,  
12 protection of soils from erosion along the rivers, and recreation
- 13 • Flows and water quality in the Delta, including Delta outflow and reverse  
14 flows, and associated use of the rivers to support beneficial uses including  
15 biological resources and food and water supplies for human consumption
- 16 • CVP and SWP deliveries, and associated changes in groundwater use, CVP  
17 and SWP energy use and generation, and land use which could affect air  
18 quality, human health, soil erosion, and cultural resources.

19 References are provided for each chapter and not compiled for the entire EIS.

20 **4.3.4 Impact Analysis**

21 In accordance with the Council on Environmental Quality regulations, an EIS  
22 must evaluate the effects of implementation of the alternatives on the  
23 environment, any adverse environmental effects which cannot be avoided, the  
24 relationship between short-term uses of the human environment and long-term  
25 productivity, and any irreversible or irretrievable commitments of resources if the  
26 alternatives are implemented. The impact analyses sections address direct,  
27 indirect, and cumulative effects of the alternatives in each resource chapter  
28 (Chapters 5 through 21), and are organized in the following manner to describe  
29 the approach and present the results of the impact assessment.

- 30 • Potential Mechanisms for Change and Analytical Tools
- 31 • Conditions in Year 2030 without Implementation of Alternatives 1 through 5
- 32 • Evaluation of Alternatives
  - 33 – Comparison of the No Action Alternative to the Second Basis of
  - 34 Comparison
  - 35 – Comparison of Alternatives 1 through 5 to the No Action Alternative
  - 36 – Comparison of Alternatives 1 through 5 to the Second Basis of
  - 37 Comparison
  - 38 – Summary of Impact Analysis
  - 39 – Potential Mitigation Measures
  - 40 – Cumulative Effects Analysis

1 The impact analysis includes quantitative and qualitative analyses depending  
2 upon the availability of acceptable numerical analytical tools and available  
3 information. The quantitative analyses include numerous analytical tools, as  
4 summarized in Figure 4.2.

5 An EIS must identify relevant, reasonable mitigation measures that are not  
6 already included in the proposed action or alternatives to the proposed action that  
7 could avoid, minimize, rectify, reduce, eliminate, or compensate for the project's  
8 adverse environmental effects (40 Code of Federal Regulations [CFR] 1502.14,  
9 1502.16, 1508.8). Mitigation measures are presented for each resource to avoid,  
10 minimize, rectify, reduce, eliminate, or compensate for adverse environmental  
11 effects of Alternatives 1 through 5 as compared to the No Action Alternative.  
12 Mitigation measures were not included to address adverse impacts under the  
13 alternatives as compared to the Second Basis of Comparison because this analysis  
14 was included in this EIS for information purposes only.

15 The cumulative effects of implementation of reasonably foreseeable projects and  
16 the alternatives as compared to conditions under the No Action Alternative and  
17 Second Basis of Comparison are discussed for each resource in Chapters 5  
18 through 21. Cumulative effects are impacts on the environment that result from  
19 the incremental impacts of an alternative when added to other past, present, and  
20 reasonably foreseeable future actions of Federal, state, or local agencies or  
21 individual entities or persons (40 CFR 1508.7). Such impacts can result from  
22 individually minor, but collectively significant, actions taking place over time  
23 (40 CFR 1508.8).

#### 24 **4.3.5 Other NEPA Considerations**

25 The irreversible and irretrievable commitments of resources, and the relationship  
26 between short-term uses of the environment and long-term productivity are  
27 discussed in Chapter 22, Other NEPA Considerations.

#### 28 **4.3.6 Consultation and Coordination**

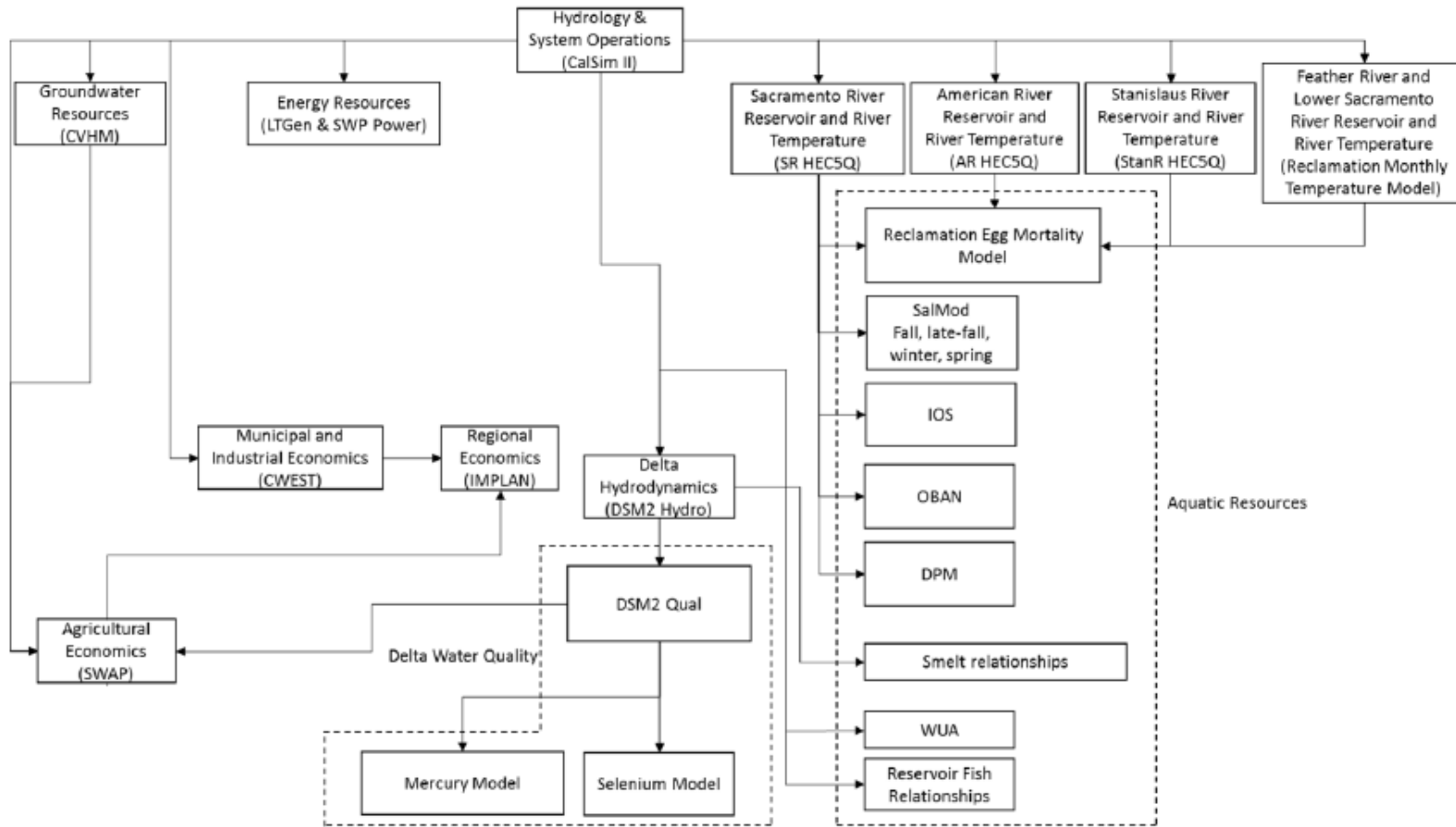
29 Public outreach and agency involvement efforts related to preparation of the Draft  
30 EIS and Final EIS are presented in Chapter 23, Consultation and Coordination. A  
31 listing of the agencies, other entities, and interest groups that received a copy of  
32 the Draft EIS and Final EIS is presented in Chapter 24, Distribution of Draft EIS.  
33 A list of preparers of the EIS is presented in Chapter 25.



1

2 **Figure 4.1 Study Area**

Chapter 4: Approach to Environmental Analysis



1  
2 **Figure 4.2 Analytical Framework Used to Evaluate Impacts of the Alternatives**

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Chapter 5

1 **Surface Water Resources and Water**  
2 **Supplies**

3 **5.1 Introduction**

4 This chapter describes the surface water resources and water supplies in the study  
5 area and potential changes that could occur as a result of implementing the  
6 alternatives evaluated in this Environmental Impact Statement (EIS).  
7 Implementation of the alternatives could affect these resources through potential  
8 changes in operation of the Central Valley Project (CVP) and State Water Project  
9 (SWP) and ecosystem restoration components of the long-term operation of the  
10 CVP and SWP.

11 **5.2 Regulatory Environment and Compliance**  
12 **Requirements**

13 Potential actions that could be implemented under the alternatives evaluated in  
14 this EIS could affect surface water resources, including rivers and reservoirs  
15 directly or indirectly impacted by changes in the operations of the CVP or SWP  
16 water facilities and users of CVP and SWP water supplies. Actions located on  
17 public agency lands or implemented, funded, or approved by Federal and state  
18 agencies would need to be compliant with appropriate Federal and state agency  
19 policies and regulations, as summarized in Chapter 4, Approach to  
20 Environmental Analysis.

21 **5.3 Affected Environment**

22 This section describes the surface water resources and water supplies that could  
23 be potentially affected by the implementation of the alternatives considered in this  
24 EIS, including:

- 25 • **Surface Water Hydrology:** Changes in surface water hydrology may occur  
26 in the rivers within the Trinity River and Central Valley regions due to  
27 changes in CVP and SWP operations as some rivers in these regions are used  
28 to convey CVP and/or SWP water supplies. Changes in reservoir elevations  
29 may occur within the Trinity River, Central Valley, San Francisco Bay Area,  
30 Central Coast, and Southern California regions due to changes in CVP and  
31 SWP operations. The ongoing CVP and SWP facilities and operations are  
32 described in Appendix 3A, No Action Alternative: Central Valley Project and  
33 State Water Project Operations.

- 1 • **Summaries of the Water Supplies used by CVP and SWP Water Users:**  
2 The water users which may be affected by changes in CVP and SWP  
3 operations are located in the Trinity River, Central Valley, San Francisco Bay  
4 Area, Central Coast, and Southern California regions.

### 5 **5.3.1 Overview of California Water Supply and Water** 6 **Management Facilities**

#### 7 **5.3.1.1 Sources of Water in California**

8 Variability and uncertainty are the dominant characteristics of California’s water  
9 resources. Precipitation is the source of 97 percent of California’s water supply  
10 (DWR 2009a). It varies greatly from year to year, as well as by season and  
11 location within the state. The unpredictability and geographic variation in  
12 precipitation that California receives make it challenging to manage the available  
13 runoff to meet urban, agricultural, and environmental water needs. With climate  
14 change, precipitation patterns are expected to become even more unpredictable, as  
15 described in Appendix 5A, CalSim II and DSM2 Modeling.

16 In an average water year, precipitation provides California with approximately  
17 200 million acre-feet (MAF) of water falling as either rain or snow (DWR 2009a),  
18 including up to 10 MAF from surface water flows entering California due to  
19 precipitation falling in the Klamath River and Lost River watersheds in Oregon;  
20 and the Colorado River watershed in Wyoming, Colorado, Utah, Nevada, New  
21 Mexico, and Arizona, and northwestern Mexico. The total volume of water the  
22 state receives can vary dramatically between dry and wet years. California may  
23 receive less than 100 MAF of water during a dry year and more than 300 MAF in  
24 a wet year (Western Regional Climate Center 2011).

25 The majority of California’s precipitation occurs between November and April,  
26 while most of the state’s demand for water is in the summer months (Western  
27 Regional Climate Center 2011). In addition, most of the precipitation falls in the  
28 northern portion of the state and much of the state water demand comes from the  
29 central and southern portions of the state where the major agricultural and  
30 population centers are located on the Central Valley floor and in Southern  
31 California. In some years, the northern regions of the state can receive 100 inches  
32 or more of precipitation, while the southern regions receive only a few inches.

33 Over time, annual precipitation trends have been changing and continue to  
34 change, as shown on Figure 5.1. From 1906 to 1960, 33 percent of the water  
35 years in California were classified by the California Department of Water  
36 Resources (DWR) as “dry” or “critically dry” and that percentage increased to  
37 36 percent from 1961 to 2013 (DWR 2014a). From 1906 to 1960, 45 percent of  
38 the water years in California were classified by DWR as “above normal” or “wet”  
39 and that percentage increased to 49 percent from 1961 to 2013. Additionally, the  
40 1906 to 1960 period had 42 percent of water years classified as extreme  
41 (“critically dry” or “wet”) and that percentage increased to 51 percent after 1960.

1 Although there were more extreme water year classifications in the later period,  
2 the overall precipitation averages in pre-1960 years and post-1960 years have  
3 little differences.

4 Despite having similar precipitation averages, the year to year variation and  
5 patterns of extreme condition occurrences are significantly different between the  
6 time periods. The year to year statewide precipitation variation is larger and more  
7 frequent from 1961 to 2013 than 1906 to 1960. Also, the occurrence of a year to  
8 year change of more than 10 inches of precipitation is 3 times higher in the post-  
9 1960 time period as compared to the pre-1960 time period. There are also more  
10 occurrences of sequential “critically dry” years and sequential “wet” years after  
11 1960.

12 Approximately 50 percent of the precipitation that California receives evaporates,  
13 is used consumptively by native vegetation and crops (not including irrigation  
14 water supplies), is used by managed wetlands, flows into streams within Oregon  
15 or Nevada, flows into saline water bodies (such as Salton Sea), or percolates into  
16 saline groundwater aquifers (DWR 2013a). Therefore, less than 50 percent of the  
17 water that enters California, or less than 100 MAF per year, is available for use by  
18 urban, agricultural, and other environmental uses, collectively.

### 19 **5.3.1.2 Development of Major California Water Management Facilities**

20 Due to the hydrologic variability that ranges from dry summers and fall months to  
21 floods in winter and spring, water from precipitation in the winter and spring must  
22 be stored for use in the summer and fall. During an average hydrological year,  
23 approximately 15 MAF of water is stored in the Sierra Nevada snowpack (DWR  
24 2013a). However, not all of the snowpack becomes available in a timely manner  
25 for uses throughout the state. Therefore, Federal, state, and local agencies and  
26 private entities have constructed reservoirs, aqueducts, pipelines, and water  
27 diversion facilities to capture and use the rainfall and the subsequent snowmelt.

#### 28 **5.3.1.2.1 Water Facilities Development through the Early 1900s**

29 Spanish settlements were initially established in the late 1700s in southern  
30 California, including conveyance systems to bring water to the pueblos. The first  
31 water storage and diversion project in California was constructed in 1772,  
32 including a 12-foot high dam on the San Diego River and 6 miles of canals to  
33 deliver water to the San Diego Mission (Reclamation 1997). Over the next  
34 80 years, other irrigation systems were constructed to provide water for  
35 communities and irrigated lands. The major levee was constructed in the Delta in  
36 1840 along Grand Island to protect agricultural lands from floods.

37 After California became a state in 1850, the state legislature adopted English  
38 Common Law, which included the doctrine of riparian rights to provide water  
39 supplies to lands adjacent to rivers and streams (Reclamation 1997). The  
40 California legislature at this time also recognized “pueblo water rights” that were  
41 granted under both Spanish and Mexican governments, including water rights on  
42 the Los Angeles and San Diego rivers. Water rights also were influenced by the  
43 practice of miners of “posting notice” at their points of diversion to substantiate

1 water rights as an “appropriative right” for areas not adjacent to the rivers and  
2 streams. This set of appropriative rights was catalogued with respect to “first in  
3 time, first in right.” Appropriative water rights were given statutory recognition  
4 in 1872.

5 Between the 1850s and early 1900s, numerous dams and canals were constructed  
6 by miners, agricultural water users, and communities (Reclamation 1997). In the  
7 1870s, the first wells were constructed with wood-burning engines. By the late  
8 1890s, natural gas engines and electricity became available to power pumps.  
9 Between 1906 and 1910, over 4,000 natural gas or electric groundwater pumps  
10 were installed in the San Joaquin Valley. Substantial use of groundwater caused  
11 extensive groundwater aquifer depletions and land subsidence in some areas of  
12 the Central Valley. The availability of electricity to communities also resulted in  
13 more hydroelectric generation facilities and associated dams being constructed  
14 throughout the Sierra Nevada.

#### 15 **5.3.1.2.2 Conceptual Development of the Central Valley Project and State** 16 **Water Project**

17 The need for coordinated water development was evaluated in the 1870s when  
18 Congress authorized the Alexander Commission to evaluate water supply  
19 concepts in the Sacramento and San Joaquin rivers watersheds, including  
20 reservoirs and large-scale irrigation water supply projects (Reclamation 1997).

##### 21 *1919 Marshall Plan*

22 In 1919, Colonel Robert Marshall, chief geographer for the U.S. Geological  
23 Survey, proposed a major water storage and conveyance plan to irrigate lands in  
24 the Central Valley and San Francisco Bay Area and provide water to communities  
25 in the San Francisco Bay Area and southern California (Marshall 1919). The  
26 Marshall Plan recommended two major dams on the San Joaquin River near  
27 Friant and Stanislaus River between the present locations of Tulloch and  
28 Goodwin dams to serve the eastern San Joaquin Valley and reduce groundwater  
29 overdraft in Tulare and Kern counties; four dams on Kern River to serve the Los  
30 Angeles area; and dams on the Sacramento River near Red Bluff, Klamath River  
31 downstream of Klamath Falls, and dams along the Sacramento River tributaries to  
32 provide stored water into two canals along the western and eastern sides of the  
33 Central Valley to provide exchange water to San Joaquin River water rights  
34 holders affected by the San Joaquin River dam, water to other San Joaquin Valley  
35 users, and water to communities in Contra Costa, Alameda, Santa Clara, and San  
36 Francisco counties.

##### 37 *1930s State Water Plan*

38 During the 1920s, the California state legislature commissioned a series of  
39 investigations to further evaluate the Marshall Plan (DPW 1930; Reclamation  
40 1997). The 1930 Division of Water Resources Bulletin No. 25 outlined a  
41 statewide water plan, including the concept that became the CVP and SWP. The  
42 plan included 37 water supply and flood management reservoirs, including a dam  
43 on the San Joaquin River near Friant and canals to distribute the water along the  
44 eastern San Joaquin Valley to reduce groundwater overdraft in Tulare and Kern

1 counties; 14 dams along the Trinity River, Sacramento River, and Sacramento  
 2 River tributaries to provide water to the San Joaquin River water rights  
 3 contractors affected by the dam on the San Joaquin River and water users on the  
 4 west side of the San Joaquin Valley and in Contra Costa County; and eight dams  
 5 on San Joaquin Valley rivers to provide water to the San Joaquin Valley. These  
 6 dams included recommended facilities near the present CVP Trinity, Shasta,  
 7 Folsom, New Melones, and Friant dams and the present SWP Oroville Dam. The  
 8 recommendations also included a Delta Cross Channel canal to improve south  
 9 Delta water quality; a canal from a south Delta pumping plant to a regulating  
 10 reservoir and pumping plant near Mendota; canals from Mendota to the San  
 11 Joaquin Valley; a canal from the Delta into Contra Costa County; and expansion  
 12 of the San Joaquin River and associated channels with five operable barriers along  
 13 the San Joaquin River.

14 The study also addressed use of aquifer storage, improved navigation along the  
 15 Sacramento and San Joaquin rivers, flood management, salt water barrier along  
 16 the western Delta, recycled wastewater and stormwater in Southern California,  
 17 and importation of Colorado River water to Southern California.

18 In 1933, the state authorized the Central Valley Project Act. However, during the  
 19 1930s depression, the state could not raise the funds. The state appealed to the  
 20 Federal Government for assistance. The overall SWP was approved by the State  
 21 Legislature in 1941.

22 As described above, six of the 37 dams in the SWP were included in the CVP and  
 23 SWP facilities (Reclamation 1997). However, most of the recommended dams  
 24 were constructed by the U.S. Army Corps of Engineers (USACE), local or  
 25 regional water supply and/or flood management agencies, and hydropower  
 26 entities on the Yuba, Bear, Feather, American, Mokelumne, Calaveras,  
 27 Chowchilla, Fresno, Merced, Tuolumne, Stanislaus, Kings, Kaweah, Tule, and  
 28 Kern rivers. Dams on the Fresno and Chowchilla rivers were initially developed  
 29 by the USACE; however, the Hidden and Buchanan dams, respectively, were  
 30 integrated into the CVP to supply water to portions of the eastern side of the San  
 31 Joaquin Valley (DPW 1930; Reclamation 1997).

32 **5.3.1.2.3 Overview of the Central Valley Project**

33 With the passage of the Rivers and Harbors Act of 1935, Congress appropriated  
 34 funds and authorized construction of the CVP by the USACE (Reclamation 1997;  
 35 Reclamation 2011a). When the Rivers and Harbors Act was reauthorized in 1937,  
 36 the construction and operation of the CVP was assigned to Reclamation, and the  
 37 CVP became subject to Reclamation Law (as defined in the Reclamation Act of  
 38 1902 and subsequent legislation).

39 The CVP facilities were initiated in the late 1930s (Reclamation 1997, 2011a).  
 40 The CVP facilities, as shown on Figure 5.2, include:

- 41 • Trinity and Lewiston dams on the Trinity River.
- 42 • Shasta and Keswick dams on the Sacramento River.

- 1 • Red Bluff Pumping Plant on the Sacramento River to deliver water into the  
2 Tehama-Colusa Canal and the Corning Canal.
- 3 • Folsom and Nimbus dams on the American River and the Folsom-South  
4 Canal.
- 5 • Delta Cross Channel in the Delta.
- 6 • Rock Slough Intake to deliver water into the Contra Costa Canal, Contra  
7 Costa Pumping Plant, and Contra Loma Reservoir.
- 8 • Friant Dam along the San Joaquin River to deliver water into the Friant-Kern  
9 and Madera.
- 10 • C.W. Jones Pumping Plant (Jones Pumping Plant) (previously known as the  
11 Tracy Pumping Plant) in the south Delta to deliver water into the Delta-  
12 Mendota Canal and Mendota Pool.
- 13 • Delta-Mendota Canal/California Aqueduct Intertie downstream of the CVP  
14 Jones Pumping Plant and the SWP Banks Pumping Plant.
- 15 • San Luis Reservoir-related facilities, including the CVP facilities consisting of  
16 the O'Neill Forebay, Pumping Plant, and Canal; Coalinga Canal, Pleasant  
17 Valley Pumping Plant, and San Luis Drain. The O'Neill Forebay is operated  
18 in coordination with the SWP. The SWP facilities operated in coordination  
19 with the CVP include the B.F. Sisk San Luis Dam (the major dam that forms  
20 San Luis Reservoir), San Luis Canal, Los Banos and Little Panoche dams, and  
21 associated pumping plants.
- 22 • Pacheco Tunnel and Conduit to deliver water from the San Luis Reservoir into  
23 the San Justo Dam and Reservoir, Hollister Conduit, and Santa Clara Tunnel  
24 and Conduit.
- 25 • New Melones Dam along the Stanislaus River.

26 The CVP reservoirs are listed in Table 5.1 and shown on Figures 5.3 through 5.5.  
27 Table 5.1 also includes reservoirs of the Bureau of Reclamation Orland Project  
28 (which are not part of CVP) because these reservoirs also affect hydrology of  
29 Stony Creek, a tributary to the Sacramento River.

1 **Table 5.1 Major Central Valley Project and Orland Project Reservoirs**

Project	Reservoir	Dam	Stream	Year Initiated	Capacity (acre-feet)
CVP	Millerton Lake	Friant	San Joaquin River	1942	524,000
CVP	Shasta Lake	Shasta	Sacramento River	1945	4,552,000
CVP	Keswick Reservoir	Keswick	Sacramento River	1950	23,772
CVP	Trinity Lake	Trinity	Trinity River	1962	2,447,650
CVP	Lewiston Reservoir	Lewiston	Trinity River	1963	14,660
CVP	Spring Creek Reservoir	Spring Creek Debris Dam	Spring Creek (tributary of Sacramento River)	1963	5,874
CVP	Whiskeytown Lake	Whiskeytown	Clear Creek (tributary of Sacramento River)	1963	241,100
CVP	Folsom Lake	Folsom	American River	1956	967,000
CVP	Lake Natoma	Nimbus	American River	1955	9,000
CVP	Contra Loma Reservoir	Contra Loma	Off-Stream	1967	2,627
CVP	Martinez Reservoir	Martinez	Wildcat Creek	1938	268
CVP	San Luis Reservoir	B.F. Sisk	San Luis Creek	1967	2,041,000
CVP	O'Neill Forebay	O'Neill	San Luis Creek	1967	56,400
CVP	Los Banos Creek Reservoir	Los Banos Detention	Los Banos Creek	1965	34,600
CVP	Little Panoche Creek Reservoir	Little Panoche Detention	Little Panoche Creek	1966	5,580
CVP	San Justo Reservoir	San Justo	Offstream	1985	10,300
CVP	Funks Reservoir	Funks	Funks Creek	1976	2,460
CVP	New Melones Reservoir	New Melones	Stanislaus River	1979	2,400,000
CVP	Hensley Lake	Hidden	Fresno River	1975	90,000
CVP	H.V. Eastman Lake	Buchanan	Chowchilla River	1975	150,000
Orland	East Park Reservoir	East Park	Little Stony Creek (tributary of Sacramento River)	1910	51,000
Orland	Stony Gorge Reservoir	Stony Gorge	Stony Creek (tributary of Sacramento River)	1928	50,350

2 Sources: DWR 2014b; Reclamation 1994, 2014a, 2014b.

3 Note: CVP is Central Valley Project; Orland is Orland Project

1 Detailed information describing the CVP facilities and operations is presented in  
2 Appendix 3A, No Action Alternative: Central Valley Project and State Water  
3 Project Operations.

#### 4 **5.3.1.2.4 Overview of the State Water Project**

5 As the CVP facilities were being constructed after World War II, the state began  
6 investigations to meet additional water needs through development of the  
7 California Water Plan. In 1957, DWR published Bulletin Number 3 that  
8 identified new facilities to provide flood control in northern California and water  
9 supplies to the San Francisco Bay Area, San Joaquin Valley, San Luis Obispo and  
10 Santa Barbara counties in the Central Coast Region, and southern California  
11 (DWR 1957, 2012; Reclamation 2011a). The study identified a seasonal  
12 deficiency of 2.675 MAF/year in 1950 that resulted in groundwater overdraft  
13 throughout many portions of California. The report described facilities to meet  
14 the water demands and reduce groundwater overdraft, including facilities that  
15 would become part of the SWP.

16 In 1960, California voters authorized the Burns-Porter Act to construct the initial  
17 SWP facilities. The SWP facilities, as shown on Figure 5.2, include:

- 18 • Antelope Lake, Lake Davis, and Frenchman Lake on the upper Feather River  
19 upstream of Oroville Dam.
- 20 • Oroville Dam and Thermalito Diversion Dam on the Feather River.
- 21 • Barker Slough Pumping Plant in the north Delta which delivers water to the  
22 North Bay Aqueduct.
- 23 • Clifton Court Forebay and Harvey O. Banks Pumping Plant (Banks Pumping  
24 Plant) in the south Delta, which delivers water into the Bethany Forebay and  
25 California Aqueduct.
- 26 • South Bay Pumping Plant to deliver water from Bethany Forebay to the South  
27 Bay Aqueduct and Lake Del Valle.
- 28 • San Luis Reservoir-related facilities, including the SWP facilities B.F. Sisk  
29 San Luis Dam (the major dam that forms San Luis Reservoir), San Luis  
30 Canal, Los Banos and Little Panoche dams, and associated pumping plants,  
31 and the CVP O'Neill Forebay. These facilities are operated in coordination  
32 between the SWP and CVP.
- 33 • California Aqueduct to deliver water to the San Joaquin Valley, Central Coast,  
34 and southern California. The California Aqueduct extends from the Banks  
35 Pumping Plant to San Luis Reservoir and continues to Lake Perris in  
36 Riverside County. The California Aqueduct reach in southern California also  
37 includes Quail Lake, Pyramid Lake, Castaic Lake, Silverwood Lake, Crafton  
38 Hills Reservoir, and Lake Perris.
- 39 • The Coastal Branch of the California Aqueduct to deliver water from the  
40 California Aqueduct to San Luis Obispo and Santa Barbara counties.



1 Major SWP reservoirs are listed in Table 5.2 and shown on Figures 5.3  
 2 through 5.6.

3 **Table 5.2 State Water Project Reservoirs**

Reservoir	Dam	Stream	Year Initiated	Capacity (acre-feet)
Frenchman Lake	Frenchman	Little Last Chance Creek (tributary of Feather River)	1961	55,477
Antelope Lake	Antelope	Indian Creek (tributary of Feather River)	1964	22,566
Lake Davis	Grizzly Valley	Big Grizzly Creek (tributary of Feather River)	1966	83,000
Oroville Reservoir	Oroville	Feather River	1968	3,537,577
Thermalito Pool	Thermalito Diversion	Feather River	1967	13,328
Thermalito Forebay	Thermalito Forebay	Cottonwood Creek (tributary of Feather River)	1967	11,768
Thermalito Afterbay	Thermalito Afterbay	Feather River	1967	57,041
Clifton Court Forebay	Clifton Court Forebay	Old River	1970	29,000
Bethany Forebay	Bethany Forebay	Italian Slough	1961	5,250
Patterson Reservoir	Patterson	Offstream	1962	98
Lake Del Valle	Del Valle	Arroyo Valle	1968	77,100
Quail Lake	No dam	Offstream	Historic	5,654
Pyramid Lake	Pyramid	Piru Creek	1973	180,000
Castaic Lake	Castaic	Castaic Creek	1973	323,700
Silverwood Lake	Cedar Springs	Mojave River (West Fork)	1971	78,000
Crafton Hills Reservoir	Crafton Hills	Yucaipa Creek	2001	130
Lake Perris	Perris	Bernasconi Pass	1973	131,452

4 Sources: DWR 2014b, 2014c.

5 Detailed information describing the SWP is presented in Appendix 3A, No Action  
 6 Alternative: Central Valley Project and State Water Project Operations.

### 7 **5.3.1.2.5 Other Major Water Supply and Flood Management Reservoirs**

8 During the past 100 years, numerous water supply, flood management, and  
 9 hydroelectric generation reservoirs were constructed throughout California.  
 10 Many of these projects were constructed on tributaries to the Sacramento and San  
 11 Joaquin rivers and tributaries to the Tulare Lake Basin. Operations of these  
 12 non-CVP and non-SWP reservoirs affect flow patterns into the Sacramento and  
 13 San Joaquin rivers and the Delta. However, implementation of the alternatives

1 evaluated in this EIS would not result in changes in operations in most of these  
 2 reservoirs, except on the lower Stanislaus River.

3 Major non-CVP and non-SWP reservoirs in the Sacramento Valley and San  
 4 Joaquin Valley watersheds, generally with storage capacities greater than  
 5 100,000 acre-feet, which could affect operations of CVP or SWP reservoirs or  
 6 Delta facilities or could be affected by implementation of the alternatives  
 7 evaluated in this EIS, are listed in Tables 5.3 and 5.4.

8 **Table 5.3 Major Non-Central Valley Project and Non-State Water Project Reservoirs**  
 9 **in the Sacramento Valley Watershed Considered in this EIS**

Owner	Reservoir	Dam	Stream	Year Initiated	Capacity (acre-feet)
U.S. Army Corps of Engineers	Black Butte Reservoir	Black Butte	Stony Creek (tributary of Sacramento River)	1963	143,700
Yuba County Water Agency	Bullards Bar Reservoir	New Bullards Bar	Yuba River (North Fork)	1970	969,600
U.S. Army Corps of Engineers	Englebright Reservoir	Englebright	Yuba River	1941	70,000
South Sutter Water District	Camp Far West Reservoir	Camp Far West	Bear River	1963	104,500
Pacific Gas & Electric Company	Bucks Lake	Bucks Storage	Bucks Creek (tributary of Feather River)	1928	103,000
Pacific Gas & Electric Company	Lake Almanor	Lake Almanor	Feather River (North Fork)	1927	1,308,000
South Feather Water And Power Agency	Little Grass Valley Reservoir	Little Grass Valley	Feather River (South Fork)	1961	93,010
Pacific Gas & Electric Company	Salt Springs Reservoir	Salt Springs	Mokelumne River (North Fork)	1931	141,900
East Bay Municipal Utility District	Pardee Lake	Pardee	Mokelumne River	1929	209,950
East Bay Municipal Utility District	Camanche Lake	Camanche	Mokelumne River	1963	417,120
Sacramento Municipal Utility District	Union Valley Reservoir	Union Valley	Silver Creek (tributary of American River)	1963	230,000
Placer County Water Agency	French Meadows Reservoir	L. L. Anderson	American River (Middle Fork)	1965	136,400
Placer County Water Agency	Hell Hole Reservoir	Lower Hell Hole	Rubicon River (tributary of American River)	1966	208,400

10 Sources: DWR 2014b, 2014c.

1 **Table 5.4 Major Non-Central Valley Project and Non-State Water Project Reservoirs**  
 2 **in the San Joaquin Valley Watersheds Considered in this EIS**

Owner	Reservoir	Dam	Stream	Year Initiated	Capacity (acre-feet)
Southern California Edison Company	Lake Thomas A. Edison	Vermilion Valley	Mono Creek (tributary of San Joaquin River)	1954	125,000
Southern California Edison Company	Shaver Lake	Shaver Lake	Stevenson Creek (tributary of San Joaquin River)	1927	135,283
Merced Irrigation Dist	Lake McClure	New Exchequer	Merced River	1967	1,032,000
San Francisco Public Utilities Commission	Cherry Lake	Cherry Valley	Cherry Creek (tributary of Tuolumne River)	1956	273,500
San Francisco Public Utilities Commission	Hetch Hetchy Reservoir	O' Shaughnessy	Tuolumne River	1923	360,000
Turlock Irrigation District	New Don Pedro Reservoir	New Don Pedro	Tuolumne River	1971	2,030,000
Calaveras County Water District	New Spicer Meadow Reservoir	New Spicer Meadow	Highland Creek (tributary of Stanislaus River)	1989	190,000
Tri-Dam Project	Donnells Reservoir	Donnells	Stanislaus River (Middle Fork)	1958	56,893
Tri-Dam Project	Beardsley Reservoir	Beardsley	Stanislaus River (Middle Fork)	1957	77,600
Tri-Dam Project	Tulloch Reservoir	Tulloch	Stanislaus River	1958	68,400
Oakdale Irrigation District and South San Joaquin Irrigation District	Goodwin Diversion	Goodwin	Stanislaus River	1912	500
South San Joaquin Irrigation District	Woodward Reservoir	Woodward	Simmons Creek (tributary of Stanislaus River)	1918	35,000
U.S. Army Corps of Engineers	New Hogan Lake	New Hogan	Calaveras River	1963	317,000

3 Sources: DWR 2014b, 2014c.

1 Major reservoirs used to store CVP and SWP water supplies in the San Francisco  
 2 Bay Area, Central Coast, and Southern California regions are shown on  
 3 Figures 5.5 and 5.6 and listed in Tables 5.5, 5.6, and 5.7.

4 **Table 5.5 Major Non-Central Valley Project and Non-State Water Project Reservoirs**  
 5 **in the San Francisco Bay Area Region Used to Store Central Valley Project and/or**  
 6 **State Water Project Water**

Owner	Reservoir	Dam	Stream	Year Initiated	Capacity (acre-feet)
Contra Costa Water District	Los Vaqueros Reservoir	Los Vaqueros	Kellogg Creek	1997	160,000
East Bay Municipal Utility District	Briones Reservoir	Briones	Bear Creek	1964	67,520
East Bay Municipal Utility District	San Pablo Reservoir	San Pablo	Bear Creek	1964	38,600
East Bay Municipal Utility District	Lafayette Reservoir	Lafayette	Marsh Creek	1963	4,250
East Bay Municipal Utility District	Upper San Leandro Reservoir	Upper San Leandro	San Leandro Creek	1977	37,960
East Bay Municipal Utility District	Chabot Reservoir	Chabot	San Leandro Creek	1892	10,281

7 Sources: DWR 2014b, 2014c; East Bay Municipal Utility District (EBMUD) 2011; City and County of  
 8 San Francisco (CCSF) 2009; Santa Clara Valley Water District (SCVWD) 2011.

9 Note:

10 a. Anderson Reservoir capacity is restricted due to California Department of Safety and Dams  
 11 (SCVWD 2011).

12 **Table 5.6 Major Non-Central Valley Project and Non-State Water Project Reservoirs**  
 13 **in the Central Coast Region Used to Store State Water Project Water**

Owner	Reservoir	Dam	Stream	Year Initiated	Capacity (acre-feet)
Bureau of Reclamation	Cachuma Lake	Bradbury	Santa Ynez River	1953	205,000

14 Sources: DWR 2014b; Reclamation 2014c.

1 **Table 5.7 Major Non-Central Valley Project and Non-State Water Project Reservoirs**  
 2 **in the Southern California Region Used to Store State Water Project Water**

Owner	Reservoir	Dam	Stream	Year Initiated	Capacity (acre-feet)
United Water Conservation District	Lake Piru	Santa Felicia	Piru Creek	1955	100,000
Metropolitan Water District Of Southern California	Diamond Valley Lake	Diamond Valley Lake	Domenigoni Valley Creek	2000	800,000
Metropolitan Water District Of Southern California	Lake Skinner	Robert A Skinner	Tucalota Creek	1973	43,800
Rancho California Water District	Vail Lake	Vail	Temecula Creek	1949	51,000
City of Escondido	Dixon Lake	Dixon	Escondido Creek	1970	2,500
San Diego County Water Authority	Olivenhain Reservoir	Olivenhain	Escondido Creek	2003	24,900
City of San Diego	Lake Hodges	Lake Hodges	San Dieguito River	1918	37,700
City of San Diego	San Vicente Reservoir	San Vicente	San Vicente Creek	1943	146,994
City of San Diego	El Capitan Reservoir	El Capitan	San Diego River	1934	112,800
Helix Water District	Lake Jennings	Chet Harritt	Quail Canyon Creek	1962	9,790
Sweetwater Authority	Sweetwater Reservoir	Sweetwater	Sweetwater River	1888	27,700
City of San Diego	Murray Reservoir	Murray	Off-stream	1918	4,818
City of San Diego	Morena Reservoir	Morena	Cottonwood Creek	1912	50,694
City of San Diego	Lower Otay Reservoir	Savage	Otay River	1919	49,849

3 Sources: DWR 2014b, 2014c; City of San Diego 2014a, 2014b, 2014c, 2014d; SDCWA and  
 4 USACE 2008.

### 5 **5.3.2 Hydrologic Conditions and Major Surface Water Facilities**

6 This section of Chapter 5 provides an overview of hydrologic conditions in the  
 7 Trinity River and Central Valley watersheds. As described below, not all of the  
 8 tributaries and sub-watersheds would be affected by changes in the CVP and SWP  
 9 operations considered under the alternatives in this EIS.

10 Changes in surface water hydrology may occur in the rivers within the Trinity  
 11 River and Central Valley regions due to changes in CVP and SWP operations  
 12 because some rivers in these regions are used to convey CVP and/or SWP water

1 supplies. Tributaries to the Sacramento and San Joaquin rivers that are not  
2 affected by CVP and SWP operations are also discussed briefly in this section to  
3 provide an overview of the major streams in the Central Valley watersheds.  
4 Available information related to flow conditions between Water Years 2001 and  
5 2012 (October 2000 through September 2012) are provided for reservoirs and  
6 rivers that are affected by CVP and/or SWP operations.

7 In the San Francisco Bay Area, Central Coast, and Southern California regions,  
8 the surface water streams generally are not used to convey CVP and SWP water  
9 supplies. The streams downstream of reservoirs that store CVP and SWP water  
10 supplies generally receive either reservoir overflows in storm conditions or  
11 minimum instream flows related to water rights and/or aquatic resources  
12 beneficial uses. After the minimum instream flow requirements are fulfilled, the  
13 remaining volumes of water are provided to municipal, agricultural, and/or  
14 environmental water users. Changes in CVP and SWP water operations will not  
15 affect the need to meet minimum instream flows or high flows during storm  
16 conditions.

### 17 **5.3.2.1 Trinity River Region**

18 The Trinity River Region includes the area along the Trinity River from Trinity  
19 Lake to the confluence with the Klamath River; and along the lower Klamath  
20 River from the confluence with the Trinity River to the Pacific Ocean. The  
21 Trinity River Region includes Trinity Lake, Lewiston Reservoir, the Trinity River  
22 between Lewiston Reservoir and the confluence with the Klamath River, and  
23 along the lower Klamath River.

#### 24 **5.3.2.1.1 Trinity River Watershed**

25 The Trinity River watershed extends over approximately 1,897,600 acres and  
26 ranges in elevation from over 9,000 feet above sea level in the headwaters area to  
27 less than 300 feet at the confluence of the Trinity River with the Klamath River  
28 (California North Coast Regional Water Quality Control Board [NCRWQCB]  
29 et al. 2009; U.S. Fish and Wildlife Service [USFWS] et al. 1999). Average  
30 precipitation in the Trinity River watershed range from 30 to 70 inches per year,  
31 with a long-term average of approximately 62 inches per year. Over 90 percent of  
32 the precipitation has historically occurred between October and April.  
33 Precipitation ranges from mostly snow at higher elevations to mostly rain near the  
34 confluence with the Klamath River.

35 The Trinity River includes the mainstem, North Fork Trinity River, South Fork  
36 Trinity River, New River, and numerous smaller streams (NCRWQCB et al.  
37 2009; USFWS et al. 1999). The mainstem of the Trinity River flows 170 miles to  
38 the west from the headwaters to the confluence with the Klamath River. The  
39 CVP Trinity and Lewiston dams are located at approximately River Miles 105  
40 and 112, respectively; and upstream of the confluences of the Trinity River and  
41 the North Fork, South Fork, and New River. Flows on the North Fork, South  
42 Fork, and New River are not affected by CVP facilities. The Trinity River flows  
43 approximately 112 miles from Lewiston Dam to the Klamath River through

1 Trinity and Humboldt counties and the Hoopa Indian Reservation within Trinity  
2 and Humboldt counties.

3 Trinity Lake, a CVP facility on the Trinity River formed by the Trinity Dam, was  
4 constructed by 1962. The 2.4-MAF reservoir is located approximately 50 miles  
5 northwest of Redding (USFWS et al. 1999). Lewiston Reservoir, a CVP facility  
6 on the Trinity River formed by Lewiston Dam, was constructed by 1963 and is  
7 located 7 miles downstream of the Trinity Dam. Lewiston Reservoir is used as a  
8 regulating reservoir for downstream releases to the Trinity River and to  
9 Whiskeytown Lake, located in the adjacent Clear Creek watershed. Water is  
10 diverted from the lower outlets in Trinity Lake to Lewiston Reservoir to provide  
11 cold water to Trinity River. There are no other major dams in the Trinity River  
12 watershed.

13 Prior to completion of Trinity and Lewiston dams, flows in the Trinity River were  
14 highly variable and could range from over 100,000 cubic feet per second (cfs) in  
15 the winter and spring to 25 cfs in the summer and fall (USFWS et al. 1999). Total  
16 annual flow volume at Lewiston (immediately downstream of the current location  
17 of Lewiston Dam) ranged from 0.27 to 2.7 MAF with a long-term average of  
18 1.2 MAF.

19 A large portion of the Trinity River flows upstream of Trinity Lake and Lewiston  
20 Dam is exported to the Sacramento River watershed through CVP facilities. The  
21 reduction in flows in the Trinity River initially caused substantial reductions in  
22 the Trinity River fish populations (Department of the Interior [DOI] 2000). In  
23 response to the reductions in fish populations, Congress enacted legislation and  
24 directed that restoration actions be evaluated for the Trinity River. In December  
25 2000, the U.S. Department of the Interior (DOI) adopted the Trinity River  
26 Mainstem Fishery Restoration Record of Decision (Trinity River ROD) which  
27 restored Trinity River flow and habitat to produce a healthy, functioning alluvial  
28 river system. The Trinity River ROD included physical channel rehabilitation;  
29 sediment management; watershed restoration; and variable annual instream flow  
30 releases from Lewiston Dam based on forecasted hydrology for the Trinity River  
31 Basin as of April 1<sup>st</sup> each year that range from 368,600 acre-feet/year in critically  
32 dry years to 815,000 acre-feet/year in extremely wet years. The Trinity River  
33 ROD was challenged in United States District Court for the Eastern District of  
34 California (District Court); and the changes in operations related to flow were not  
35 allowed to proceed while supplemental environmental documentation was  
36 prepared and reviewed (NCRWQCB et al. 2009). In 2004, the United States  
37 Court of Appeals for the Ninth Circuit entered an opinion that reversed the  
38 District Court order; and all actions in the Trinity River ROD were mandated.  
39 The flow actions were not completely implemented until several infrastructure  
40 projects in the Trinity River channel were completed to protect areas from flood  
41 damage.

42 Additional water releases periodically occur into the Trinity River as part of flood  
43 control operations and to provide other flow releases (NCRWQCB et al. 2009;  
44 Reclamation 2011a). Although flood control is not an authorized purpose of the  
45 Trinity River Division, flood control benefits are provided through normal

1 operations. The Reclamation Safety of Dams release criteria generally provide  
2 for maximum storage in Trinity Lake of 2.1 between November and March.  
3 Initial flood releases are discharged from Trinity Lake into Lewiston Reservoir,  
4 and then, through the powerplant and into Whiskeytown Lake in the Clear Creek  
5 watershed. To reduce the potential for flooding on the Trinity River, releases into  
6 Trinity River generally are less than 11,000 cfs from Lewiston Dam (under Safety  
7 of Dams criteria) due to local high water concerns in the floodplain and local  
8 bridge flow capacities. Reclamation has periodically released water from  
9 Lewiston Dam into the Trinity River to improve late summer flow conditions to  
10 avoid fish die-offs in the lower Klamath River or for tribal requirements along the  
11 Trinity River (DOI 2014; Trinity River Restoration Program [TRPP] 2014).

12 Temperature objectives for the Trinity River are set forth in State Water  
13 Resources Control Board (SWRCB) Water Rights Order 90-5, as summarized in  
14 Appendix 3A, No Action Alternative: Central Valley Project and State Water  
15 Project Operations. These objectives vary by reach and by season. Between  
16 Lewiston Dam and Douglas City Bridge, the daily average temperature should not  
17 exceed 60 degrees Fahrenheit (°F) from July 1 to September 14, and 56°F from  
18 September 15 to September 30. From October 1 to December 31, the daily  
19 average temperature should not exceed 56°F between Lewiston Dam and the  
20 confluence of the North Fork Trinity River.

21 Historical water storage volumes and water storage elevations for Trinity Lake for  
22 Water Years 2001 through 2012 are presented on Figures 5.7 and 5.8 (DWR  
23 2013d, 2013e). Trinity Lake storage varies in accordance with upstream  
24 hydrology and downstream water demands and instream flow requirements.  
25 Reclamation maintains at least 600 TAF in Trinity Reservoir, except during the  
26 10 to 15 percent of the years when Shasta Lake is also drawn down.

27 Historical water storage volumes and water storage elevations in Lewiston  
28 Reservoir for Water Years 2001 through 2012 are presented on Figures 5.9  
29 and 5.10 (DWR 2013g, 2013h). The Lewiston Reservoir water storage volume is  
30 more consistent throughout the year because this reservoir is used to regulate flow  
31 releases to the powerplant and other downstream uses; and not to provide  
32 long-term water storage.

33 Trinity River flows downstream of Lewiston Reservoir at Douglas City are  
34 presented on Figure 5.11 (DWR 2013i). The flow record is limited at the Douglas  
35 City gauge to 2003 through 2012. The mean monthly flows reflect the wet year  
36 pattern in 2006 and the drier year patterns in 2008 and 2009.

### 37 **5.3.2.1.2 Lower Klamath River from Trinity River Confluence to the** 38 **Pacific Ocean**

39 The Klamath River watershed extends over 15,600 square miles from southern  
40 Oregon to northern California, and ranges in elevation from over 9,500 feet above  
41 sea level near the headwaters to sea level at the Pacific Ocean (USFWS et al.  
42 1999). The Klamath River watershed is generally divided into two or three  
43 subbasins. For the purpose of this study, the upper Klamath River basin extends  
44 over 60 miles from the headwaters to Iron Gate Dam (DOI and DFG 2012).



1 The lower Klamath River basin extends 190 miles from Iron Gate Dam to the  
 2 Pacific Ocean. Four major tributaries flow into the lower Klamath River,  
 3 including Shasta, Scott, Salmon, and Trinity rivers. The lower Klamath River  
 4 flows 43.5 miles from the confluence with the Trinity River to the Pacific Ocean  
 5 (USFWS et al. 1999). Downstream of the Trinity River confluence, the Klamath  
 6 River flows through Humboldt and Del Norte counties and through the Hoopa  
 7 Indian Reservation, Yurok Indian Reservation, and Resighini Indian Reservation  
 8 within Humboldt and Del Norte counties (DOI and Department of Fish and Game  
 9 [now known as Department of Fish and Wildlife] DFG 2012).

10 The Trinity River is the largest tributary to the Klamath River (DOI and DFG  
 11 2012). There are no dams located in the Klamath River watershed downstream of  
 12 the confluence with the Trinity River. The western portion of the Klamath River  
 13 watershed receives substantial rainfall during the winter months. Average  
 14 precipitation in the western portion of the watershed ranges from 60 to 125 inches  
 15 per year (DWR 2013a). Due to the heavy precipitation and the upstream water  
 16 supply projects in the Klamath River, approximately 85 percent of the flows in the  
 17 lower Klamath River occur due to runoff in the lower watershed during the winter  
 18 months (DOI and DFG 2012).

19 The Klamath River estuary extends from approximately 5 miles upstream of the  
 20 Pacific Ocean (DOI and DFG 2012). This area is generally under tidal effects and  
 21 salt water can occur up to 4 miles from the coastline during high tides in summer  
 22 and fall when Klamath River flows are low. Klamath River flows at Klamath  
 23 within the Klamath River estuary are affected by tidal influence within the  
 24 estuary, as presented on Figure 5.12 (DWR 2014d).

25 **5.3.2.2 Central Valley Region**

26 The Central Valley Region extends from above Shasta Lake to the Tehachapi  
 27 Mountains, and includes the Sacramento Valley, San Joaquin Valley, Delta, and  
 28 Suisun Marsh.

29 **5.3.2.2.1 Sacramento Valley**

30 Rivers in the Sacramento Valley that could be affected by changes in CVP and  
 31 SWP operations include the following:

- 32 • Clear Creek from Whiskeytown Reservoirs to the confluence with the  
 33 Sacramento River
- 34 • Sacramento River from Shasta Lake to the confluence with the San Joaquin  
 35 River in the Delta
- 36 • Feather River from upstream of Oroville Reservoir to the confluence with the  
 37 Sacramento River
- 38 • Yuba River from New Bullards Bar Reservoir to the confluence with the  
 39 Feather River
- 40 • Bear River from Camp Far West Reservoir to the confluence with the  
 41 Feather River

- 1 • American River from Folsom Lake to the confluence with the  
2 Sacramento River

3 Flows from smaller tributaries to the Sacramento River and the Cosumnes and  
4 Mokelumne rivers in the Sacramento Valley contribute substantial flows into the  
5 Sacramento River and affect CVP and SWP operations; however, flows in these  
6 rivers would not be affected by changes in CVP and SWP operations. Therefore,  
7 hydrologic conditions on these waterbodies are not described in this EIS.

8 The Sacramento River watershed encompasses an area over 15,360,000 acres in  
9 the northern portion of the Central Valley; extends from the foothills of the Coast  
10 Ranges and Klamath Mountains on the west; extends from the foothills of the  
11 Sierra Nevada and Cascade Range on the east; and extends through the Delta on  
12 the south (Reclamation 2013a).

13 Ground surface elevations in the northern portion of the Sacramento River  
14 watershed range from approximately 14,000 feet above mean sea level in the  
15 headwaters of the Sacramento River to approximately 1,070 feet at Shasta Lake  
16 (Reclamation 2013a). In the mountains surrounding the valley, annual average  
17 precipitation generally ranges between 60 and 70 inches up to 90 inches, with  
18 snow prevalent at higher elevations. The floor of the Sacramento Valley is  
19 relatively flat, with elevations ranging from approximately 60 to 300 feet above  
20 mean sea level. This area is characterized by hot dry summers and mild winters.  
21 Average precipitation ranges from 15 to 20 inches per year, falling mostly as rain.

22 The Sacramento River flows approximately 351 miles from the north near Mount  
23 Shasta to the confluence with the San Joaquin River at Collinsville in the western  
24 Delta (Reclamation 2013a). The Sacramento River receives contributing flows  
25 from numerous major and minor streams and rivers that drain the east and west  
26 sides of the basin. The Sacramento River also receives imported flows from the  
27 Trinity River watershed, as discussed above. The volume of flow increases as the  
28 river progresses southward, and is increased considerably by the contribution of  
29 flows from the Feather River and the American River.

### 30 *Upper Sacramento River Watershed Hydrology*

31 The portion of the watershed upstream of Keswick Dam includes the McCloud  
32 River, Pit River, Squaw Creek, headwaters of the Sacramento River, and Goose  
33 Lake basins. The Goose Lake basin is located within the Pit River watershed;  
34 however, water rarely spills from Goose Lake into the Pit River. The last  
35 recorded spill occurred in 1880 (Reclamation 2013a). Long-term average annual  
36 inflows into Shasta Lake are approximately 4.875 MAF between the mid-1940s  
37 and 2010.

38 The McCloud River watershed extends over approximately 402,000 acres  
39 (Reclamation 2013a). The McCloud River flows approximately 59 miles from  
40 the headwaters in Moosehead Creek located southeast of Mount Shasta, through  
41 McCloud Reservoir, and into Shasta Lake. McCloud Reservoir is operated  
42 primarily to generate hydroelectric power.

1 The Pit River watershed extends over approximately 3,008,000 acres along the  
2 north and south forks of the Pit River basins, and includes 21 named tributaries  
3 and numerous smaller tributaries (Reclamation 2013a). Pacific Gas and Electric  
4 Company operate several hydropower diversions and reservoirs within the Pit  
5 River watershed.

6 The Squaw Creek watershed extends over approximately 66,000 acres located to  
7 the east of Shasta Lake (Reclamation 2013a).

8 The Sacramento River extends approximately 40 miles from the headwaters to  
9 Shasta Lake downstream of the town of Delta (Reclamation 2013a). The basin  
10 extends into portions of Mount Shasta and the Trinity and Klamath mountains.

11 Hydrological conditions in these upper watersheds would not be affected by  
12 implementation of the alternatives considered in this EIS.

### 13 *Whiskeytown Lake*

14 Whiskeytown Lake is located within the Clear Creek watershed. The Clear Creek  
15 watershed is 238 square miles that extends from the Trinity Mountains to the  
16 confluence with the Sacramento River downstream of the City of Redding (DWR  
17 1986 and Western Shasta Resource Conservation District [WSRCD] 2004).

18 Hydrology in the watershed is divided into the upper 238-square mile watershed  
19 upstream of Whiskeytown Dam at River Mile 18.1, and the lower 49 square miles  
20 watershed downstream of the dam. Clear Creek flows approximately 17 miles  
21 from the Trinity Mountains into Whiskeytown Lake. Clear Creek continues for  
22 18.1 miles downstream of Whiskeytown Lake into the Sacramento River  
23 downstream of the CVP Keswick Dam and south of the City of Redding.

24 Whiskeytown Dam, a CVP facility constructed by 1963, is the only dam on Clear  
25 Creek and is located approximately 16.5 miles downstream of the headwaters  
26 (Reclamation 1997). Whiskeytown Lake, which is formed by the dam, has a  
27 storage capacity of 0.241 MAF; and regulates runoff from Clear Creek and  
28 diversions from the Trinity River watershed, as described in Appendix 3A, No  
29 Action Alternative: Central Valley Project and State Water Project Operations.  
30 Flows from Lewiston Reservoir in the Trinity River watershed are diverted to  
31 Whiskeytown Lake through the Clear Creek Tunnel. Currently, the Clear Creek  
32 Tunnel between Lewiston Reservoir and Whiskeytown Lake has a capacity of  
33 3,200 cfs (Reclamation 2011b).

34 Water from Whiskeytown Lake is released to the Sacramento River through the  
35 Spring Creek Tunnel which conveys water to the Spring Creek Conduit, and then  
36 to Keswick Reservoir. Water from Whiskeytown Lake also is released into Clear  
37 Creek directly from Whiskeytown Lake; or during high flow conditions  
38 (e.g., flood flows), from a Glory Hole within Whiskeytown Lake through a  
39 conduit into Clear Creek. Most of the flows are released through the Spring  
40 Creek Tunnel and Powerplant to Keswick Reservoir. These flows into Keswick  
41 Reservoir provide cold water flows that reduce temperatures in the upper  
42 Sacramento River, especially during the fall months. Water also is discharged  
43 from Whiskeytown Lake to Clear Creek to provide for instream flows and water

1 for users located in the CVP Clear Creek South Unit within, or adjacent to, the  
2 Clear Creek watershed.

3 The capacity of the outlet from Whiskeytown Dam that conveys water to Clear  
4 Creek is 1,240 cfs when the water elevation in Whiskeytown Lake is at  
5 1,220.5 feet. To provide flows into Clear Creek in excess of 1,240 cfs, the  
6 Whiskeytown Reservoir water elevations need to be raised higher than 1,220 feet  
7 to allow water to flow through the Glory Hole spillway, as described below  
8 (CALFED 2004; Reclamation 2009a).

9 Historical water storage volume and water storage elevations related to  
10 Whiskeytown Lake for Water Years 2001 through 2012 are presented on  
11 Figures 5.13 and 5.14 (DWR 2013j, 2013k, 2013l). Whiskeytown Lake storage is  
12 relatively constant due to agreements between Reclamation and the National Park  
13 Service to maintain certain winter and summer lake elevations for recreation.  
14 Whiskeytown Lake outflow variations were greater prior to 2006 when Trinity  
15 River restoration flows were implemented which reduced the amount of water  
16 available for conveyance to CVP water users. In addition, hydrologic conditions  
17 in the years following 2006 were drier than the water years between 2001  
18 and 2006.

19 *Implementation of 2009 National Marine Fisheries Service Biological*  
20 *Opinion*

21 In accordance with the 2009 National Marine Fisheries Service (NMFS)  
22 Biological Opinion (BO) Reasonable and Prudent Alternative (RPA),  
23 Reclamation is required to manage Whiskeytown Lake releases to meet daily  
24 water temperatures in Clear Creek at Igo, as discussed in Appendix 3A, No  
25 Action Alternative: Central Valley Project and State Water Project Operations.

26 *Clear Creek*

27 Substantial modifications of the Clear Creek stream channel occurred due to  
28 placer mining activities from the mid-1800s through the early 1900s. In addition,  
29 several irrigation diversions were constructed along the lower Clear Creek reach  
30 during the late 1800s and early 1900s. One of the largest diversions was the  
31 15-foot-high, 200-foot-wide McCormick-Saeltzer Dam constructed in 1903 at  
32 River Mile 6.5 (approximately 12 miles downstream of Whiskeytown Dam). The  
33 downstream of Whiskeytown Dam was constructed upstream of a steep gorge  
34 along Clear Creek and removed in 2001. More recent channel modifications  
35 occurred in the lower Clear Creek due to gravel extraction activities from the  
36 1950s to 1970s.

37 Construction of Whiskeytown Dam modified the hydraulics, gravel loading, and  
38 sediment transport in the lower Clear Creek. The overall average annual flow in  
39 the lower Clear Creek was reduced by 87 percent following construction of the  
40 dam (DWR 1984, 1986). The dam also reduced gravel loading into the lower  
41 Clear Creek and the frequency of high flow events that move the gravel and  
42 remove fine sediments from riffles. This change in hydrology and loss of gravel  
43 loading adversely affected the salmonid habitat downstream of Whiskeytown  
44 Dam, including compaction of riffles with sand. Recently, minimum flow

1 releases from Whiskeytown Lake into Clear Creek occur in accordance with  
 2 Federal and state requirements (DWR 1984), as described in Appendix 3A, No  
 3 Action Alternative: Central Valley Project and State Water Project Operations.  
 4 Historical flow data has been collected since 1941 at the Igo Gage at River  
 5 Mile 10.9 (approximately 7.2 miles downstream of Whiskeytown Dam)  
 6 (DWR 1986 and WSRCD 2004).

7 Since the early 1980s, numerous studies were conducted to evaluate methods to  
 8 rehabilitate and/or restore habitat along lower Clear Creek. In the 1990s,  
 9 additional studies were conducted following the adoption of the 1992 Central  
 10 Valley Project Improvement Act (CVPIA). In 1998, a watershed management  
 11 plan prepared by the WSRCD evaluated methods to achieve healthy fish  
 12 populations, diverse biological habitats, recreational opportunities, clean and safe  
 13 conditions for visitors, and protection of property rights developed by the Lower  
 14 Clear Creek Coordinated Resource Management and Planning Group of local  
 15 landowners, stakeholders, and agencies (WSRCD 1998). The recommendations  
 16 included the following:

- 17 • Removal of the McCormick-Saeltzer Dam.
- 18 • Inject gravel downstream of Whiskeytown Dam and reconstruct gravel  
 19 channels below McCormick-Saeltzer Dam to reduce stranding.
- 20 • Modify water release patterns from Whiskeytown Dam.
- 21 • Reduce exotic vegetation along Clear Creek.
- 22 • Reduce sands in Clear Creek through erosion control programs in the lower  
 23 watershed.

24 This and other studies led to the formation of the Lower Clear Creek Floodway  
 25 Rehabilitation Project that was implemented under CVPIA (CALFED 2004,  
 26 WSRCD 2002). Initial actions under this program included gravel augmentation  
 27 initiated in 1996, increase in Whiskeytown Dam releases initiated in 2001,  
 28 removal of the McCormick-Saeltzer Dam in 2001, reconstruction and  
 29 revegetation of the floodway, and reduction of watershed erosion.

30 Following the removal of the McCormick-Saeltzer Dam, extensive  
 31 geomorphological studies have been conducted to recommend approaches for  
 32 restoration of the channel and adjacent floodplain downstream of the McCormick-  
 33 Saeltzer Dam site. Based upon hydrological data collected at the Igo gage, one of  
 34 the studies discussed that peak flow events in lower Clear Creek following  
 35 completion of Whiskeytown Dam occur about once every 3 years; although, the  
 36 pre-dam frequency was approximately once every 2 years. Clear Creek flows at  
 37 Igo between 2000 and 2012 are presented on Figure 5.15. During this period,  
 38 high flow events occurred in April and May of 2003 and December 2005 (DWR  
 39 2013s). The high flow events: 1) naturally moved gravel placed downstream of  
 40 Whiskeytown Dam and along Clear Creek; 2) developed and maintained Clear  
 41 Creek channel and adjacent floodplain habitat for spring-run and fall-run Chinook  
 42 Salmon and steelhead; 3) created and maintained deep pools in the channel to  
 43 support spawning of spring-run Chinook Salmon and steelhead, and create

1 appropriate salmonid habitat within and along Clear Creek; and 4) established and  
2 maintained nesting and foraging habitat for neotropical migrant birds, native  
3 resident birds, and amphibians.

4 Following removal of McCormick-Saeltzer Dam, the Clear Creek channel and  
5 adjacent floodplain geomorphology changed. The Clear Creek channel capacity  
6 is generally about 3,000 cfs. The 2004 studies indicated that flows in excess of  
7 3,000 cfs are required to overflow from the Clear Creek channel onto the adjacent  
8 floodplains. The study discussed that during pre- and post-Whiskeytown periods,  
9 the 5-year flood event at Igo decreased from 9,000 to 3,400 cfs and the 2.5-year  
10 flood event decreased from 6,200 to 1,800 cfs. Therefore, the study discussed  
11 that flows in excess of 5,000 cfs did not occur more frequently than 3 times in  
12 10 years (CALFED 2004).

13 *Implementation of 2009 National Marine Fisheries Service Biological*  
14 *Opinion*

15 The 2009 NMFS BO RPA requires Reclamation to release spring attraction flows  
16 for adult spring-run Chinook Salmon and channel maintenance flows in Clear  
17 Creek and to continue gravel augmentation programs initiated under CVPIA. The  
18 spring attraction flows are to be released from Whiskeytown Lake into Clear  
19 Creek in at least two pulse flows of at least 600 cfs in May and June.

20 The channel maintenance flows are to be released at a minimum flow of  
21 3,250 cfs, which is excess of the 1,240 cfs capacity of the Whiskeytown Dam  
22 outlet to Clear Creek. Therefore, to provide channel maintenance flows, the  
23 Whiskeytown Lake water elevation must be increased to provide flow of water  
24 over the Glory Hole inlet. The Glory Hole is designed to operate with the higher  
25 water elevations during flood events. However, during non-flood periods, raising  
26 the water elevations and operating the Glory Hole inlet can cause safety concerns  
27 for recreationists along the Whiskeytown Lake shoreline.

28 *Shasta Lake and Keswick Reservoir*

29 The CVP Shasta and Keswick dams are located at approximately River Miles 308  
30 and 299, respectively, as described in Appendix 3A, No Action Alternative:  
31 Central Valley Project and State Water Project Operations. Shasta Lake, a CVP  
32 facility on the Sacramento River formed by Shasta Dam, is located near Redding.  
33 Construction on the 4.552-MAF reservoir was initiated in 1945. Water flows  
34 from Shasta Lake along the Sacramento River into the 0.0238 MAF Keswick  
35 Reservoir, a CVP facility, which operates as an afterbay, or regulating reservoir,  
36 for Shasta Lake hydropower operations. Construction on Keswick Reservoir was  
37 initiated in 1950. A temperature control device at Shasta Dam was constructed  
38 between 1996 and 1998 to provide cold water without power bypass to the  
39 Sacramento River downstream of Keswick Reservoir.

40 Historical water storage volumes and water storage elevations for Shasta Lake for  
41 Water Years 2001 through 2012 are presented on Figures 5.16 and 5.17 (DWR  
42 2013m, 2013n, 2013o). Shasta Lake storage varies in accordance with upstream  
43 hydrology and downstream water demands and instream flow requirements. For  
44 example, storage declined during the drier years in 2008 and 2009.

1 Keswick Reservoir receives water from Shasta Lake and Whiskeytown Lake, as  
 2 described above; and from Spring Creek. Flows on Spring Creek are partially  
 3 regulated by the CVP Spring Creek Debris Dam (Reclamation 2014d, 2014e).  
 4 The debris dam minimizes the potential for debris entering the Spring Creek  
 5 Powerplant, which is located at the discharge end of the Spring Creek Conduit  
 6 immediately upstream of Keswick Reservoir. The debris dam also controls  
 7 contaminated runoff from old mine tailings on upper Spring Creek, which reduces  
 8 water quality effects on aquatic resources.

9 The Keswick Reservoir water storage volume is more consistent throughout the  
 10 year because this reservoir is used to regulate flow releases to the powerplant and  
 11 other downstream uses and not to provide long-term water storage, as shown on  
 12 Figures 5.18 and 5.19 (DWR 2013p, 2013q, 2013r).

13 *Implementation of 2009 National Marine Fisheries Service Biological*  
 14 *Opinion*

15 The 2009 NMFS BO RPA requires Reclamation meet specific temperature  
 16 requirements at Balls Ferry, Jelly's Ferry, and Bend Bridge based upon minimum  
 17 end-of-September storage in Shasta Lake for a specified frequency over 10 years,  
 18 as described in Appendix 3A, No Action Alternative: Central Valley Project and  
 19 State Water Project Operations. Reclamation also is required to evaluate a  
 20 monthly Keswick release schedule to address releases in fall and early winter  
 21 within the range of 7,000 and 3,250 cfs; to be adjusted in consideration of the  
 22 water year type, Shasta Lake storage, and the need to provide flow releases under  
 23 the 2009 NMFS BO RPA and to meet other Federal and state water quality  
 24 requirements in the Delta.

25 *Sacramento River from Keswick Dam to the Delta*

26 Water released from Shasta Dam travels approximately 245 miles over three to  
 27 four days to the northern Delta boundary near Freeport (Reclamation 2013a). The  
 28 upper reach of the Sacramento River flows for approximately 60 miles from  
 29 Keswick Dam to Red Bluff; and the middle reach of the Sacramento River flows  
 30 approximately 160 miles from Red Bluff to the confluence with the Feather River.  
 31 The lower reach of the Sacramento River flows for approximately 20 river miles  
 32 between the confluence with the Feather River and Freeport, immediately  
 33 downstream of the confluence with the American River.

34 Moderately high releases (greater than 10,000 cfs) are typically sustained during  
 35 the major irrigation season of June through September. Flows are released in the  
 36 fall months from CVP and SWP reservoirs to meet water temperature criteria for  
 37 winter-run Chinook Salmon spawning and incubation, to provide suitable habitat  
 38 for spring-run and early returning fall-run Chinook Salmon, provide water  
 39 supplies to rice farms for rice stubble decomposition, and to provide water for  
 40 wildlife refuges.

41 *Sacramento River from Keswick Dam to Red Bluff*

42 Reclamation operates the Shasta, Sacramento River, and Trinity River divisions  
 43 of the CVP to meet (to the extent possible) the provisions of SWRCB Order  
 44 90-05. An April 5, 1960 Memorandum of Agreement between Reclamation and

1 California Department of Fish and Wildlife (CDFW) originally established flow  
2 objectives in the Sacramento River for the protection and preservation of fish and  
3 wildlife resources. The agreement provided for minimum releases into the natural  
4 channel of the Sacramento River at Keswick Dam for normal and critically dry  
5 years, as described in Appendix 3A, No Action Alternative: Central Valley  
6 Project and State Water Project Operations. Since October 1981, Keswick Dam  
7 has operated based on a minimum release of 3,250 cfs for normal years from  
8 September 1 through the end of February, in accordance with an agreement  
9 between Reclamation and CDFW. This release schedule was included in  
10 SWRCB Order 90-05, which maintains a minimum release of 3,250 cfs at  
11 Keswick Dam and Red Bluff Pumping Plant from September through the end of  
12 February in all water years except critically dry years.

13 Generally, releases from Keswick Reservoir are implemented to comply with the  
14 minimum fishery requirement by October 15 each year and to minimize changes  
15 in Keswick releases between October 15 and December 31. Releases may be  
16 increased during this period to meet downstream needs such as higher outflows in  
17 the Delta to meet water quality requirements, or to meet flood control  
18 requirements. Releases from Keswick Dam may be reduced when downstream  
19 tributary inflows increase to a level that will meet flow needs. Reclamation  
20 attempts to establish a base flow that minimizes release fluctuations to reduce  
21 impacts to fisheries and bank erosion from October through December.

22 The Sacramento River between Keswick Dam and the City of Red Bluff flows  
23 through the northern foothills of the Sacramento Valley. Flows are influenced by  
24 outflow from Keswick Reservoir and inflows from Clear Creek (described  
25 above); and Cow Creek, Bear Creek, Cottonwood Creek, Battle Creek, and  
26 Paynes Creek which provide 15 to 20 percent of the flows in this reach as  
27 measured at Bend Bridge. There are several moderate major diversions along the  
28 Sacramento River upstream of Red Bluff, including the CVP Wintu Pumping  
29 Plant to provide water for the Bella Vista Water District, and the Anderson-  
30 Cottonwood Irrigation District Diversion. Both of these diversions near Redding  
31 provide water to agricultural, municipal, and industrial water users (Reclamation  
32 1997). No major storage or diversion structures have been constructed in the  
33 tributary watersheds in this reach of the Sacramento River, although several small  
34 diversions for irrigation, domestic use, and hydroelectric power generation are  
35 present (Reclamation 1997). Flow patterns on one major tributary in this reach,  
36 Battle Creek, are undergoing changes as the Battle Creek Salmon and Steelhead  
37 Restoration Project is implemented to restore ecological processes along 42 miles  
38 of Battle Creek and 6 miles of tributaries while minimizing reductions to  
39 hydroelectric power generation through the decommissioning of five powerplants.

#### 40 *Sacramento River from Red Bluff to the Delta*

41 Between Red Bluff and Colusa, the Sacramento River is a meandering stream,  
42 migrating through alluvial deposits between widely spaced levees. From Colusa  
43 to the northern boundary of the Delta near Freeport, flows increase due to the  
44 addition of the Feather and American rivers flows.



1 Recent mean daily flows in the Sacramento River at Bend Bridge (near Red  
2 Bluff), Vina Bridge (near Tehama), Hamilton City, Wilkins Slough (upstream of  
3 the Feather River confluence), Verona (downstream of the Feather River  
4 confluence), and Freeport (downstream of the American River Confluence and  
5 near the northern boundary of the Delta), are presented on Figures 5.20  
6 through 5.25 (DWR 2013u, 2013v, 2013w, 2013x, 2013y, 2013z). Flows in  
7 the Sacramento River generally peak during winter and spring storm events.  
8 Upstream of Hamilton City, sharp increases in flow occur during rainfall events,  
9 such as events in February 2004, December 2005/January 2006, and January  
10 2010. Downstream of Hamilton City, the high flow events occur over a longer  
11 period of time as water flows into the river from the tributaries.

12 Historically, Reclamation has maintained a minimum flow of 5,000 cfs at Chico  
13 Landing to support navigation in accordance with references to Sacramento River  
14 Division operations in the River and Harbors Act of 1935 and the Rivers and  
15 Harbors Act of 1937. Currently, there is no commercial traffic between  
16 Sacramento and Chico Landing, and USACE has not dredged this reach to  
17 preserve channel depths since 1972. However, long-time water users diverting  
18 from the river have set their pump intakes just below this level. Therefore, the  
19 CVP is operated to meet the navigation flow requirement of 5,000 cfs at the  
20 Wilkins Slough gauging station when diversions are occurring downstream, under  
21 all but the most critical water supply conditions.

22 Major diversions in this reach of the Sacramento River include the CVP Red  
23 Bluff Pumping Plant, Glenn-Colusa Irrigation District (GCID) intake, and  
24 individual diversions for the CVP Sacramento River Settlement Contractors. The  
25 Red Bluff Pumping Plant was completed in August 2012 to improve fish passage  
26 conditions on the Sacramento River by removing the Red Bluff Diversion Dam,  
27 and to continue to divert water from the Sacramento River into the Tehama-  
28 Colusa and Corning canals. The GCID Main Pump Station is located near  
29 Hamilton City to divert water into the GCID Canal that conveys water to over  
30 130,000 acres, including the USFWS Sacramento National Wildlife Refuge; and  
31 terminates at the Colusa Basin Drain near Williams. In 2001, the GCID Fish  
32 Screen was completed in addition to several canal improvements to allow year-  
33 round water deliveries.

34 Major streams entering the Sacramento River between Red Bluff and the Feather  
35 River include Antelope, Elder, Mill, Thomes, Deer, Stony, Big Chico, and Butte  
36 creeks. No major storage or diversion structures have been constructed on  
37 Antelope, Elder, Mill, and Thomes creeks, although several small seasonal  
38 diversions for irrigation, domestic use, and hydroelectric power generation are  
39 present (Reclamation 1997). Moderate non-CVP and non-SWP diversion dams  
40 are located on Deer, Big Chico, and Butte creeks.

41 Stony Creek flows are controlled by East Park Dam, Stony Gorge Dam, and  
42 Black Butte Dam (Reclamation 1997). East Park and Stony Gorge reservoirs  
43 store surplus water for irrigation deliveries and are operated by Reclamation as  
44 part of the Orland Project which is independent of the CVP. Black Butte Dam is  
45 operated by the USACE for flood control and irrigation supply. Black Butte Dam

1 operations are coordinated with the CVP. The GCID canal, which crosses Stony  
2 Creek downstream of Black Butte Dam, includes a seasonal gravel dam  
3 constructed across the creek on the downstream side of the canal.

4 The Sacramento River between Red Bluff and Chico Landing, the Sacramento  
5 River Flood Control Project has provided bank protection and incidental channel  
6 modification since 1958 (DWR 2013t). Between Chico Landing and Colusa, the  
7 flood management facilities consist of levees and overflow areas. Black Butte  
8 Reservoir regulates Stony Creek flood flows, which enter the Sacramento River  
9 downstream of Hamilton City. Right bank levees from Ord Ferry through Colusa  
10 prevent Sacramento River flood water from entering the Colusa Basin, except  
11 when flows exceed 300,000 cfs near Ord Ferry (DWR 2013t). Three flood relief  
12 weirs along the right bank, downstream of Chico Landing, allow flood flows to  
13 spill into the Butte Basin Overflow Area. The left bank levee begins midway  
14 between Ord Ferry and Butte City and extends south through Verona, and  
15 includes the Moulton and Colusa weirs that allow flood flows to spill into the  
16 Butte Basin Overflow Area. The natural Sutter Basin overflow (Sutter Bypass) to  
17 the east of the Sacramento River and downstream of the Sutter Buttes was  
18 included in the Sacramento River Flood Control Project. The Sutter Bypass  
19 conveys floodwaters from the Butte Basin Overflow Area, Butte Creek,  
20 Wadsworth Canal, and Reclamation Districts 1660 and 1500 drainage plants, state  
21 drainage plants, and Tisdale Weir to the confluence of the Sacramento and  
22 Feather rivers. Downstream of Colusa, Reclamation Districts 70, 108, and  
23 787 pump flood waters from adjacent closed basin lands into the river.

24 The Colusa Basin Drain provides drainage for a large portion of the irrigated  
25 lands on the western side of the Sacramento Valley in Glenn, Colusa, and Yolo  
26 counties; and supplies irrigation water to lands in this area. Water from the drain  
27 is discharged to the Sacramento River through the Knights Landing Outfall, a  
28 gravity flow structure and prevents the Sacramento River from flowing into the  
29 Colusa Basin.

30 *Implementation of 2009 National Marine Fisheries Service Biological*  
31 *Opinion*

32 The 2009 NMFS BO RPA requires Reclamation to evaluate approaches to  
33 provide minimum flows at Wilkins Slough of less than 5,000 cfs.

34 *Yolo Bypass*

35 Flows from the Sacramento River, Feather River, Sutter Bypass, and Natomas  
36 Cross Canal join upstream of Verona on the Sacramento River. When the  
37 Sacramento River flows exceed 62,000 cfs, flows spill over the Fremont Weir into  
38 the Yolo Bypass. The Yolo Basin was a natural overflow area located to the west  
39 of the Sacramento River. The Sacramento River Flood Control Project modified  
40 the basin by confining the extent of overflow through a leveed bypass and  
41 allowing flood flows to enter the Yolo Bypass from the Sacramento River over  
42 the Fremont and Sacramento weirs. The Yolo Bypass conveys floodwaters  
43 around the Sacramento metropolitan area and reconnects to the Sacramento River

1 at Rio Vista (DWR 2013t). Tributaries within the Yolo Bypass include the Cache  
2 Creek Detention Basin, Willow Slough, and Putah Creek.

3 Flows also enter the Yolo Bypass from the Colusa Basin, including from the  
4 Colusa Basin Drain through the Knights Landing Ridge Cut. In 2011 and 2012,  
5 construction at the outfall gates required water from the Colusa Basin Drain to be  
6 diverted into the Yolo Bypass. These events temporarily resulted in a fall pulse  
7 flow in the Yolo Bypass that increased the volume of flow by more than 300 to  
8 900 percent (Frantzich 2014).

9 Historical mean daily flows into the Yolo Bypass at Fremont Weir are presented  
10 on Figure 5.26 (DWR 2013aa). Between 2002 and 2012, flows have entered the  
11 Yolo Bypass at Fremont Weir during 13 periods, including:

- 12 • January 2002 – spill continued for 7 days with flows up to 30,000 cfs
- 13 • January 2003 – spill continued for 6 days with flows up to 22,000 cfs
- 14 • May 2003 – spill continued for 1 day with flows up to 100 cfs
- 15 • January 2004 – spill continued for 3 days with flows up to 3,000 cfs
- 16 • February 2004 – spill continued for 20 days with flows up to 79,000 cfs
- 17 • May 2005 – spill continued for 4 days with flows up to 35,000 cfs
- 18 • January/February 2006 (2 events) – spill continued for a total of 37 days with  
19 flows up to 205,000 cfs
- 20 • March/April/May 2006 – spill continued for 65 days with flows up to  
21 96,000 cfs
- 22 • January 2010 – spill continued for 4 days with flows up to 5,000 cfs
- 23 • December 2010 – spill continued for 4 days with flows up to 9,000 cfs
- 24 • March/April 2011 – spill continued for 24 days with flows up to 85,000 cfs
- 25 • December 2012 – spill continued for 5 days with flows up to 26,000 cfs

26 *Implementation of 2009 National Marine Fisheries Service Biological*  
27 *Opinion*

28 The 2009 NMFS BO RPA requires Reclamation to evaluate approaches to  
29 increase acreage of seasonal floodplain rearing habitat with biologically  
30 appropriate durations and magnitudes, from December through April, in the lower  
31 Sacramento River basin, on a return rate of approximately one to three years. The  
32 initial performance measure was defined in the RPA as 17,000 to 20,000 acres of  
33 floodplain rearing habitat, such as in the Yolo Bypass, excluding tidally  
34 influenced areas. Reclamation also is required to develop enhancement plans for  
35 Lower Putah Creek, Liberty Island/Lower Cache Slough, and Lower Yolo  
36 Bypass. The plans also are required to develop improvements to Fremont Weir  
37 and Lisbon Weir to eliminate migration barriers and stranding potential.

1 *Feather River Watershed*

2 The Feather River, with a drainage area of 3,607 square miles on the east side of  
3 the Sacramento Valley, is the largest tributary to the Sacramento River below  
4 Shasta Dam (Reclamation 1997, DWR 2007a). The Feather River enters the  
5 Sacramento River from the east at Verona. The total flow is provided by the  
6 Feather River and tributaries, which include the Yuba and Bear rivers.

7 *Upper Feather River, Lake Oroville, and the Thermalito Complex*

8 The upper Feather River includes numerous reservoirs and powerplant diversions,  
9 including the 1,308-TAF Lake Almanor owned by Pacific Gas & Electric  
10 Company; and the SWP Upper Feather River Lakes, including Antelope Lake,  
11 Lake Davis, and Frenchman Lake. The major SWP facility on the Feather River  
12 is the 3,500-TAF Lake Oroville, which is formed by the Oroville Dam located at  
13 the confluence of the North, Middle, and South forks of the Feather River. Lake  
14 Oroville stores winter and spring runoff, which is released into the Feather River  
15 to meet SWP water demands; provide pumpback capability to allow for on-peak  
16 electrical generation; provide 750 TAF of flood control storage, recreation, and  
17 freshwater releases to control salinity intrusion in the Delta; and for fish and  
18 wildlife protection, as described in Appendix 3A, No Action Alternative: Central  
19 Valley Project and State Water Project Operations. Historical water storage  
20 volumes and water storage elevations for Lake Oroville for Water Years 2001  
21 through 2012 are presented on Figures 5.27 and 5.28 (DWR 2013 ab, 2013ac).

22 A maximum of 17,400 cfs can be released from Lake Oroville through the  
23 Edward Hyatt Powerplant, and the Thermalito Power Canal into the Thermalito  
24 Diversion Pool. Water continues through the Thermalito Diversion Pool into the  
25 Feather River Fish Hatchery and the 11,768-acre-foot Thermalito Forebay formed  
26 by the Thermalito Diversion Dam. Water is released from the Thermalito  
27 Forebay through the Thermalito Powerplant into the Thermalito Afterbay and the  
28 low flow channel of the Feather River.

29 Historical water storage volumes and water storage elevations for Thermalito  
30 Afterbay for Water Years 2001 through 2012 are presented on Figures 5.29  
31 and 5.30 (DWR 2013ab, 2013ac, 2013ad). Water from the afterbay flows into the  
32 Feather River. Historical mean daily flows in the Feather River are presented on  
33 Figure 5.31 (DWR 2013af). Local agricultural districts divert water directly from  
34 the afterbay.

35 Maximum allowable ramp-down release requirements in the low flow channel of  
36 the Feather River are required to prevent rapid reductions in water levels that  
37 could potentially cause redd dewatering and stranding of juvenile salmonids and  
38 other aquatic organisms. Water releases from Lake Oroville are also affected by  
39 temperature criteria, as described in Appendix 3A, No Action Alternative: Central  
40 Valley Project and State Water Project Operations.

41 Major diversions on the Feather River downstream of the Thermalito Complex  
42 include diversions into the Western Canal, Richvale Canal, the Pacific Gas and  
43 Electric Company Lateral, and the Sutter-Butte Canal. Some of the water  
44 diverted into these canals is exported to the Butte Creek watershed. Riparian

1 water users along the Feather River also divert water for agricultural and  
2 municipal uses within the Feather River and Butte Creek watersheds  
3 (Reclamation 1997; DWR 2007).

#### 4 *Lower Yuba River*

5 The Yuba River watershed extends over 1,339 square miles in the Sierra Nevada.  
6 The Yuba River is a major tributary to the Feather River, and historically has  
7 contributed over 40 percent of the lower Feather River flows (Reclamation 1997).  
8 The major reservoir in the watershed is the 970-TAF New Bullards Bar Reservoir  
9 that is owned and operated by the Yuba County Water Agency to provide flood  
10 control, water storage, and hydroelectric generation (Yuba County Water Agency  
11 [YCWA] 2012). The Yuba River watershed also includes over 400 TAF  
12 additional storage in reservoirs located upstream of New Bullards Bar Reservoir.

13 Water is diverted from New Bullards Bar Reservoir through the Colgate Tunnel  
14 and Powerhouse and discharged into the Yuba River. The 70-TAF Englebright  
15 Lake is formed by the Harry L. Englebright Dam downstream of New Bullards  
16 Dam. Englebright Lake was constructed by the California Debris Commission to  
17 trap and store sediment from historical hydraulic mining sites in the upper  
18 watershed and provide recreation and hydroelectric generation opportunities  
19 (USACE 2013). Following decommissioning of the California Debris  
20 Commission in 1986, administration of Englebright Dam and Lake was assumed  
21 by the USACE (USACE 2012, 2013, 2014). Major water diversions from the  
22 Yuba River occur 12.5 miles downstream of Englebright Dam at Daguerre Point  
23 Dam. Water transfers have occurred between Yuba County Water Agency and  
24 other water agencies, including CVP and SWP water users, since 2008 under the  
25 Lower Yuba River Accord, as described in Appendix 3A, No Action Alternative:  
26 Central Valley Project and State Water Project Operations (Lower Yuba River  
27 Accord, River Management Team [LYRARMT] 2013).

#### 28 *American River from Folsom Lake to Sacramento River*

29 The American River watershed extends over 1,895 square miles and contributes  
30 approximately 15 percent of the flow in the lower Sacramento River.

#### 31 *Folsom Lake and Lake Natoma*

32 Folsom Lake and Lake Natoma on the American River are located within portions  
33 of the American River watershed that could be affected by changes in CVP and/or  
34 SWP operations. Folsom Lake is a CVP facility formed by Folsom Dam 7 miles  
35 upstream of the CVP Nimbus Dam (Reclamation et al. 2006). Folsom, Lake is  
36 the largest reservoir in the American River watershed, and has a capacity of  
37 967 TAF. Numerous smaller reservoirs in the upper basin provide hydroelectric  
38 generation and water supply and are not owned or operated by Reclamation or  
39 DWR. The total upstream reservoir storage above Folsom Lake is approximately  
40 820 TAF. Ninety percent of this upstream storage is provided by five reservoirs:  
41 French Meadows (136 TAF); Hell Hole (208 TAF); Loon Lake (76 TAF); Union  
42 Valley (271 TAF); and Ice House (46 TAF).

1 Nimbus Dam creates Lake Natoma, a forebay built to re-regulate flows of the  
2 American River and to direct water into the CVP Folsom South Canal. Releases  
3 from Nimbus Dam to the American River pass through the Nimbus Powerplant  
4 when releases are less than 5,000 cfs or the spillway gates for higher flows. The  
5 American River flows 23 miles between Nimbus Dam and the confluence with  
6 the Sacramento River. Historical water storage volumes and water storage  
7 elevations for Folsom Lake and Lake Natoma for Water Years 2001 through 2012  
8 are presented on Figures 5.32 through 5.35) (DWR 2013ag, 2013ah, 2013ai,  
9 2013aj). Median daily flows in American River downstream of Nimbus Dam are  
10 presented in Figure 5.36 (DWR 2013ak).

11 Water is diverted to municipal and industrial water users, including water rights  
12 holders, upstream of Folsom Dam, from the Folsom South Canal, and from the  
13 American River downstream of Folsom Dam. During extreme critical dry years,  
14 water elevations in Folsom Lake can be too low for adequate operation of  
15 diversion facilities; and Reclamation has provided temporary barges with intake  
16 and conveyance facilities to divert water from the lake to the adjacent water users.

17 *Lower American River Flows*

18 Flow patterns in the lower American River (downstream of Lake Natoma) are  
19 influenced by operations of the CVP both within the American River watershed  
20 and within the entire Sacramento River watershed. Flows can be affected by local  
21 operations such as flood management requirements at Folsom Lake and Lake  
22 Natoma, federal and state flow requirements, temperature requirements and water  
23 uses in the American River watershed. Flows can also be affected by delta  
24 operations including outflow and salinity requirements as well as exports within  
25 and south of the delta. Recent mean daily flows in the American River are  
26 presented on Figure 5.36 (DWR 2013ak).

27 *Lower American River Flood Management*

28 Flood management requirements and regulating criteria for October 1 through  
29 May 31 each year were specified in 1987 by the USACE to manage flooding in  
30 the Sacramento area, as practicable; provide maximum amount of water  
31 conservation storage in Folsom without impairing the flood control; and provide  
32 maximum amount of power practicable and be consistent with required flood  
33 control operations and the conservation functions of the reservoir. Following  
34 significant flood events in February 1986 and January 1997, the lower American  
35 River flooding issues were analyzed; and revised flood operations criteria were  
36 developed by the Sacramento Area Flood Control Agency (SAFCA), as described  
37 in Appendix 3A, No Action Alternative: Central Valley Project and State Water  
38 Project Operations. The SAFCA release criteria are generally equivalent to the  
39 USACE plan, except the SAFCA diagram may prescribe flood releases earlier  
40 than the USACE plan. The SAFCA diagram also relies on Folsom Dam outlet  
41 capacity to make the earlier flood releases. The outlet capacity at Folsom Dam is  
42 currently limited to 32,000 cfs based on lake elevation. Since 1996, Reclamation  
43 has operated according to modified flood control criteria, which reserve 400 to  
44 670 TAF of flood control space in Folsom Reservoir in combination with empty

1 reservoir space in Hell Hole, Union Valley, and French Meadows to be treated as  
2 if it were available in Folsom Reservoir.

3 Reclamation and USACE constructed an auxiliary spillway under the Joint  
4 Federal Project, at Folsom Dam in accordance with the recommendations of the  
5 Water Control Manual Update (Reoperation Study). The USACE is also  
6 implementing increased system capabilities provided by the authorized features of  
7 the Common Features Project to strengthen the American River levees to convey  
8 up to 160,000 cfs and completion of the authorized Folsom Dam Mini-Raise  
9 Project.

#### 10 *Lower American River Minimum Flow and Temperature Requirements*

11 The minimum allowable flows in the lower American River are defined by  
12 SWRCB Water Right Decision 893 (D-893), which states that, in the interest of  
13 fish conservation, releases should not ordinarily fall below 250 cfs between  
14 January 1 and September 15 or below 500 cfs at other times. D-893 minimum  
15 flows are rarely the controlling objective of CVP operations at Nimbus Dam.  
16 Nimbus Dam releases are nearly always controlled during significant portions of a  
17 water year by either flood control requirements or are coordinated with other CVP  
18 and SWP releases to meet CVP water supply and Delta operations objectives.  
19 Power regulation and management needs occasionally control Nimbus Dam  
20 releases. Nimbus Dam releases generally exceed the D-893 minimum flows in all  
21 but the driest of conditions.

22 Dedication of water in accordance with Section 3406(b)(2) of CVPIA on the  
23 American River provides instream flows below Nimbus Dam greater than those  
24 that would have occurred under pre-CVPIA conditions, as described in Appendix  
25 3A, No Action Alternative: Central Valley Project and State Water Project  
26 Operations. Instream flow objectives from October through May generally aim to  
27 provide suitable habitat for salmon and steelhead spawning, incubation, and  
28 rearing, while considering impacts to other CVP and SWP uses. Instream flow  
29 objectives for June to September endeavor to provide suitable flows and water  
30 temperatures for juvenile steelhead rearing, while balancing the effects on  
31 temperature operations into October and November to help support fall-run  
32 Chinook Salmon spawning.

33 In July 2006, Reclamation, the Sacramento Area Water Forum and other  
34 stakeholders agreed to a flow and temperature regime (known as the Lower  
35 American River Flow Management Standard [FMS]) to improve conditions for  
36 fish in the lower American River, as described in Appendix 3A, No Action  
37 Alternative: Central Valley Project and State Water Project Operations.  
38 Minimum flow requirements during October, November, and December are  
39 primarily intended to address fall-run Chinook Salmon spawning, and flow  
40 requirements during January and February address fall-run Chinook Salmon egg  
41 incubation and steelhead spawning. From March through May, minimum flow  
42 requirements are primarily intended to facilitate steelhead spawning and egg  
43 incubation, as well as juvenile rearing and downstream movement of fall-run  
44 Chinook Salmon and steelhead. The June through September flows are designed

1 to address over-summer rearing by juvenile steelhead, although this period  
2 partially overlaps with adult fall-run Chinook Salmon immigration.

3 Water temperature control operations in the lower American River are affected by  
4 many factors and operational tradeoffs. These include available cold water  
5 resources, Nimbus release schedules, annual hydrology, Folsom power penstock  
6 shutter management flexibility, Folsom Dam Urban Water Supply Temperature  
7 Control Device (TCD) management, and Nimbus Hatchery considerations, as  
8 described in Appendix 3A, No Action Alternative: Central Valley Project and  
9 State Water Project Operations. Meeting both the summer steelhead and fall  
10 salmon temperature objectives without negatively impacting other CVP project  
11 purposes requires reserving water in Folsom Lake for use in the fall to provide  
12 suitable fall-run Chinook Salmon spawning temperatures. In most years, the  
13 volume of cold water is not sufficient to support strict compliance with the  
14 summer water temperature target of 65°F at the downstream end of the  
15 compliance reach at the Watt Avenue Bridge; while at the same time reserving  
16 adequate water for fall releases to protect fall-run Chinook Salmon, or in some  
17 cases, continuing to meet steelhead over-summer rearing objectives later in the  
18 summer. The Folsom Water Supply Intake TCD has provided additional  
19 flexibility to conserve cold water for later use.

20 *American River Flows to Meet Delta Salinity Requirements*

21 Folsom Reservoir also is operated by Reclamation to release water to meet Delta  
22 salinity and flow objectives established to improve fisheries conditions. Weather  
23 conditions combined with tidal action and local accretions from runoff and return  
24 flows can quickly affect Delta salinity conditions, and require increases in spring  
25 Delta inflow to maintain salinity standards, as described in Appendix 3A, No  
26 Action Alternative: Central Valley Project and State Water Project Operations. In  
27 accordance with Federal and state regulatory requirements, the CVP and SWP are  
28 frequently required to release water from upstream reservoirs to maintain Delta  
29 water quality. Folsom Lake is located closer to the Delta than Lake Oroville and  
30 Shasta Lake; therefore, the water generally is first released from Folsom Lake.  
31 Water released from Lake Oroville and Shasta Lake generally reaches the Delta in  
32 approximately three and four days, respectively. As water from the other  
33 reservoirs arrives in the Delta, Folsom Reservoir releases can be reduced.

34 *Implementation of 2009 National Marine Fisheries Service Biological*  
35 *Opinion*

36 The 2009 NMFS BO RPA requires Reclamation to implement the FMS; minimize  
37 flow fluctuation effects in the lower American River between January and May;  
38 and meet specific temperature requirements in the lower American River, as  
39 described in Appendix 3A, No Action Alternative: Central Valley Project and  
40 State Water Project Operations, through operational modifications of temperature  
41 control shutters on Folsom Dam, and installation of structural improvements  
42 (TCDs or the functional equivalent) on several intakes in Folsom Lake and  
43 Lake Natoma.



### 1 **5.3.2.2.2 San Joaquin Valley**

2 The San Joaquin Valley is divided into two drainage major drainage basins. The  
3 northern drainage basin extends from the San Joaquin River along the southern  
4 boundary of the Delta and along the adjacent lands to the San Joaquin River from  
5 the northern drainage of the San Joaquin River in Madera County to the southern  
6 drainage in Fresno County (DWR 2013a). The northern drainage basin includes  
7 the San Joaquin River; five major tributaries that flow from westward from the  
8 Sierra Nevada, including Fresno, Chowchilla, Tuolumne, Merced, Stanislaus, and  
9 Calaveras rivers; and three major creeks that flow eastward from the Coast Range,  
10 including Del Puerto, Orestimba, and Panoche Creek. All flows in the San  
11 Joaquin River flow westward to the Delta.

12 The southern drainage basin (also known as the Tulare Lake Basin) extends into  
13 the southern San Joaquin Valley between the Sierra Nevada on the east,  
14 Tehachapi Mountains on the south, and the Coast Range on the west (DWR  
15 2013a). The southern basin includes four major tributaries, including Kings,  
16 Kaweah, Tule, and Kern rivers, which drain towards three ancient lakes on the  
17 valley floor, including the Tulare, Buena Vista, and Goose lakes. Flows into  
18 these lakes have declined as water supply projects and agricultural development  
19 has occurred. The northern and southern drainage basins are generally  
20 hydrologically separated by a low, broad ridge that extends across the San  
21 Joaquin Valley between the San Joaquin and Kings rivers. However, in flood  
22 years, water flows from the Kings River through the James Bypass and Fresno  
23 Slough into the San Joaquin River near Mendota; therefore, the basins become  
24 hydrologically connected.

25 Flows from Fresno, Chowchilla, Tuolumne, Merced, Calaveras, Kings, Kaweah,  
26 Tule, and Kern rivers contribute substantial flows into the San Joaquin Valley and  
27 affect operations of CVP and SWP water users and operations. However, the  
28 operations of reservoirs on these rivers are not modified within the alternatives  
29 evaluated in this EIS. Therefore, these rivers are not discussed in this chapter.  
30 This chapter will focus on the flows in the San Joaquin and Stanislaus rivers that  
31 are affected by changes in CVP and SWP operations considered in the alternatives  
32 evaluated in this EIS.

#### 33 *San Joaquin River*

34 The San Joaquin River flows 100 miles from Friant Dam to the Delta. Flows in  
35 the upper San Joaquin River are regulated by the CVP Friant Dam which forms  
36 Millerton Lake. Flows downstream of Friant Dam are influenced by flows from  
37 tributary rivers and streams, as described below; including CVP operations of  
38 New Melones Reservoir on the Stanislaus River. Flows on the San Joaquin River  
39 have recently changed since the expiration of the Vernalis Adaptive Management  
40 Plan in 2012.

#### 41 *Millerton Lake*

42 Operations of Millerton Lake and the CVP Friant Division will not be modified  
43 by changes in CVP and SWP operations under the alternatives considered in this  
44 EIS. Therefore, Millerton Lake and Friant Division are not analyzed in this EIS.

1 The following information is presented to provide a general understanding of  
2 Millerton Lake and Friant Division operations as part of the CVP.

3 Friant Dam is located on the San Joaquin River, 25 miles northeast of Fresno  
4 where the San Joaquin River exits the Sierra foothills and enters the valley. The  
5 drainage basin is 1,676 square miles. Millerton Lake, formed by Friant Dam, has  
6 a capacity of 520 TAF. Several reservoirs in the upper portion of the San Joaquin  
7 River watershed, including Mammoth Pool and Shaver Lake, affect the inflow to  
8 Millerton Lake (Reclamation and DWR 2011).

9 Millerton Lake provides flood control capacity on the San Joaquin River, provides  
10 downstream releases to meet senior water rights requirements above Mendota  
11 Pool, and provides conservation storage as well as diversion into Madera and  
12 Friant-Kern Canals. Flood control storage space in Millerton Lake is based on a  
13 complex formula, which considers storage in upstream reservoirs, forecasted  
14 snowmelt, and time of year. Flood management releases occur approximately  
15 once every 3 years and are managed based on downstream channel design  
16 capacity to the extent possible.

17 *San Joaquin River from Friant Dam to Mendota Pool*

18 Historically, in the 40-mile reach between Friant Dam and the Gravelly Ford,  
19 flow is influenced by releases from Friant Dam, with minor contributions from  
20 agricultural and urban return flows. Gravelly Ford, located downstream of Friant  
21 Dam, is a sandy and gravelly section of the San Joaquin River that is subject to  
22 high losses of river flow. The 17-mile reach of the San Joaquin River between  
23 Gravelly Ford and the Mendota Pool historically has been generally dry since  
24 construction of Friant Dam except when flood control flows are released from  
25 Millerton Lake. Reclamation releases water from Millerton Lake to comply with  
26 Holding Contracts between Reclamation and riparian water right holders  
27 downstream of Friant Dam that will provide for at least 5 cfs past each of the  
28 Holding Contract diversion locations that extend to Gravelly Ford (San Joaquin  
29 River Restoration Program [SJRRP] 2011a). The typical release from  
30 Millerton Lake to provide water to water rights holders is approximately 125 cfs  
31 (SWRCB 2012).

32 Two major flood control facilities, the Chowchilla and Eastside bypasses,  
33 intercept flows of the San Joaquin, Fresno, and Chowchilla rivers and smaller San  
34 Joaquin River tributaries to provide flood protection for downstream agricultural  
35 lands. During flood control operations, up to 6,500 cfs of excess flows in the San  
36 Joaquin River at Mendota Pool are diverted into the Chowchilla Bypass which  
37 conveys water to the Chowchilla River. The East Side Bypass conveys high  
38 flows from the Chowchilla River to the San Joaquin River upstream of Fremont  
39 Ford. These bypasses are located in highly permeable soils and are used to  
40 provide an area for groundwater recharge using flood flows.

41 The 50-TAF Mendota Pool serves as a forebay for diversions to the Main and  
42 Outside canals; and is the termination of the Delta-Mendota Canal, which conveys  
43 CVP water from the Delta, as described in Appendix 3A, No Action Alternative:  
44 Central Valley Project and State Water Project Operations. Water also enters

1 Mendota Pool via Fresno Slough (also known as James Bypass) which conveys  
 2 flood flows to the San Joaquin River from the Kings River (located in the Tulare  
 3 Lake Basin). Recent mean daily flows in the San Joaquin River at Mendota are  
 4 presented on Figure 5.37 (DWR 2013al).

5 *San Joaquin River Restoration Program: Friant Dam to Confluence of*  
 6 *Merced River*

7 In 2006, parties to *NRDC, et al., v. Rodgers, et al.*, executed a stipulation of  
 8 settlement that called for a comprehensive long-term effort to restore flows to the  
 9 San Joaquin River from Friant Dam to the confluence of the Merced River and a  
 10 self-sustaining Chinook Salmon fishery while reducing or avoiding adverse water  
 11 supply impacts. The SJRRP implements the settlement consistent with the  
 12 San Joaquin River Restoration Settlement Act in Public Law 111-11. The  
 13 USFWS issued a Programmatic BO for the implementation of the SJRRP on  
 14 August 21, 2012 and NMFS issued a Programmatic BO on September 18, 2012  
 15 for SJRRP flow releases of up to 1,660 cfs from Millerton Lake into the San  
 16 Joaquin River. The settlement-required flow targets for releases from Millerton  
 17 Lake include six water year types for releases depending upon available water  
 18 supply as measures of inflow to Millerton Lake, as described in Appendix 3A, No  
 19 Action Alternative: Central Valley Project and State Water Project Operations.  
 20 The Millerton Lake releases include the flexibility to reshape and retune releases  
 21 forwards or backwards by 4 weeks during the spring and fall pulse periods. Flood  
 22 flows may potentially occur and meet or exceed the Settlement flow targets. If  
 23 flood flows meet the settlement flow targets, then Reclamation would not release  
 24 additional water from Millerton Lake. The San Joaquin River channel  
 25 downstream of Friant Dam currently lacks the capacity to convey flows to the  
 26 Merced River and releases are limited accordingly. Reclamation has initiated  
 27 planning and environmental compliance activities to improve river channel  
 28 conveyance and allow for the full release of SJRRP flows. Diversions and  
 29 infiltration losses reduce the amount of Settlement flows reaching the San Joaquin  
 30 River and Merced River confluence. For the purposes of this analysis, flows that  
 31 reach the Merced confluence are assumed to continue to the Delta.

32 *San Joaquin River from Merced River to the Delta*

33 Two major tributaries, the Tuolumne and Stanislaus rivers, join the San Joaquin  
 34 River between the confluence with the Merced River and Vernalis (located at the  
 35 southeastern boundary of the Delta). The flows in this reach are influenced by  
 36 flow and water quality requirements at Vernalis as well as releases from the  
 37 upstream reach and the two major tributaries. Recent mean daily flows in the San  
 38 Joaquin River at Vernalis are presented on Figure 5.38 (DWR 2013am).

39 *Stanislaus River*

40 The Stanislaus River originates in the western slopes of the Sierra Nevada and  
 41 drains a watershed of approximately 900 square miles. The median annual  
 42 unimpaired runoff in the basin is approximately 1.08 MAF per year (SWRCB  
 43 2012). Snowmelt from March through early July contributes the largest portion  
 44 of the flows in the Stanislaus River, with the highest runoff occurring in the  
 45 months of April, May, and June.

1 The North, Middle, and South forks of the Stanislaus River converge upstream of  
2 the CVP New Melones Reservoir. The 2.4 MAF New Melones Reservoir is  
3 located approximately 60 miles upstream from the confluence of the Stanislaus  
4 River and the San Joaquin River. Water from New Melones Reservoir flows into  
5 Tulloch Reservoir (Reclamation 2010a). Tulloch Reservoir is owned and  
6 operated by the Tri-Dams Project for recreation, power, and flow re-regulation of  
7 New Melones Reservoir releases. Water released by Tulloch Reservoir and  
8 Powerplant flows downstream to Goodwin Reservoir where water is either  
9 diverted to canals to serve, Oakdale Irrigation District, South San Joaquin  
10 Irrigation District, and Stockton East Water District; or released from Goodwin  
11 Reservoir to the lower Stanislaus River (SWRCB 2012).

12 Below Goodwin Dam, the lower Stanislaus River flows approximately 40 miles to  
13 the confluence with the San Joaquin River. Agricultural return flows and  
14 operational spills from irrigation canals also enter the lower Stanislaus River.

15 *New Melones Reservoir*

16 The operating criteria for New Melones Reservoir are constrained by water rights  
17 requirements, flood control operations, contractual obligations, and federal  
18 requirements under the Federal Endangered Species Act (ESA) and CVPIA.  
19 Reclamation must operate New Melones Reservoir to meet senior water rights  
20 and in-basin demands. Senior water rights are defined for both current and future  
21 upstream water right holders in accordance with the SWRCB Decision 1422  
22 (D-1422) and Decision 1616 (D-1616); through protest settlement agreements  
23 with Tuolumne and Calaveras Counties; and for current downstream water right  
24 holders and riparian rights whose priorities are either senior to Reclamation or  
25 senior to appropriative rights in general, respectively, as described in  
26 Appendix 3A, No Action Alternative: Central Valley Project and State Water  
27 Project Operations. Reclamation also is required to make full contract amounts  
28 available to Stockton East Water District and Central San Joaquin Water  
29 Conservation District except for when contractual shortage provisions apply.

30 Required releases include flows to meet flow and water quality requirements  
31 included in the SWRCB Revised Decision 1641 (D-1641). This includes  
32 dissolved oxygen requirements in the lower Stanislaus River in accordance with  
33 the Central Valley Regional Water Quality Control Board (CVRWQCB) Basin  
34 Plan; minimum flow requirements in the lower San Joaquin River at Vernalis per  
35 SWRCB D-1641; and total dissolved solids requirement in the lower San Joaquin  
36 River at Vernalis per SWRCB D-1641.

37 Reservoir storage varies in accordance with upstream hydrology and downstream  
38 water demands and instream flow requirements. Recent water storage volumes  
39 and elevations for Water Years 2001 through 2012 in New Melones and Goodwin  
40 reservoirs are presented on Figures 5.39 through 5.42 (DWR 2013an, 2013ao,  
41 2013ap, 2013aq). Recent mean daily flows in the Stanislaus River downstream of  
42 Goodwin Dam are presented on Figure 5.43 (DWR 2013as).

1            *Implementation of 2009 National Marine Fisheries Service Biological*  
 2            *Opinion*

3 The 2009 NMFS BO RPA requires Reclamation to adaptively manage available  
 4 flows to meet minimum instream flow, ramping flow, pulse flow, floodplain  
 5 inundation, and geomorphic and function flow patterns, through the following  
 6 actions. The available flows to meet the 2009 NMFS BO RPA are defined  
 7 following compliance with water rights needs.

- 8     • Minimum base flows to optimize available steelhead habitat for adult  
 9       migration, spawning, and juvenile rearing by water year type, as measured  
 10      downstream of Goodwin Dam, as specified in Appendix 2-E of the 2009  
 11      NMFS BO RPA.
- 12    • Fall pulse flows to improve instream conditions sufficiently to attract  
 13      steelhead to the Stanislaus River.
- 14    • Winter instability flows to simulate natural variability in the winter  
 15      hydrograph and to enhance access to varied rearing habitats.
- 16    • Channel forming and maintenance flows in the 3,000 to 5,000 cfs range in  
 17      above normal and wet years to maintain spawning and rearing habitat quality  
 18      after March 1 to protect incubating eggs and to provide outmigration flow  
 19      cues and late spring flows.
- 20    • Outmigration flow cues to enhance likelihood of anadromy.
- 21    • Late spring flows for conveyance and maintenance of downstream migratory  
 22      habitat quality in the lowest reaches and into the Delta.

23 The 2009 NMFS BO also required Reclamation to meet temperature requirements  
 24 at Orange Blossom Bridge and Knights Ferry to protect steelhead, as discussed in  
 25 Appendix 3A, No Action Alternative: Central Valley Project and State Water  
 26 Project Operations. Reclamation is also required to evaluate an approach to  
 27 operate New Melones Reservoir flow releases to achieve floodplain inundation  
 28 flows and improved freshwater migratory habitat for steelhead. Reclamation also  
 29 participates in gravel augmentation to improve spawning habitat.

30 **5.3.2.2.3 Delta and Suisun Marsh**

31 The Delta and Suisun Marsh area constitutes a natural floodplain that covers  
 32 1,315 square miles and drains approximately 40 percent of the state (DWR  
 33 2013a). The Delta and Suisun Marsh have a complex web of channels and islands  
 34 and is located at the confluence of the Sacramento and San Joaquin rivers.

35 Historically, the natural Delta system was formed by water inflows from upstream  
 36 tributaries in the Delta watershed and outflow to Suisun Bay and San Francisco  
 37 Bay. In the late 1800s, local land reclamation efforts in the Delta resulted in the  
 38 construction of channels and levees that began altering the Delta's surface water  
 39 flows. Over time, the natural pattern of water flows continued to change as the  
 40 result of upper watershed diversions and the construction of facilities to divert and  
 41 export water through the Delta to areas where supplemental water supplies are

1 needed, including densely populated areas such as San Francisco and Southern  
2 California and agricultural regions such as the San Joaquin Valley and Tulare  
3 Lake. The SWP and CVP use the Delta as the hub of their conveyance systems to  
4 deliver water to large pumps located in the southern Delta.

5 Inflows to the Delta occur primarily from the Sacramento River system and Yolo  
6 Bypass, the San Joaquin River, and other eastside tributaries such as the  
7 Mokelumne, Calaveras, and Cosumnes rivers. In general, in any given year,  
8 approximately 77 percent of water enters the Delta from the Sacramento River,  
9 approximately 15 percent enters from the San Joaquin River, and approximately  
10 8 percent enters from the eastside tributaries (DWR 1994). The Delta is tidally  
11 influenced; rise and fall varies from less than 1 foot in the eastern Delta to more  
12 than 5 feet in the western Delta (DWR 2013a).

13 Water quality in the Delta is highly variable and strongly influenced by inflows  
14 from the rivers and by seawater intrusion into the western and central portions of  
15 the Delta during periods of low outflow that may be affected by high volumes of  
16 export pumping. The concentrations of salts and other materials in the Delta are  
17 affected by river inflows, tidal flows, agricultural diversions, drainage flows,  
18 wastewater discharges, water exports, cooling water intakes and discharges, and  
19 groundwater accretions. Seawater intrusion into the Delta is dependent on tidal  
20 conditions, inflows to the Delta, and Delta channel geometry. Delta channels are  
21 typically less than 30 feet deep, unless dredged, and vary in width from less than  
22 100 feet to more than 1 mile. Although some channels are edged with riparian  
23 and aquatic vegetation, steep mud or rip-rap covered levees border most channels.  
24 To enhance flow and aid in levee maintenance, vegetation is often removed from  
25 the channel margins. The tidal currents carry large volumes of seawater back and  
26 forth through the San Francisco Bay-Delta Estuary with the tidal cycle. The  
27 mixing zone of salt and fresh water can shift 2 to 6 miles daily depending on the  
28 tides, and may reach far into the Delta during periods of low inflow.

29 Salinity objectives adopted by the SWRCB were established to protect beneficial  
30 uses, including agricultural and municipal water supplies, and fisheries. The CVP  
31 and SWP facilities are operated to comply with the requirements that would  
32 protect the Delta water quality, as described in Appendix 3A, No Action  
33 Alternative: Central Valley Project and State Water Project Operations. These  
34 operational requirements affect the hydrology in the Delta.

35 Hydrological conditions in the Delta and Suisun Marsh are substantially affected  
36 by structures that route water through the Delta towards the major Delta water  
37 diversions in the south Delta, including the CVP Jones Pumping Plant, the SWP  
38 Banks Pumping Plant, the Delta-Mendota/California Aqueduct Intertie, the CVP  
39 Contra Costa Canal Pumping Plant at Rock Slough, and the Contra Costa Water  
40 District (CCWD) intakes on Old and Middle rivers; while protecting Delta water  
41 quality for these intakes, the SWP Barker Slough Pumping Plant in the north  
42 Delta and over 1,800 municipal and agricultural in-Delta diversions (DWR  
43 2010b). These structures include the Delta Cross Channel and temporary barriers  
44 in the south Delta. Diversion patterns for the major facilities also are regulated to  
45 maintain Delta water quality and to protect fish that are listed as threatened or

1 endangered species under ESA in accordance with the SWRCB D-1641, 2008  
 2 USFWS BO, and the 2009 NMFS BO. The diversion patterns are implemented to  
 3 maintain ratios of exports of the CVP and SWP facilities to the Delta inflow;  
 4 ratios of San Joaquin River inflow to Delta exports; and reverse flow conditions  
 5 in Old and Middle rivers (known as the OMR criteria). Operations of the Jones  
 6 and Banks pumping plants are affected by downstream CVP and SWP water  
 7 demands and reservoir operations in San Luis Reservoir that is jointly used by the  
 8 CVP and SWP.

9 Facilities implemented in Suisun Marsh also affect hydrologic and water quality  
 10 conditions throughout the Delta. To meet the Delta water quality requirements  
 11 and water rights requirements of users located upstream of the Delta, the CVP and  
 12 SWP are operated in a coordinated manner in accordance with Coordinated  
 13 Operation Agreement (COA), as described in the following section.

14 *Delta Cross Channel*

15 The Delta Cross Channel (DCC) is a gated diversion channel in the Sacramento  
 16 River near Walnut Grove and Snodgrass Slough, as described in Appendix 3A,  
 17 No Action Alternative: Central Valley Project and State Water Project  
 18 Operations. When the gates are open, water flows from the Sacramento River  
 19 through the cross channel to channels of the lower Mokelumne and San Joaquin  
 20 Rivers toward the interior Delta. The DCC operation improves water quality in  
 21 the interior Delta by improving circulation patterns of good quality water from the  
 22 Sacramento River towards Delta diversion facilities.

23 Reclamation operates the DCC in the open position to (1) improve the movement  
 24 of water from the Sacramento River to the export facilities at the Banks and Jones  
 25 Pumping Plants, (2) improve water quality in the southern Delta, and (3) reduce  
 26 salt water intrusion rates in the western Delta. During the late fall, winter, and  
 27 spring, the gates are often periodically closed to protect out migrating salmonids  
 28 from entering the interior Delta. In addition, whenever flows in the Sacramento  
 29 River at Sacramento reach 20,000 to 25,000 cfs (on a sustained basis) the gates  
 30 are closed to reduce potential scouring and flooding that might occur in the  
 31 channels on the downstream side of the gates.

32 Flow rates through the gates are determined by Sacramento River stage and are  
 33 not affected by export rates in the south Delta. The DCC also serves as a link  
 34 between the Mokelumne River and the Sacramento River for small craft, and is  
 35 used extensively by recreational boaters and fishermen whenever it is open. The  
 36 SWRCB D-1641 requires closure of the DCC gates for fisheries protection as  
 37 follows.

- 38 • From November through January, the DCC may be closed for up to 45 days  
 39 for fishery protection purposes.
- 40 • From February 1 through May 20, the gates are closed for fishery protection  
 41 purposes.
- 42 • The gates may also be closed for 14 days for fishery protection purposes  
 43 during the May 21 through June 15 time period.

1        *Implementation of 2009 National Marine Fisheries Service Biological*  
2        *Opinion*

3        The 2009 NMFS BO RPA requires Reclamation to close the DCC for additional  
4        days from October 1 through November 30, if fish are present; December 1  
5        through December 14, unless closures cause adverse impacts on water quality  
6        conditions; and December 15 through January 31.

7        *Temporary Agricultural Barriers*

8        The DWR South Delta Temporary Barrier Project (TBP) was initiated in 1991 to  
9        seasonally construct and demolish four rock barriers across south Delta channels,  
10       as described in Appendix 3A, No Action Alternative: Central Valley Project and  
11       State Water Project Operations. In various combinations, these barriers improve  
12       water levels and San Joaquin River salmon migration in the south Delta. The  
13       existing TBP consists of installation and removal of temporary rock barriers at the  
14       following locations.

- 15       • Middle River near Victoria Canal, about 0.5 miles south of the confluence of  
16       Middle River, Trapper Slough, and North Canal.
- 17       • Old River near Tracy, about 0.5 miles east of the DMC intake.
- 18       • Grant Line Canal near Tracy Boulevard Bridge, about 400 feet east of Tracy  
19       Boulevard Bridge.
- 20       • The head of Old River (HOR) at the confluence of Old River and San Joaquin  
21       River.

22       The barriers on Middle River, Old River near Tracy, and Grant Line Canal are  
23       flow control facilities designed to improve water levels for agricultural diversions  
24       and are in place during the irrigation season. The Head of Old River Barrier  
25       (HORB) is only installed from early September to November 30th when  
26       requested by CDFW if needed to improve dissolved oxygen in the San Joaquin  
27       River. The HORB also has been installed in the spring months to improve  
28       outmigrating conditions for juvenile salmonids.

29       The agricultural barriers at Middle River and Old River near Tracy can be  
30       installed as early as March 1 if the HORB is installed; and can be fully operated  
31       as early as April 1, if the HORB is installed, or May 15, if the HORB is not  
32       installed. From May 15 to May 31 (if the barrier at the head of Old River is  
33       removed), the barrier tide gates are tied open in Middle River and Old River near  
34       Tracy. After May 31, the barriers in Middle River, Old River near Tracy, and  
35       Grant Line Canal are permitted to be operational until they are completely  
36       removed by November 30.

37       *Major Delta Water Diversions*

38       Major water diversions in the Delta include the CVP Jones Pumping Plant, the  
39       SWP Banks Pumping Plant, the CVP Contra Costa Canal Pumping Plant at Rock  
40       Slough, the SWP Barker Slough Pumping Plant for the North Bay Aqueduct,  
41       Contra Costa Water District intakes on Old and Middle rivers, and over  
42       1,800 municipal and agricultural diversions for in-Delta use (DWR 2010b).



1 Delta channels have been modified to allow transport of Delta inflow to the  
2 diversions throughout the Delta, including the CVP and SWP south Delta intakes,  
3 and to reduce the effects of pumping on the direction of flows and salinity  
4 intrusion within the Delta. The conveyance of water from the Sacramento River  
5 southward through the Delta to the CVP and SWP south Delta intakes is aided by  
6 the Delta Cross Channel (DCC), a constructed, gated channel that conveys water  
7 from the Sacramento River to the Mokelumne River.

#### 8 *CVP Jones Pumping Plant*

9 The CVP Jones Pumping Plant, located about 5 miles north of Tracy, has a  
10 permitted diversion capacity of 4,600 cfs and sits at the end of a 2.5-mile long  
11 earth-lined intake channel that extends to Old River, as described in  
12 Appendix 3A, No Action Alternative: Central Valley Project and State Water  
13 Project Operations. Water diverted at the Jones Pumping Plant is discharged to  
14 the CVP Delta-Mendota Canal (DMC) which extends 117 miles to the Mendota  
15 Pool. Water from Jones Pumping Plant may be pumped from the DMC O'Neill  
16 Forebay, and then pumped into San Luis Reservoir by the Gianelli Pumping-  
17 Generating Plant. The DMC has an initial capacity of 4,600 cfs at Jones Pumping  
18 Plant that decreases to about 3,200 cfs at its terminus.

#### 19 *SWP Clifton Court and Banks Pumping Plant*

20 The SWP facilities in the southern Delta include the 31-TAF Clifton Court  
21 Forebay (CCF), located about 10 miles northwest of the city of Tracy, and the  
22 Banks Pumping Plant, as described in Appendix 3A, No Action Alternative:  
23 Central Valley Project and State Water Project Operations. Water is diverted  
24 from Old River into CCF that provides storage for off-peak pumping, moderates  
25 the effect of the pumps on the fluctuation of flow and stage in adjacent Delta  
26 channels, and collects sediment upstream of the Banks Pumping Plant and the  
27 California Aqueduct. Water flows from CCF to Banks Pumping Plant which  
28 conveys the water to California Aqueduct. The California Aqueduct transports  
29 water to O'Neill Forebay, from which water can be released to the San Luis  
30 Canal, a portion of the California Aqueduct jointly owned by the SWP and CVP;  
31 or pumped into San Luis Reservoir at the Gianelli Pumping Plant. Water from  
32 San Luis Reservoir is released into the San Luis Canal which ends near Kettleman  
33 City. From that location, the California Aqueduct continues to southern  
34 California.

35 The nominal capacity of the Banks Pumping Plant is 10,300 cfs. Permits issued  
36 by the USACE regulate the rate of diversion of water into CCF. This diversion  
37 rate is normally restricted to 6,680 cfs as a three-day average inflow to CCF and  
38 6,993 cfs as a one-day average inflow to CCF. CCF diversions may be greater  
39 than these rates between December 15 and March 15, when the inflow into CCF  
40 may be augmented by one-third of the San Joaquin River flow at Vernalis when  
41 those flows are equal to or greater than 1,000 cfs.

42 In 2000, the maximum diversion rate was increased for the months of July,  
43 August, and September through 2016 to recover export reductions that occurred  
44 due to actions taken to benefit fisheries resources. The expanded maximum

1 allowable daily diversion rate into CCF was increased from 13,870 acre-feet to  
2 14,860 acre-feet and three-day average diversions from 13,250 acre-feet to  
3 14,240 acre-feet (500 cfs per day equals 990 acre-feet per day). Implementation  
4 of this action is contingent on meeting the following conditions.

5 • The increased diversion rate will not result in greater annual SWP water  
6 supply allocations than would occur in the absence of the increased diversion  
7 rate. Water pumped due to the increased capacity will only be used to offset  
8 reduced diversions that occurred or will occur because of actions taken to  
9 benefit fisheries.

10 • Use of the increased diversion rate will be in accordance with all terms and  
11 conditions of existing BOs governing SWP operations.

12 • All three temporary agricultural barriers (Middle River, Old River near Tracy  
13 and Grant Line Canal) must be in place and operating when SWP diversions  
14 are increased.

15 Between July 1 and September 30, if the combined salvage of listed fish species  
16 reaches a level of concern, the relevant fish regulatory agencies will determine  
17 whether the 500 cfs increased diversion is or continues to be implemented.  
18 Variations to hydrologic conditions coupled with regulatory requirements may  
19 limit the ability of the SWP to fully utilize the proposed increased diversion rate.  
20 Also, facility capabilities may limit the ability of the SWP to fully utilize the  
21 increased diversion rate. The CCF radial gates are closed during critical periods  
22 of the ebb/flood tidal cycle to protect water levels relied upon by local agricultural  
23 water diverters in the south Delta area.

24 Banks Pumping Plant is operated to minimize the impact on power loads on the  
25 California electrical grid to the extent practical. Generally more pump units are  
26 operated during off-peak periods and fewer during peak periods with water stored  
27 temporarily in CCF. Because the installed capacity of the pumping plant is  
28 10,300 cfs, the plant can be operated to reduce power grid impacts by running all  
29 available pumps at night and fewer during the higher energy-demand hours.

#### 30 *SWP Barker Slough Pumping Plant*

31 The SWP Barker Slough Pumping Plant (BSPP) diverts water from Barker  
32 Slough into the SWP North Bay Aqueduct (NBA) for delivery to the Solano  
33 County Water Agency and the Napa County Flood Control and Water  
34 Conservation District, as described in Appendix 3A, No Action Alternative:  
35 Central Valley Project and State Water Project Operations. The current 162.5-cfs  
36 NBA intake with a positive barrier fish screen, located approximately 10 miles  
37 from the Sacramento River at the end of Barker Slough.

38 The NBA was designed to deliver up to 131,181 acre-feet per year SWP water  
39 supply contracts. However, the ability of BSPP to deliver this amount of water is  
40 limited due to several factors. The current BSPP pumping capacity is limited due  
41 to a thick bio-film growth on the interior of the NBA pipeline and a need to  
42 reduce the pressure in the pipeline within safe limits. Water quality in Barker  
43 Slough becomes degraded during winter and spring rainfall events due to elevated

1 levels of coliform bacteria, organic matter, turbidity, and pollutants from the  
 2 upstream watershed, which limits the period of time that the BSPP can be  
 3 operated each year. In 2008, USFWS issued a BO for preservation of delta smelt  
 4 that reduced the total BSPP annual diversion to 71 TAF. In 2009, CDFW issued  
 5 an incidental take permit for the preservation of longfin smelt that restricted  
 6 pumping rates during dry and critical dry years from January 15 to March 31.  
 7 As tidal wetlands in Suisun Marsh and Cache Slough and floodplains in the Yolo  
 8 Bypass are restored in accordance with the 2008 USFWS BO and 2009 NMFS  
 9 BO, respectively, Delta smelt, longfin smelt and salmonid populations in the  
 10 Barker Slough area are anticipated to increase which could further restrict  
 11 diversions at BSPP.

#### 12 *Contra Costa Water District Intakes*

13 The CCWD diverts approximately 127 TAF per year, including approximately  
 14 110 TAF under the CVP water service contract. The CCWD diverts water at the  
 15 CVP Rock Slough Intake, and at the CCWD Mallard Slough, Old River, and  
 16 Middle River (on Victoria Canal) intakes, as described in Appendix 3A, No  
 17 Action Alternative: Central Valley Project and State Water Project Operations.  
 18 Water diverted at Mallard Slough, Old River, and Middle River intakes occur  
 19 under water rights issued by the SWRCB to CCWD. Water diverted at Rock  
 20 Slough, Old River, and Middle River intakes occur under water rights issued by  
 21 the SWRCB to Reclamation for the CVP. All four intakes have positive barrier  
 22 fish screens. Water from the Old River and Middle River intakes can be diverted  
 23 to the 160-TAF Los Vaqueros Reservoir when Delta salinity is low. When Delta  
 24 salinity is high, typically in the fall months, CCWD blends low salinity water  
 25 from Los Vaqueros Reservoir with water from the Delta to meet CCWD water  
 26 quality goals. Water from Los Vaqueros Reservoir is also used by CCWD when  
 27 Delta diversions are restricted.

28 The Mallard Slough Intake, located on a channel that extends to Suisun Bay  
 29 (across from Chipps Island), can divert water into the CCWD conveyance system,  
 30 as described in Appendix 3A, No Action Alternative: Central Valley Project and  
 31 State Water Project Operations. Generally, less than 3 percent of CCWD  
 32 diversions are from Mallard Slough intake due to high salinity in Suisun Bay from  
 33 late spring until winter.

34 The CVP Rock Slough Intake, located about four miles southeast of Oakley, can  
 35 divert into the CVP Contra Costa Canal for conveyance into the CCWD water  
 36 system. CCWD may divert approximately 30 percent to 50 percent of its total  
 37 supply through the Rock Slough Intake depending upon salinity.

38 The Old River Intake, located on Old River near State Route 4, can divert water to  
 39 the CVP Contra Costa Canal or to the 160-TAF Los Vaqueros Reservoir.  
 40 Diversion to Los Vaqueros Reservoir storage is limited to 200 cfs by the terms of  
 41 the Los Vaqueros Project BOs and SWRCB Decision 1629 (D-1629), the water  
 42 right decision for the Los Vaqueros Project.

43 The Middle River Intake (formerly referred to as Alternative Intake Project),  
 44 located on Victoria Canal, diverts water to the Contra Costa Canal or to

1 Los Vaqueros Reservoir. Salinity at the Middle River Intake is generally lower in  
2 the late summer and fall than at the other intakes. Therefore, CCWD can decrease  
3 winter and spring diversions while still meeting water quality goals in the summer  
4 and fall through use of the Middle River Intake.

5 *Delta-Mendota Canal/California Aqueduct Intertie*

6 The DMC/California Aqueduct Intertie between the DMC and the California  
7 Aqueduct allows water to flow in both directions between the CVP and SWP  
8 conveyance facilities, as described in Appendix 3A, No Action Alternative:  
9 Central Valley Project and State Water Project Operations. The DMC/California  
10 Aqueduct Intertie achieves multiple benefits, including meeting current water  
11 supply demands, allowing for the maintenance and repair of the CVP Delta export  
12 and conveyance facilities, and providing operational flexibility to respond to  
13 emergencies. The DMC/California Aqueduct Intertie can be used under one of  
14 the following three different scenarios.

- 15 • Up to 467 cfs may be pumped from the DMC to the California Aqueduct to  
16 ease DMC conveyance constraints related to Jones Pumping Plant capacity  
17 limitations.
- 18 • Up to 467 cfs may be pumped from the DMC to the California Aqueduct to  
19 minimize impacts on water deliveries due to temporary restrictions in flow or  
20 water levels on the lower DMC (south of the Intertie) or the upper California  
21 Aqueduct (north of the Intertie) for system maintenance or due to an  
22 emergency shutdown.
- 23 • Up to 900 cfs may be conveyed from the California Aqueduct to the DMC  
24 using gravity flow to minimize impacts on water deliveries due to temporary  
25 restrictions in flow or water levels on the lower California Aqueduct  
26 (downstream of the Intertie) or the upper DMC (upstream of the Intertie) for  
27 system maintenance or for an emergency shutdown.

28 *San Luis Reservoir*

29 The 2.027-MAF San Luis Reservoir, formed by Sisk Dam, is jointly operated by  
30 Reclamation and DWR, with approximately 0.965 MAF used by the CVP and  
31 1.062 MAF used by the SWP. Water generally is diverted into San Luis  
32 Reservoir during late fall through early spring when irrigation water demands of  
33 CVP and SWP water users are low and are being met by Delta exports.

34 When all SWP demands are met, including diversion to storage facilities south of  
35 the Delta and Table A demands, and the Delta is in excess conditions, DWR  
36 would use available excess pumping capacity at Banks Pumping Plant to make  
37 excess water supplies, called Article 21 water under the long-term SWP water  
38 supply contracts, available to the SWP Contractors. Article 21 of the SWP water  
39 contracts describes the conditions under which water can be delivered in addition  
40 to the amounts specified in Table A of the contracts.

41 Unlike Table A water, which is an allocated annual SWP supply made available  
42 for scheduled delivery throughout the year, Article 21 water is an interruptible  
43 water supply made available only when certain conditions exist. However, while

1 not a dependable supply, Article 21 water is an important part of the total SWP  
 2 supplies provided to the SWP contractors. As with all SWP water, Article 21  
 3 water is pumped consistent with the existing terms and conditions of SWP water  
 4 rights permits, and is pumped from the Delta under the same environmental,  
 5 regulatory, and operational constraints that apply to all SWP operations.

6 Article 21 water is only available as long as the required conditions exist as  
 7 determined by DWR. As Article 21 deliveries are in addition to scheduled  
 8 Table A deliveries, this supply is delivered to SWP contractors that can, on  
 9 relatively short notice, put it to beneficial use. SWP contractors have used  
 10 Article 21 water to meet needs such as additional short-term irrigation demands,  
 11 replenishment of local groundwater basins, short-term substitution of local  
 12 supplies and storage in local surface reservoirs for later use by the requesting  
 13 SWP contractor, all of which provide SWP contractors with opportunities for  
 14 better water management through more efficient coordination with their local  
 15 water supplies. Allocated Article 21 water to a SWP contractor cannot be  
 16 transferred.

17 Article 21 water is typically offered to SWP contractors on a short-term (daily or  
 18 weekly) basis when all of the following conditions exist: the SWP share of San  
 19 Luis Reservoir is physically full, or projected to be physically full; other SWP  
 20 reservoirs south of the Delta are at their storage targets or the SWP conveyance  
 21 capacity to fill these reservoirs is maximized; the Delta is in excess condition;  
 22 current Table A and SWP operational demands are being fully met; and Banks  
 23 Pumping Plant has export capacity beyond that which is needed to meet all  
 24 Table A and other SWP operational demands. The increment of available unused  
 25 Banks Pumping Plant capacity is offered as the Article 21 delivery capacity.  
 26 SWP contractors then indicate their desired rate of delivery of Article 21 water.  
 27 DWR allocates the available Article 21 water in proportion to the requesting SWP  
 28 contractors annual Table A amounts if requests exceed the amount offered.  
 29 Deliveries can be discontinued at any time when SWP operations change. In the  
 30 modeling for Article 21, deliveries are only made in months when the SWP share  
 31 of San Luis Reservoir is full. In actual operations, Article 21 may be offered a  
 32 short period in advance of actual filling.

33 By April or May, demands from both agricultural and M&I SWP Contractors  
 34 usually exceed the pumping rate at Banks Pumping Plant, and releases from San  
 35 Luis Reservoir to the SWP facilities are needed to supplement the Delta pumping  
 36 at Banks Pumping Plant to meet SWP contractor demands for Table A water.

37 Historical water storage volumes and water storage elevations for San Luis  
 38 Reservoir for Water Years 2001 through 2012 are presented on Figures 5.44  
 39 and 5.45 (DWR 2013as, 2013at).

40 The San Luis Complex consists of the following.

- 41 • O'Neill Pumping-Generating Plant (CVP facility)
- 42 • William R. Gianelli Pumping-Generating Plant (joint CVP and SWP facility)
- 43 • San Luis Canal (joint CVP and SWP facility)

- 1 • Dos Amigos Pumping Plant (joint CVP and SWP facility)
- 2 • Coalinga Canal (CVP facility)
- 3 • Pleasant Valley Pumping Plant (CVP facility)
- 4 • Los Banos and Little Panoche Detention Dams and Reservoirs (joint CVP and
- 5 SWP facilities)

6 The CVP diverts water from San Luis Reservoir by the Pacheco Pumping Plant  
7 through the Pacheco Tunnel and Pacheco Conduit that conveys water to CVP  
8 water service contractors in Santa Clara and San Benito counties, as described in  
9 Appendix 3A, No Action Alternative: Central Valley Project and State Water  
10 Project Operations.

11 *Regulatory Limitations on Operations of Delta Water Diversions*

12 Operations of the CVP and SWP are implemented in accordance with SWRCB  
13 water rights and water quality decisions, including SWRCB D-1641, and the 2008  
14 USFWS BO and 2009 NMFS BO.

15 *Decision 1641*

16 The SWRCB adopted the 1995 Bay-Delta Plan on May 22, 1995, which became  
17 the basis of SWRCB D-1641 (adopted on December 29, 1999 and revised on  
18 March 15, 2000). The SWRCB D-1641 amended certain terms and conditions of  
19 the SWP and CVP water rights to include flow and water quality objectives to  
20 assure protection of beneficial uses in the Delta and Suisun Marsh. SWRCB also  
21 grants conditional changes to points of diversion for the CVP and SWP under  
22 SWRCB D-1641. The SWRCB adopted a revised Bay-Delta Plan on  
23 December 13, 2006; however, there were no changes to the beneficial uses or  
24 water quality objectives. The changes were primarily to improve readability and  
25 consistency to reflect current physical conditions and other regulations.

26 The requirements in SWRCB D-1641 address the standards for fish and wildlife  
27 protection, water supply water quality, and Suisun Marsh salinity. These  
28 objectives include specific Delta outflow requirements throughout the year,  
29 specific export limits in the spring, and export limits based on a percentage of  
30 estuary inflow throughout the year. The water quality objectives are designed to  
31 protect agricultural, municipal and industrial, and fishery uses, and vary  
32 throughout the year and by water year type. One of the requirements is to provide  
33 a minimum flow on the Sacramento River at Rio Vista in September through  
34 December of 3,000 to 4,500 cfs, depending on the month and water year type, to  
35 protect water quality for Delta water users.

36 The SWRCB D-1641 includes two Delta outflow criteria. A Net Delta Outflow  
37 Index is specified for all months in all water year types. A “spring X2” Delta  
38 outflow is specified from February through June to maintain freshwater and  
39 estuarine conditions in the western Delta to protect aquatic life. The criteria  
40 require operations of the CVP and SWP upstream reservoir releases and Delta  
41 exports in a manner that maintains a salinity objective at an “X2” location. X2  
42 refers to the horizontal distance from the Golden Gate Bridge up the axis of the

1 Delta estuary to where tidally averaged near-bottom salinity concentration of  
 2 2 parts of salt in 1,000 parts of water occurs; the X2 standard was established to  
 3 improve shallow water estuarine habitat in the months of February through June  
 4 and relates to the extent of salinity movement into the Delta (DWR, Reclamation,  
 5 USFWS and NMFS 2013). The location of X2 is important to both aquatic life  
 6 and water supply beneficial uses.

7 During February through June, SWRCB D-1641 also limits CVP and SWP  
 8 exports as compared to Delta inflows (also known as the “E/I Ratio”) to reduce  
 9 potential impacts on migrating salmon and spawning Delta smelt, Sacramento  
 10 Splittail, and Striped Bass.

11 Historical mean daily Delta outflow flows for Water Years 2001 through 2012 are  
 12 presented on Figure 5.46 (DWR 2013au).

13 Historical mean daily flows for Water Years 2001 through 2012 are presented on  
 14 Figures 5.46 through 5.52 for diversions at Jones, Banks, Barker Slough, and  
 15 Contra Costa Canal pumping plants; and Contra Costa Water District intakes at  
 16 Old River and Middle River (DWR 2013av, 2103aw, 2013ax, 2013ay, 2013az,  
 17 2013ba).

18 *Joint Point of Diversion*

19 SWRCB D-1641 authorized the SWP and CVP to jointly use both Jones and  
 20 Banks pumping plants in the southern Delta, with conditional limitations and  
 21 required response coordination plans (referred to as Joint Point of Diversion  
 22 [JPOD]). Use of JPOD is based on staged implementation and conditional  
 23 requirements for each stage of implementation. The stages of JPOD in  
 24 SWRCB D-1641 are:

- 25 • Stage 1—for water service to a group of CVP water service contractors (Cross  
 26 Valley contractors, San Joaquin Valley National Cemetery and Musco Family  
 27 Olive Company), and to recover export reductions implemented to benefit  
 28 fish;
- 29 • Stage 2—for any purpose authorized under the current CVP and SWP water  
 30 right permits; and
- 31 • Stage 3—for any purpose authorized, up to the physical capacity of the  
 32 diversion facilities.

33 In general, JPOD capabilities are used to accomplish four basic CVP and SWP  
 34 objectives:

- 35 • When wintertime excess pumping capacity becomes available during Delta  
 36 excess conditions and total CVP and SWP San Luis storage is not projected to  
 37 fill before the spring pulse flow period, the Project with the deficit in San Luis  
 38 storage may elect to pursue the use of JPOD capabilities;
- 39 • When summertime pumping capacity is available at Banks Pumping Plant and  
 40 CVP reservoir conditions can support additional releases, the CVP may elect  
 41 to use JPOD capabilities to enhance annual CVP south of Delta water  
 42 supplies;

- 1 • When summertime pumping capacity is available at Banks or Jones Pumping  
2 Plant to facilitate water transfers, JPOD may be used to further facilitate the  
3 water transfer; and
- 4 • During certain coordinated CVP and SWP operation scenarios for fishery  
5 entrainment management, JPOD may be used to shift CVP and SWP exports  
6 to the facility with the least fishery entrainment impact while minimizing  
7 export at the facility with the most fishery entrainment impact.

8 Each stage of JPOD has regulatory terms and conditions that must be satisfied in  
9 order to implement JPOD. All stages require a response plan to ensure water  
10 elevations in the southern Delta will not be lowered to the injury of local riparian  
11 water users (Water Level Response Plan); and a response plan to ensure the water  
12 quality in the southern and central Delta will not be significantly degraded  
13 through operations of the JPOD to the injury of water users in the southern and  
14 central Delta. Stage 2 has an additional requirement to complete an operations  
15 plan that will protect fish and wildlife and other legal users of water (Fisheries  
16 Response Plan). Stage 3 has an additional requirement to protect water levels in  
17 the southern Delta. All JPOD diversions under excess conditions in the Delta are  
18 junior to CCWD water right permits for the Los Vaqueros Project, and must have  
19 an X2 location west of certain compliance locations consistent with the 1993 Los  
20 Vaqueros BO for Delta smelt.

21 *Implementation of 2008 USFWS and 2009 NMFS Biological Opinions*

22 The 2008 USFWS BO and the 2009 NMFS BO restrict CVP and SWP diversions  
23 to reduce reverse flows in OMR. The 2008 USFWS BO also includes criteria for  
24 fall Delta outflow. The 2009 NMFS BO includes criteria for a San Joaquin River  
25 Inflow/Export (I:E) ratio.

26 *2008 USFWS BO OMR Criteria*

27 The 2008 USFWS BO restricts south Delta pumping to preserve certain OMR  
28 flows as prescribed in the following three actions.

- 29 • **Action 1:** to protect adult Delta smelt migration and entrainment. Limits  
30 exports so that the average daily OMR flow is no more negative  
31 than -2,000 cfs for a total duration of 14 days, with a 5-day running average  
32 no more negative than -2,500 cfs (within 25 percent).
  - 33 – December 1 to December 20 – Based upon turbidity data from turbidity  
34 stations (Prisoner’s Point, Holland Cut, and Victoria Canal) and salvage  
35 data from CVP and SWP fish handling facilities at the south Delta intakes,  
36 and other parameters important to the protection of delta smelt including,  
37 but not limited to, preceding conditions of X2, Fall Midwater Trawl  
38 Survey (FMWT), and river flows.
  - 39 – After December 20 – The action will begin if the three-day average  
40 turbidity at Prisoner’s Point, Holland Cut, and Victoria Canal exceeds  
41 12 nephelometric turbidity units (NTU).



- 1           – Triggers would be based on:
- 2           ○ Three-day average of 12 NTU or greater at all three turbidity stations;
- 3           or
- 4           ○ Three days of delta smelt salvage after December 20 at either facility
- 5           or cumulative daily salvage count that is above a risk threshold based
- 6           upon the “daily salvage index” approach reflected in a daily salvage
- 7           index value of greater than or equal to 0.5 (daily delta smelt salvage is
- 8           greater than one-half prior year FMWT index value). The window for
- 9           triggering Action 1 concludes when either off-ramp condition
- 10          described below is met. These off-ramp conditions may occur without
- 11          Action 1 ever being triggered. If this occurs, then Action 3 is
- 12          triggered, unless the Service concludes on the basis of the totality of
- 13          available information that Action 2 should be implemented instead.
- 14          – Action 1 offramps occur when water temperature reaches 12 degrees
- 15          Centigrade (°C) based on a three station daily mean at the temperature
- 16          stations: Mossdale, Antioch, and Rio Vista; or the onset of spawning
- 17          based upon the presence of spent females in the Spring Kodiak Trawl
- 18          Survey or at the CVP or SWP fish handling facilities.
- 19          • **Action 2:** to protect adult Delta smelt migration and entrainment. An action
- 20          implemented using an adaptive process to tailor protection to changing
- 21          environmental conditions after Action 1. As in Action 1, the intent is to
- 22          protect pre-spawning adults from entrainment and, to the extent possible, from
- 23          adverse hydrodynamic conditions. The range of net daily OMR flows will be
- 24          no more negative than -1,250 to -5,000 cfs. Depending on extant conditions,
- 25          specific OMR flows within this range are recommended by the USFWS Smelt
- 26          Working Group (SWG) from the onset of Action 2 through its termination.
- 27          The SWG would provide weekly recommendations based upon review of the
- 28          sampling data, from real-time salvage data at the CVP and SWP, and utilizing
- 29          most up-to-date technological expertise and knowledge relating population
- 30          status and predicted distribution to monitored physical variables of flow and
- 31          turbidity. The USFWS will make the final determination.
- 32          – Action 2 begins immediately following Action 1. If Action 1 is not
- 33          implemented based upon triggers, the SWG may recommend a start date
- 34          for Action 2.
- 35          – Action 2 is suspended when whenever a three-day flow average is greater
- 36          than or equal to 90,000 cfs in Sacramento River at Rio Vista and
- 37          10,000 cfs in San Joaquin River at Vernalis. Once such flows have
- 38          abated, the OMR flow requirements of Action 2 are restarted.
- 39          – Offramps for Action 2 are related to water temperature reaches 12°C
- 40          based on a three-station daily average at the temperature stations: Rio
- 41          Vista, Antioch, and Mossdale; or the onset of spawning based upon the
- 42          presence of a spent female in the Spring Kodiak Trawl Survey or at the
- 43          CVP or SWP fish handling facilities.

- 1 • **Action 3:** to protect larval and juvenile Delta Smelt. Minimize the number of  
2 larval delta smelt entrained at the facilities by managing the hydrodynamics in  
3 the Central Delta flow levels pumping rates spanning a time sufficient for  
4 protection of larval delta smelt. Net daily OMR flow will be no more  
5 negative than -1,250 to -5,000 cfs based on a 14-day running average with a  
6 simultaneous 5-day running average within 25 percent of the applicable  
7 requirement for OMR. Depending on extant conditions, specific OMR flows  
8 within this range are recommended by the SWG from the onset of Action 3  
9 through its termination.
- 10 – Action 3 begins when temperature reaches 12°C based on a three-station  
11 average at the temperature stations: Mossdale, Antioch, and Rio Vista; or  
12 onset of spawning based upon the presence of a spent female in the Spring  
13 Kodiak Trawl Survey or at the CVP or SWP fish handling facilities.
- 14 – Offramps for Action 3 would occur by June 30; or if water temperature  
15 reaches a daily average of 25°C for three consecutive days 10 at Clifton  
16 Court Forebay.

17 *2009 NMFS BO OMR Criteria*

18 The 2009 NMFS BO includes OMR criteria to protect juvenile salmonids during  
19 winter and spring emigration downstream into the San Joaquin River, and to  
20 increase survival of salmonids and green sturgeon entering the San Joaquin River  
21 from Georgiana Slough and the lower Mokelumne River by reducing the potential  
22 for entrainment at the south Delta intakes. The action is implemented from  
23 January 1 through June 15, and reduces exports, as necessary, to limit negative  
24 flows to -2,500 to -5,000 cfs in Old and Middle Rivers, depending on the presence  
25 of salmonids. The reverse flow is managed within this range to reduce flows  
26 toward the pumps during periods of increased salmonid presence. The negative  
27 flow objective within the range is determine based on the decision tree presented  
28 in Table 5.8.

1 **Table 5.8 Old and Middle River Criteria under the 2009 NMFS BO**

Date	Action Triggers	Action Responses
January 1 – June 15	January 1 – June 15	-5,000 cfs
January 1 – June 15 First Stage Trigger (increasing level of concern)	Daily SWP/CVP older juvenile loss density (fish per TAF): 1) is greater than incidental take limit divided by 2000, with a minimum value of 2.5 fish per TAF, or 2) daily loss is greater than daily measured fish density divided by 12 TAF, or 3) Coleman National Fish Hatchery coded wire tag late-fall run or Livingston Stone National Fish Hatchery coded wire tag winter-run cumulative loss greater than 0.5%, or 4) daily loss of wild steelhead (intact adipose fin) is greater than the daily measured fish density divided by 12 TAF.	-3,500 to -5,000 cfs
January 1 – June 15 Second Stage Trigger (analogous to high concern level)	Daily SWP/CVP older juvenile loss density (fish per TAF) is: 1) greater than incidental take limit divided by 1000, with a minimum value of 2.5 fish per TAF, or 2) daily loss is greater than daily fish density divided by 8 TAF, or 3) Coleman National Fish Hatchery coded wire tag late-fall run or Livingston Stone National Fish Hatchery coded wire tag winter-run cumulative loss greater than 0.5%, or 4) daily loss of wild steelhead (intact adipose fin) is greater than the daily measured fish density divided by 8 TAF.	-2,500 to -5,000 cfs
End of Triggers	Continue action until June 15 or until average daily water temperature at Mossdale is greater than 72°F (22°C) for 7 consecutive days (1 week), whichever is earlier.	No OMR restriction

2 *2009 NMFS BO San Joaquin River Inflow: Export Ratio*

3 The 2009 NMFS BO requires south Delta exports to be reduced during April and  
4 May to protect emigrating steelhead from the lower San Joaquin River into the  
5 south Delta channels and intakes. The I:E ratio from April 1 through May 31  
6 specifies that Reclamation operates the New Melones Reservoir to maintain the  
7 2009 NMFS BO flow schedule for the Stanislaus River at Goodwin in accordance  
8 with Action III.1.3 and Appendix 2-E of the 2009 NMFS BO. In addition, the  
9 CVP and SWP pumps are operated to meet the ratios based upon a 14-day  
10 running average, as summarized in Table 5.9.

1 **Table 5.9 Inflow:Export Ratios under the 2009 NMFS BO**

San Joaquin Valley Classification	San Joaquin River flow at Vernalis (cfs):CVP/SWP combined export ratio (cfs)
Critically dry	1:1
Dry	2:1
Below normal	3:1
Above normal	4:1
Wet	4:1
Vernalis flow equal to or greater than 21,750 cfs	Unrestricted exports until flood recedes below 21,750 cfs.

2 During multiple dry years, the ratio will be limited to 1:1 if the New Melones  
 3 Index related to storage is less than 1,000 TAF and the sum of the “indicator”  
 4 numbers established for water year classifications in SWRCB D-1641 (based on  
 5 the San Joaquin Valley 60-20-20 Water Year Classification in SWRCB D-1641)  
 6 is greater than 6 for the past two years and the current year. The indicator  
 7 numbers are 1 for a critically dry year, 2 for a dry year, 3 for a below normal year,  
 8 4 for an above normal year, and 5 for a wet year.

9 Implementation of the I:E ratio under all conditions would allow a minimum  
 10 pumping rate of 1,500 cfs to meet public health and safety needs of communities  
 11 that solely rely upon water diverted from the CVP and SWP pumping plants.

12 *2008 USFWS BO Fall X2 Criteria*

13 The 2008 USFWS BO also includes an additional Delta salinity requirement in  
 14 September and October in wet and above normal water years. This new  
 15 requirement is frequently referred to as “Fall X2.” The action requires that  
 16 2 Practical Salinity Units (psu) is maintained at 74 kilometers (km) during wet  
 17 years, and 81 km during above normal water years when the preceding year was  
 18 wet or above normal based upon the Sacramento Basin 40-30-30 index in the  
 19 SWRCB D-1641. In November of these years, there is no specific X2  
 20 requirement; however, there is a requirement that all inflow into SWP and CVP  
 21 upstream reservoirs be conveyed downstream to augment Delta outflow to  
 22 maintain X2 at the locations in September and October. If storage increases  
 23 during November under this action, the increased storage volume is to be released  
 24 in December in addition to the requirements under SWRCB D-1641 net Delta  
 25 Outflow Index.

26 *Coordinated Operation Agreement*

27 The CVP and SWP are operated in a coordinated manner in accordance with  
 28 Public Law 99-546 (October 27, 1986), directing the Secretary to execute the  
 29 COA. The CVP and SWP are also operated under the SWRCB decisions and  
 30 water right orders related to the CVP’s and SWP’s water right permits and  
 31 licenses to appropriate water by diverting to storage, by directly diverting to use,  
 32 or by re-diverting releases from storage later in the year or in subsequent years.

1 The CVP and SWP are permitted by SWRCB to store water, divert water and re-  
 2 divert CVP and SWP water that has been stored in upstream reservoirs. The CVP  
 3 and SWP have built water storage and water delivery facilities in the Central  
 4 Valley to deliver water supplies to CVP and SWP contractors, including senior  
 5 water users. The CVP's and SWP's water rights are conditioned by the SWRCB  
 6 to protect the beneficial uses of water within the watersheds.

7 As conditions of the water right permits and licenses, SWRCB requires the CVP  
 8 and SWP to meet specific water quality objectives within the Delta. Reclamation  
 9 and DWR coordinate operation of the CVP and SWP, pursuant to the COA, to  
 10 meet these and other operating requirements. The COA is an agreement between  
 11 the Federal government and the State of California for the coordinated operation  
 12 of the CVP and SWP. The agreement suspended a 1960 agreement and  
 13 superseded annual coordination agreements that had been implemented following  
 14 construction of the SWP.

15 *Obligations for In-Basin Uses*

16 In-basin uses are defined in the COA as legal uses of water in the Sacramento  
 17 Basin, including the water required under the SWRCB D-1485.

18 Balanced water conditions are defined in the COA as periods when it is mutually  
 19 agreed that releases from upstream reservoirs plus unregulated flows  
 20 approximately equals the water supply needed to meet Sacramento Valley  
 21 in-basin uses plus exports. Excess water conditions are periods when it is  
 22 mutually agreed that releases from upstream reservoirs plus unregulated flow  
 23 exceed Sacramento Valley in-basin uses plus exports.

24 During excess water conditions, sufficient water is available to meet all beneficial  
 25 needs, and the CVP and SWP are not required to make additional releases. In  
 26 excess water conditions, water accounting is not required and some of the excess  
 27 water is available to CVP water contractors, SWP water contractors, and users  
 28 located upstream of the Delta. However, during balanced water conditions, CVP  
 29 and SWP share the responsibility in meeting in-basin uses.

30 When water must be withdrawn from reservoir storage to meet in-basin uses,  
 31 75 percent of the responsibility is borne by the CVP and 25 percent is borne by  
 32 the SWP. When unstored water is available for export (i.e., Delta exports exceed  
 33 storage withdrawals while balanced water conditions exist), the sum of CVP  
 34 stored water, SWP stored water, and the unstored water for export is allocated  
 35 55/45 to the CVP and SWP, respectively. The percentages and ratios included in  
 36 the COA were derived from negotiations between Reclamation and DWR for  
 37 SWRCB D-1485 standards and CVP and SWP annual supplies existing at the  
 38 time and projected into the future. Reclamation and DWR have continued to  
 39 apply these ratios as new SWRCB standards and other statutory and regulatory  
 40 changes have been adopted.

41 *Accounting and Coordination of Operations*

42 Reclamation and DWR coordinate on a daily basis to determine target Delta  
 43 outflow for water quality, reservoir release levels necessary to meet in-basin

1 demands, schedules for joint use of the San Luis Unit facilities, and for the use of  
2 each other's facilities for pumping and wheeling. During balanced water  
3 conditions, daily water accounting is maintained for the CVP and SWP  
4 obligations. This accounting allows for flexibility in operations and avoids the  
5 necessity of daily changes in reservoir releases that originate several days' travel  
6 time from the Delta.

7 The accounting language of the COA provides the mechanism for determining the  
8 responsibility of each project for Delta outflow influenced standards; however,  
9 real-time operations dictate actions. For example, conditions in the Delta can  
10 change rapidly. Weather conditions combined with tidal action can quickly affect  
11 Delta salinity conditions, and therefore, the Delta outflow required to maintain  
12 standards. If, in this circumstance, it is decided the reasonable course of action is  
13 to increase upstream reservoir releases, then the response may be to increase  
14 Folsom Reservoir releases first because the released water will reach the Delta  
15 before flows released from other CVP and SWP reservoirs. Lake Oroville water  
16 releases require about three days to reach the Delta, while water released from  
17 Shasta Lake requires five days to travel from Keswick Reservoir to the Delta. As  
18 water from the other reservoirs arrives in the Delta, Folsom Reservoir releases can  
19 be adjusted downward. Any imbalance in meeting each project's initial shared  
20 obligation would be captured by the COA accounting.

21 Reservoir release changes are one means of adjusting to changing in-basin  
22 conditions. Increasing or decreasing project exports can also immediately achieve  
23 changes to Delta outflow. As with changes in reservoir releases, imbalances in  
24 meeting the CVP and SWP initial shared obligations are captured by the COA  
25 accounting.

26 The duration of balanced water conditions varies from year to year. Some very  
27 wet years have had no periods of balanced conditions, while very dry years may  
28 have had long continuous periods of balanced conditions, and still other years  
29 may have had several periods of balanced conditions interspersed with excess  
30 water conditions.

### 31 *Joint Facilities in Suisun Marsh*

32 The Suisun Marsh Preservation Agreement (SMPA) requires DWR and  
33 Reclamation to meet salinity standards, sets a timeline for implementing the Plan  
34 of Protection, and delineates monitoring and mitigation requirements in  
35 accordance with SWRCB D-1641 to implement and operate physical facilities in  
36 the Marsh; and management of Delta outflow.

### 37 *Suisun Marsh Salinity Control Gates*

38 The Suisun Marsh Salinity Control Gates (SMSCG) are located on Montezuma  
39 Slough about two miles downstream from the confluence of the Sacramento and  
40 San Joaquin Rivers, near Collinsville. The objective of SMSCG operation is to  
41 decrease the salinity of the water in Montezuma Slough by restricting the flow of  
42 higher salinity water from Grizzly Bay into Montezuma Slough during incoming  
43 tides and retaining lower salinity Sacramento River water from the previous ebb  
44 tide. Operation of the gates in this fashion lowers salinity in Suisun Marsh

1 channels and results in a net movement of water from east to west. When Delta  
2 outflow is low to moderate and the gates are not operating, tidal flow past the gate  
3 is approximately 5,000 to 6,000 cfs while the net flow is near zero. When  
4 operated, flood tide flows are arrested while ebb tide flows remain in the range of  
5 5,000 to 6,000 cfs. The net flow in Montezuma Slough becomes approximately  
6 2,500 to 2,800 cfs. The USACE permit for operating the SMSCG requires that it  
7 be operated between October and May only when needed to meet Suisun Marsh  
8 salinity standards. Historically, the gate has been operated as early as October 1,  
9 although in some years (e.g., 1996) the gate was not operated at all. When the  
10 channel water salinity decreases sufficiently below the salinity standards, or at the  
11 end of the control season, CVP and SWP provide unrestricted movement through  
12 Montezuma Slough.

13 The approximately 2,800 cfs net flow induced by SMSCG operation is effective  
14 at moving the salinity downstream in Montezuma Slough. Salinity is reduced by  
15 roughly 100 percent at Belden's Landing, and by lesser amounts farther west  
16 along Montezuma Slough. At the same time, the salinity field in Suisun Bay  
17 moves upstream as net Delta outflow (measured nominally at Chipps Island) is  
18 reduced by gate operation. Net outflow through Carquinez Strait is not affected.  
19 The SMSCG are operated during the salinity control season, which spans from  
20 October to May.

#### 21 *Roaring River Distribution System*

22 The Roaring River Distribution System (RRDS) was constructed during 1979 and  
23 1980 to provide lower salinity water to 5,000 acres of private and 3,000 acres of  
24 CDFW-managed wetlands on Simmons, Hammond, Van Sickle, Wheeler, and  
25 Grizzly islands.

26 The RRDS includes a 40-acre intake pond that supplies water to Roaring River  
27 Slough. Motorized slide gates in Montezuma Slough and flap gates in the pond  
28 control flows through the culverts into the pond. A manually operated flap gate  
29 and flashboard riser are located at the confluence of Roaring River and  
30 Montezuma Slough to allow drainage back into Montezuma Slough for  
31 controlling water levels in the distribution system and for flood protection.  
32 DWR owns and operates this drain gate to ensure the Roaring River levees are  
33 not compromised during extremely high tides.

34 Water is diverted through a bank of eight 60-inch-diameter culverts equipped with  
35 fish screens into the Roaring River intake pond on high tides to raise the water  
36 surface elevation in RRDS above the adjacent managed wetlands. Managed  
37 wetlands north and south of the RRDS receive water, as needed, through publicly  
38 and privately owned turnouts on the system.

#### 39 *Morrow Island Distribution System*

40 The Morrow Island Distribution System (MIDS) was constructed in 1979 and  
41 1980 in the southwestern Suisun Marsh to channel drainage water from the  
42 adjacent managed wetlands for discharge into Suisun Slough and Grizzly Bay.  
43 This approach increases circulation and reduces salinity in Goodyear Slough.

1 The MIDS is used year-round, but most intensively from September through June.  
2 When managed wetlands are filling and circulating, water is tidally diverted from  
3 Goodyear Slough just south of Pierce Harbor through three 48-inch culverts.  
4 Drainage water from Morrow Island is discharged into Grizzly Bay by way of the  
5 C-Line Outfall (two 36-inch culverts) and into the mouth of Suisun Slough by  
6 way of the M-Line Outfall (three 48-inch culverts), rather than back into  
7 Goodyear Slough. This helps prevent increases in salinity due to drainage water  
8 discharges into Goodyear Slough. The M-Line ditch is approximately 1.6 miles  
9 long and the C-Line ditch is approximately 0.8 miles long.

10 **5.3.2.3 CVP and SWP Conveyance Facilities Downstream of San Luis**  
11 **Reservoir**

12 Water is released from the San Luis Reservoir into the lower portion the  
13 California Aqueduct that extends to Lake Perris in Riverside County and delivers  
14 water to the San Joaquin Valley, Central Coast, and southern California. The first  
15 reach of the California Aqueduct, the San Luis Canal, is jointly owned by the  
16 SWP and CVP and extends from San Luis Reservoir to Kettleman City. This  
17 reach includes Dos Amigos, Buena Vista, Teerink, and Chrisman pumping plants.

18 Near Kettleman City, water is diverted into the SWP Coastal Branch Aqueduct to  
19 serves agricultural areas west of the California Aqueduct and communities in  
20 San Luis Obispo and Santa Barbara counties.

21 The California Aqueduct continues into southern California through the  
22 Edmonston Pumping Plant, located at the foot of the Tehachapi Mountains, that  
23 raises the water 1,926 feet into approximately 8 miles of tunnels and siphons that  
24 convey water into Antelope Valley. At that location, the California Aqueduct  
25 divides into two branches; the East Branch and the West Branch.

26 The East Branch conveys water through the Tehachapi East Afterbay, Alamo  
27 Powerplant, Pearblossom Pumping Plant, and Mojave Siphon Powerplant into  
28 Silverwood Lake in the San Bernardino Mountains, which stores 73,000 acre-feet  
29 of water. From Silverwood Lake, water flows through the San Bernardino Tunnel  
30 into Devil Canyon Powerplant to Lake Perris. Lake Perris, located near the City  
31 of Riverside, provides up to 131,500 acre-feet of storage, and serves as a  
32 regulatory and emergency water supply facility for the East Branch. The Phase I  
33 of the East Branch Extension was completed in 2003 and conveys water to San  
34 Gorgonio Pass Water Agency and the eastern portion of the San Bernardino  
35 Valley Municipal Water District.

36 The West Branch conveys water through Oso Pumping Plant, Quail Lake, Lower  
37 Quail Canal, and William E. Warne Powerplant into Pyramid Lake in Los  
38 Angeles County. Water from Pyramid Lake is conveyed through the Angeles  
39 Tunnel, Castaic Powerplant, Elderberry Forebay, and Castaic Lake. Castaic Lake,  
40 located north of the City of Santa Clarita, provides 324,000 acre-feet of storage,  
41 and is a regulatory and emergency water supply facility for the West Branch. The  
42 Castaic Powerplant is owned and operated by the Los Angeles Department of  
43 Water and Power.



1 **5.3.2.4 Non-CVP and SWP Reservoirs that Store CVP and SWP Water**

2 The CVP and SWP water is delivered to water agencies. Some of those water  
3 agencies store the water in regional and local reservoirs. These reservoirs  
4 frequently store non-CVP and SWP water supplies, including local runoff or  
5 water diverted under separate water rights or contracts. The capacities of these  
6 reservoirs are listed in Tables 5.5, 5.6, and 5.7.

7 In the San Francisco Bay Area Region, CVP water is stored in the Contra Costa  
8 Water District Los Vaqueros Reservoir and the East Bay Municipal Utility  
9 District Upper San Leandro, San Pablo, Briones, and Lafayette reservoirs and  
10 Lake Chabot. The Los Vaqueros Reservoir, as previously described, also stores  
11 water diverted from the Delta under separate water rights. The East Bay  
12 Municipal Utility District reservoirs primarily store water diverted under water  
13 rights on the Mokelumne River.

14 In the Central Coast Region, a portion of the SWP water supply diverted in the  
15 Coastal Branch can be stored in Cachuma Lake for use by southern Santa Barbara  
16 County communities. Cachuma Lake is a facility owned and operated by  
17 Reclamation in Santa Barbara County as part of the Cachuma Project (not  
18 the CVP).

19 In the Southern California Region, SWP water is stored in the Metropolitan Water  
20 District of Southern California's Diamond Valley Lake and Lake Skinner; United  
21 Water Conservation District's Lake Piru; City of Escondido's Dixon Lake; City  
22 of San Diego's San Vicente, El Capitan, Lower Otay, Hodges, and Murray  
23 reservoirs; Helix Water District's Lake Jennings; Sweetwater Authority's  
24 Sweetwater Reservoir; and San Diego County Water Authority's Olivenhain  
25 Reservoir. There are future plans to expand local and regional water surface  
26 water storage.

27 **5.3.3 Water Supplies Used by Central Valley Project and State**  
28 **Water Project Water Users**

29 The CVP and SWP water supplies are the only water supplies available to some  
30 water users, many of the CVP Sacramento River Settlement Contractors,  
31 communities near Redding (Centerville, Clear Creek, and Shasta community  
32 services districts; Shasta County Water Agency), communities in the San Joaquin  
33 Valley (cities of Avenal, Coalinga, and Huron), and some communities served by  
34 the Antelope Valley-East Kern Water Agency. Other CVP and SWP water users  
35 rely upon other surface water supplies and groundwater. However, when the CVP  
36 and SWP water supplies are limited due to climate conditions and hydrology, the  
37 other surface water supplies are also limited.

38 Several CVP and SWP water users also rely upon other imported water supplies,  
39 including water from Solano Project (used by the Solano County Water Agency),  
40 San Francisco Public Utilities Commission (used by portions of the service areas  
41 of Alameda County Water District, Santa Clara Valley Water District, and Zone 7  
42 Water Agency), and the Colorado River (used by portions of the service area of  
43 the Metropolitan Water District of Southern California and Coachella Valley  
44 Water District). These surface water supplies are also subject to reductions due to

1 hydrologic conditions. In the case of water users that rely upon Colorado River  
2 water supplies, Delta water is used to dilute the salts and trace elements  
3 (e.g., selenium) in the Colorado River water in addition to providing direct water  
4 supplies (Reclamation 2012).

5 In response to recent reductions in CVP and SWP water supply reliability, water  
6 agencies have been improving regional and local water supply reliability through  
7 enhanced water conservation efforts, wastewater effluent and stormwater  
8 recycling, construction of surface water and groundwater storage facilities, and  
9 construction of desalination treatment plants for brackish water sources and ocean  
10 water sources. In addition, many agencies have constructed conveyance facilities  
11 to allow sharing of water supplies between communities, including the recent Bay  
12 Area Regional Water Supply Reliability project that provided conveyance  
13 opportunities between several CVP and SWP water users in the San Francisco  
14 Bay Area Region.

15 Water conservation is an integral part of water management in the study area.  
16 Water use efficiency programs and initiatives reduce the need for more expensive  
17 water supplies by facilitating the efficient use of existing water supplies. For  
18 example, a cost-effective component of many water plans is to reduce water use  
19 through educational tools that include commercial and residential guidance for  
20 water efficient landscapes, water use calculators for agricultural and municipal  
21 users, and conservation websites. All of these efforts are implemented to meet the  
22 statewide goals to reduce municipal per capita water use by 20 percent by 2020  
23 and to optimize agricultural water use efficiency.

24 Water transfers also are an integral part of water management. Historically, water  
25 transfers primarily were in-basin transfers (e.g., Sacramento Valley water seller to  
26 Sacramento Valley water user) (Reclamation 2013b; DWR, Reclamation, USFWS  
27 and NMFS 2013). However, between 2001 and 2012, water transfers from the  
28 Sacramento Valley to the areas located south of the Delta of up to 298,806 acre-  
29 feet occurred (not including water transfers under the Environmental Water  
30 Account Program in the early 2000s) (DWR, Reclamation, USFWS and NMFS  
31 2013). These transfers occurred in drier years. In the 2012 and 2013, the  
32 following types of water transfers occurred (DWR and SWRCB 2014).

- 33 • Water transfers involving CVP and SWP water:
  - 34 – 2012: 47,420 acre-feet of water transfers (43 percent were between
  - 35 agricultural water users, 36 percent were between municipal water users,
  - 36 and 21 percent were between agricultural and municipal water users).
  - 37 – 2013: 63,790 acre-feet of water transfers (28 percent were between
  - 38 agricultural water users, and 72 percent were between agricultural and
  - 39 municipal water users).
- 40 • Water transfers involving non-CVP and SWP water:
  - 41 – 2012: 188,074 acre-feet of water transfers (72 percent were between
  - 42 agricultural water users, 14 percent were from agricultural water users to

1 wildlife refuges, and 14 percent were between agricultural and municipal  
2 water users).

3 – 2013: 268,370 acre-feet of water transfers (72 percent were between  
4 agricultural water users, 1 percent were from agricultural water users to  
5 wildlife refuges, and 27 percent were between agricultural and municipal  
6 water users).

7 Until recently, most of the water transfers extended for one or two years. In 2008,  
8 one of the first long-term water transfer agreements was approved by the SWRCB  
9 for the Lower Yuba River Accord. The plan was designed to protect and enhance  
10 fisheries resources in the Lower Yuba River, increase local water supply  
11 reliability, provide DWR with increased operational flexibility for protection of  
12 Delta fisheries resources, and provide added dry-year water supplies to CVP and  
13 SWP water users, as described in Appendix 3A, No Action Alternative: Central  
14 Valley Project and State Water Project Operations. In 2013, Reclamation  
15 approved an overall program for a 25-year period (2014 to 2038) to transfer up to  
16 150,000 acre-feet per year of water from the San Joaquin River Exchange  
17 Contractors Water Authority to DOI for refuge water supplies or CVP and SWP  
18 water users (Reclamation 2013b). Reclamation is currently evaluating a long-  
19 term water transfer program (2015 to 2024) between water sellers in the  
20 Sacramento Valley and water users located in the San Francisco Bay Area and  
21 south of the Delta (Reclamation 2014b).

#### 22 **5.3.4 Surface Water Resources and Water Supplies During** 23 **Droughts**

24 Drought is a gradual phenomenon and can best be thought of as a condition of  
25 water shortage for a particular user in a particular location. Although persistent  
26 drought may be characterized as an emergency, it differs from typical emergency  
27 events. Most natural disasters, such as floods or forest fires, occur relatively  
28 rapidly and afford little time for preparing for disaster response. Droughts occur  
29 slowly, over a period of time. There is no universal definition of when a drought  
30 begins or ends. Impacts of drought are typically felt first by those most reliant on  
31 annual rainfall -- ranchers engaged in dryland grazing, rural residents relying on  
32 wells in low-yield rock formations, or small water systems lacking a reliable  
33 water source. Criteria used to identify statewide drought conditions do not  
34 address these localized impacts. Drought impacts increase with the length of a  
35 drought, as carry-over supplies in reservoirs are depleted and water levels in  
36 groundwater basins decline.

37 Measurements of California water conditions cover only a small slice of the past.  
38 Widespread collection of rainfall and streamflow information began around the  
39 turn of the 20th century. During our period of recorded hydrology, the most  
40 significant statewide droughts occurred during 1928-34, 1976-77, 1987-92, and  
41 2007-09. A significant regional drought occurred in parts of Southern California  
42 in 1999-2002. Historical data combined with estimates created from indirect  
43 indicators such as tree rings suggest that the 1928-34 event may have been the  
44 driest period in the Sacramento River watershed since about the mid-1550s.

1 **5.3.4.1 Prior General Drought Responses**

2 Previous droughts that have occurred throughout California's history are  
3 constantly shaping and innovating the ways in which DWR and Reclamation  
4 handle both public health standards and urban and agricultural water demand, as  
5 well as protecting the Delta ecosystem and its inhabitants. The most notable  
6 droughts in recent history are the droughts that occurred in 1976-77 and 1987-92.  
7 The climactic situation helped shape legislation and stressed the importance of  
8 maintaining water supplies for all water users.

9 The impacts of a dry hydrology in 1976 were mitigated by reservoir storage and  
10 groundwater availability. The immediate succession of an even drier 1977,  
11 however, set the stage for widespread impacts. In 1977 CVP agricultural water  
12 contractors received 25 percent of their allocations, municipal contractors  
13 received 25 to 50 percent, and the exchange contractors received 75 percent.  
14 SWP agricultural contractors received 40 percent of their allocations and urban  
15 contractors received 90 percent.

16 Managing Delta salinity is a major challenge, given the competing needs to  
17 preserve critical carry-over storage and to release water from storage to meet  
18 Bay-Delta water quality standards. In February 1977, the SWRCB adopted an  
19 interim water quality control plan to modify Delta standards to allow the SWP to  
20 conserve storage in Lake Oroville. As extremely dry conditions continued that  
21 spring, the SWRCB subsequently adopted an emergency regulation superseding  
22 its interim water quality control plan, temporarily eliminating most water quality  
23 standards and forbidding the SWP to export stored water. As a further measure to  
24 conserve reservoir storage, DWR constructed temporary facilities (i.e., rock  
25 barriers, new diversions for Sherman Island agricultural water users, and facilities  
26 to provide better water quality for duck clubs in Suisun Marsh) in the Delta to  
27 help manage salinity with physical, rather than hydraulic, approaches.

28 In 1977, SWP and CVP contractors used water exchanges to respond to drought.  
29 One of the largest exchanges involved 435,000 acre-feet of SWP contract water  
30 made available by Metropolitan Water District of Southern California and three  
31 other SWP Southern California water contractors for use by San Joaquin Valley  
32 irrigators and urban agencies in the San Francisco Bay area.

33 During the 1987-92 drought, the state's 1990 population was close to 80 percent  
34 of present amounts and irrigated acreage was roughly the same as that of the  
35 present, but the institutional setting for water management differed significantly.  
36 Delta regulatory constraints affecting CVP and SWP operations were based on  
37 SWRCB D-1485, which had taken effect in 1978 immediately following the  
38 1976-77 drought. In addition to SWRCB D-1485 requirements on CVP and SWP  
39 operations in the Delta, other operational constraints included water temperature  
40 standards imposed by the SWRCB through Water Rights Orders 90-5 and 91-01  
41 for portions of the Sacramento and Trinity rivers. As part of managing salinity  
42 during the drought, DWR installed temporary barriers at two South Delta  
43 locations (along Middle River and in Old River near the Delta-Mendota Canal  
44 intake) to improve water levels and water quality/water circulation for  
45 agricultural diverters.

#### 1 **5.3.4.2 Recent General Drought Response**

2 As a result of more recent drought conditions, California Governor Edmund G.  
3 Brown issued a Drought Emergency Proclamation on January 17, 2014 that is  
4 effective through May 31, 2016. This proclamation directs the SWRCB to,  
5 among other things, consider petitions, such as Temporary Urgency Change  
6 Petitions (TUCP), to modify requirements for reservoir releases or diversion  
7 limitations that were established to implement a water quality control plan.

8 On January 29, 2014, Reclamation and DWR sought a temporary modification to  
9 their water rights permits and licenses through a TUCP, allowing the CVP and  
10 SWP to reduce Delta outflow and thus conserve upstream storage for later use.  
11 The resultant January 31, 2014, Governor's Executive Order (January Order) also  
12 allowed the projects to pump at a minimum level (up to a total of 1,500 cfs) to  
13 supply essential public health and safety needs when Delta outflow was lower  
14 than would typically allow such pumping. Reclamation and DWR convened a  
15 Real Time Drought Operations Management Team (RTDOMT) comprised of  
16 representatives from Reclamation, DWR, USFWS, NMFS, CDFW, and SWRCB  
17 to discuss more flexible operations of the projects while protecting beneficial  
18 uses. Throughout 2014, the federal and state fish and wildlife agencies worked in  
19 close coordination with Reclamation and DWR to receive, analyze, and respond  
20 to the CVP and SWP operators' requests for additional operational flexibility  
21 while still remaining within the boundaries of the applicable environmental laws  
22 and regulations.

23 The January Order was amended several times to allow project operators to pump  
24 at higher levels to capture storm run-off. The January Order was also extended  
25 and/or amended to modify SWRCB D-1641 Delta Outflow requirements. The  
26 *CVP and SWP Drought Operations Plan and Operational Forecast for*  
27 *April 1, 2014 through November 15, 2014* (DOP) (Reclamation and DWR 2014a),  
28 outlined critical CVP/SWP operational considerations including providing for  
29 essential human health and safety needs; maintaining salinity control; planning for  
30 installation of three emergency drought barriers; maintaining adequate water  
31 supply reserves for 2015; providing for cold water species' needs, CVP and SWP  
32 water supplies, and refuge water supplies; and providing for operational  
33 flexibility, exchanges, and transfers. The DOP included upstream tributary  
34 operations as well as further modifications to D-1641 provisions associated with  
35 Delta outflow levels, maximum export limits, Delta E:I averaging period,  
36 combined export limitations, Vernalis base and pulse flows, and agricultural  
37 salinity compliance locations. Modifications to the DOP were requested in  
38 September 2014, regarding changes to San Joaquin River flows at Vernalis and  
39 extension of the water transfer window.

40 The *CVP and SWP Drought Contingency Plan for October 15, 2014 through*  
41 *January 15, 2015* (Drought Contingency Plan) (Reclamation and DWR 2015a),  
42 was prepared by Reclamation and DWR in response to the SWRCB  
43 October 7, 2014 Modified TUC Order. This Plan provided an overview of  
44 current conditions and available supplies as they related to projected flow and  
45 storage conditions for assumed hydrology, and addressed projected water

1 operations based on various hydrologic scenarios and potential adjustments to  
2 regulatory requirement through January 15, 2015.

3 The subsequent *Drought Contingency Plan for January 15, 2015 through*  
4 *September 30, 2015*, was prepared to incorporate changes in snowpack, reservoir  
5 storage, and updated hydrologic forecasts. The January 15, 2015, *Drought*  
6 *Contingency Plan* appended a December 12, 2014 working draft of the  
7 *Interagency 2015 Drought Strategy for the CVP and SWP* (Reclamation and  
8 DWR 2014b). The 2015 Drought Strategy described the anticipated coordination,  
9 process, planning, and potential drought response actions for 2015.

10 Similar to 2014, Reclamation and DWR jointly filed several TUCPs starting on  
11 January 23, 2015, to temporarily modify requirements in their water right permits  
12 and licenses for the SWP and CVP. The TUCPs requested temporary  
13 modification of requirements included in SWRCB Revised D-1641 to meet water  
14 quality objectives in the *Water Quality Control Plan for the San Francisco*  
15 *Bay/Sacramento–San Joaquin Delta Estuary*. Specifically, the TUCPs during  
16 2015 requested modifications to Delta outflow, San Joaquin River flow, DCC  
17 gate operation, and export limit objectives/or requirements, as well as upstream  
18 tributary operations, Rio Vista flows, western Delta salinity, and San Joaquin  
19 River salinity objectives.

20 The combination of virtually no snowpack and diminished reservoir storage in the  
21 spring of 2015 convinced federal and state wildlife and water agency managers  
22 that an emergency salinity barrier on West False River in the Sacramento-San  
23 Joaquin Delta was needed to repel salinity that could threaten a source of water  
24 used by 25 million Californians. Installation of a single emergency salinity  
25 barrier across West False River began in early May; with removal scheduled by  
26 mid-November. The barrier helped to limit the tidal push of saltwater from San  
27 Francisco Bay into the central Delta and helped minimize the amount of fresh  
28 water that must be released during the summer from upstream reservoirs to repel  
29 saltwater. Sufficient reserves in upstream reservoirs are needed to repel saltwater  
30 and prevent the contamination of water supplies for residents of the Delta; Contra  
31 Costa, Alameda and Santa Clara counties, and the 25 million people who rely on  
32 the Delta-based federal and state water projects for at least some of their supplies.  
33 Removal of the emergency barrier by November 15 is needed to avoid the flood  
34 season and harm to migratory fish. While it is in place, boaters used alternative  
35 routes between the San Joaquin River and the Delta's interior.

### 36 **5.3.4.3 Recent Drought Effects on Surface Water Resources and** 37 **Supplies**

38 California is currently in its fourth consecutive year of below-average rainfall and  
39 very low snowpack. Water Year 2015 is also the eighth of 9 years with below-  
40 average runoff, which has resulted in chronic and significant shortages to  
41 municipal and industrial, agricultural, and refuge water supplies and historically  
42 low levels of groundwater. As of October 2015, 46 percent of the state was  
43 experiencing an Extreme Drought and 25 percent was experiencing an  
44 Exceptional Drought, as recorded by the National Drought Mitigation Center,

1 U.S. Drought Monitor (Drought Monitor 2015). Of particular concern has been  
 2 the state's critically low snow pack which typically provides much of California's  
 3 seasonal water storage. On April 1, 2015, for the first time in 75 years of early-  
 4 April measurements, DWR found no snow at the Phillips snow course, a primary  
 5 snowpack measurement site in the Sierra Nevada mountain range. Lack of  
 6 precipitation the last several years has also contributed to low reservoir storage  
 7 levels in the Sacramento watershed. Shasta Reservoir on the Sacramento River  
 8 and Lake Oroville on the Feather River, and Folsom Lake on the American River  
 9 were at 35 and 30 percent of capacity, respectively, on October 5, 2015 (58 and  
 10 49 percent of historical average, respectively). Trinity Lake on the Trinity River  
 11 was at 22 percent of capacity and 32 percent of historical average. The San  
 12 Joaquin River watershed in particular has experienced severely dry conditions for  
 13 the past three years, with and New Melones Reservoir at 11 percent capacity  
 14 (20 percent historical average as of October 5, 2015).

15 Recently, one of the most critical reservoir water elevations has occurred at  
 16 Folsom Lake. On October 5, 2015, the storage was at 17 percent of capacity, or  
 17 21 percent of historical average at this time of the year. When the water  
 18 elevations in Folsom Lake decline substantially, the intakes along Folsom Dam  
 19 may not be able to operate at full capacity. Therefore, in 2015, Reclamation  
 20 installed a barge and pump system in Folsom Lake to allow diversions when low  
 21 water surface elevations would cause capacity issues for existing intakes.

22 Overall, in 2014 and 2015, CVP and SWP water allocations were substantially  
 23 reduced. The final 2014 water allocations and the February 2015 water  
 24 allocations were as follows (Reclamation 2015; DWR 2014e, 2015):

- 25 • CVP agricultural water contractors: zero percent in 2014 and 2015.
- 26 • CVP municipal and industrial contractors: 50 percent in 2014 and 25 percent  
 27 in 2015.
- 28 • CVP Eastside Division contractors: 55 percent in 2014 and zero percent in  
 29 2015.
- 30 • CVP Friant Water Division Class I and II contractors: zero percent in 2014  
 31 and 2015.
- 32 • CVP Sacramento River Water Rights Settlement Contractors and Sacramento  
 33 Valley wildlife refuges (Level 2 water supplies): 75 percent in 2014 and 2015  
 34 (based on preliminary allocations in February 2016).
- 35 • CVP San Joaquin River Exchange Contractors and San Joaquin Valley  
 36 wildlife refuges (Level 2 water supplies): 65 percent in 2014 and 75 percent in  
 37 2015 (based on preliminary allocations in February 2016). In 2014 and 2015,  
 38 San Joaquin River Exchange Contractors received a portion of the contract  
 39 amounts from Millerton Lake.
- 40 • SWP agricultural and urban contractors: up to 20 percent of the Table A water  
 41 contract amounts in 2014 and 2015.

- 1 • SWP Feather River water rights contractors: 100 percent in 2014 and  
2 50 percent in 2015.

3 The Congressional Research Service summarized the following information  
4 prepared by the SWRCB to describe the economic impacts of the 2014 drought  
5 period (CRS 2015):

- 6 • 428,000 acres agricultural lands idled in the Central Valley, Central Coast,  
7 and Southern California regions.
- 8 • \$447 million of increased cost to increase groundwater pumping.
- 9 • \$2.2 billion total economic loss, including \$1.5 billion direct loss to  
10 agriculture (or 3 percent of the total average agricultural production value).
- 11 • 17,100 agricultural-related jobs lost (including 3.8 percent of total farm  
12 employment).
- 13 • Unaccounted loses for commercial and recreational fishing, reservoir and river  
14 recreation, and non-agricultural water dependent industrial job losses.

15 Responses to droughts have changed since the 1976-77 drought. The federal and  
16 state governments have acknowledged the droughts early in the process and  
17 implemented emergency actions to preserve water supplies for future years in  
18 case the droughts extend over long-periods. As discussed above in this section,  
19 these actions have included reductions in water supply allocations as well as  
20 modification of regulatory requirements to protect future water supplies for all  
21 beneficial uses. The responses to drought are generally limited to short-term  
22 actions, including stringent water conservation by municipal users, increased  
23 groundwater pumping by municipal and agricultural users, and modification of  
24 regulatory requirements. However, these short-term responses generally cannot  
25 be maintained on a long-term basis without economic effects. Following the  
26 drought in 1987-92, longer term programs were initiated by both municipal and  
27 industrial water users. For example, water recycling increased 144 percent  
28 between 1977 and 1987, and 251 percent between 2009 and 1987 (SWRCB  
29 2009). Other long-term water supply reduction programs were initiated after the  
30 previous droughts, including increased use of drip irrigation. For example,  
31 Westlands Water District increased the use of drip irrigation from 3 percent of the  
32 crops in 1990 to 65 percent of the crops in 2011 (WWD 2013). However, these  
33 types of long-term responses take time to implement and once the savings are  
34 realized, there is less flexibility to respond to future droughts because the savings  
35 have occurred on a long-term basis.

36 It is also recognized that some effects of droughts do not occur within the year  
37 that the drought occurs. For example, increased use of groundwater in one year  
38 may result in subsidence in following years. Effects in commercial and sport  
39 fishing ocean salmon fishing also would not be realized in the years that the  
40 drought occurs because loss of spawning populations affects available salmon  
41 stocks for several years and future spawning populations. For example, coded  
42 wire tag recoveries of Sacramento River fall-run Chinook Salmon for commercial



1 fishing noticeably declined following the 1987-1992 and 2007-09 droughts up to  
2 95 percent (PFMC 2015).

### 3 **5.4 Impact Analysis**

4 This section describes the potential mechanisms and analytical methods for  
5 change in surface water resources, results of the impact analysis, potential  
6 mitigation measures, and cumulative effects.

#### 7 **5.4.1 Potential Mechanisms for Change and Analytical Methods**

8 As described in Chapter 4, Approach to Environmental Analysis, the impact  
9 assessment considers changes in surface water resources conditions related to  
10 changes in CVP and SWP operations under the alternatives as compared to the No  
11 Action Alternative and Second Basis of Comparison.

##### 12 **5.4.1.1 Changes in CVP and SWP Reservoir Storage and Downstream 13 River Flows**

14 Changes in CVP and SWP operations under the alternatives as compared to the  
15 No Action Alternative and the Second Basis of Comparison would result in  
16 changes to reservoir storage volumes (and elevations) and flow patterns in the  
17 downstream rivers. Numerical models are available to quantitatively analyze the  
18 changes in CVP and SWP reservoirs and pumping plants in the Central Valley,  
19 affected surface water bodies, and deliveries of CVP and SWP water. Changes in  
20 reservoirs that store CVP and SWP water outside of the Central Valley are not  
21 included in the CVP and SWP numerical models, and are evaluated qualitatively.

22 The surface water supply analysis was conducted using the CalSim II model, as  
23 described in Appendix 5A, CalSim II and DSM2 Modeling, to simulate the  
24 operational assumptions of each alternative that were described in Chapter 3,  
25 Description of Alternatives.

##### 26 **5.4.1.1.1 Use of CalSim II Model**

27 CalSim II is a reservoir-river basin planning model developed by DWR and  
28 Reclamation to simulate the operation of the CVP and SWP over a range of  
29 different hydrologic conditions. Inputs to CalSim II include water demands  
30 (including water rights), stream accretions and depletions, reservoir inflows,  
31 irrigation efficiencies, and parameters to calculate return flows, non-recoverable  
32 losses and groundwater operations. Sacramento Valley and tributary rim basin  
33 hydrology uses an adjusted historical sequence of monthly stream flows over an  
34 82-year period (1922 to 2003) to represent a sequence of flows at a future level of  
35 development. Adjustments to historic water supplies are imposed based on future  
36 land use conditions and historical meteorological and hydrologic conditions. The  
37 resulting hydrology represents the water supply available from Central Valley  
38 streams to the CVP and SWP at a future level of development. Water rights  
39 deliveries to non-CVP and non-SWP water rights holders are not modified in the  
40 CalSim II simulations of the alternatives. CalSim II produces outputs for river

1 flows and diversions, reservoir storage, Delta flows and exports, Delta inflow and  
2 outflow, deliveries to project and non-project users, and controls on project  
3 operations.

4 The CalSim II model monthly simulation of an actual daily (or even hourly)  
5 operation of the CVP and SWP results in several limitations in use of the model  
6 results. The model results must be used in a comparative manner to reduce the  
7 effects of use of monthly assumptions and other assumptions that are indicative of  
8 real-time operations, but do not specific match real-time observations. The  
9 CalSim II model output is based upon a monthly time step. The CalSim II model  
10 output includes minor fluctuations of up to 5 percent due to model assumptions  
11 and approaches. Therefore, if the quantitative changes between a specific  
12 alternative and the No Action Alternative and/or Second Basis of Comparison are  
13 5 percent or less, the conditions under the specific alternative would be  
14 considered to be “similar” to conditions under the No Action Alternative and/or  
15 Second Basis of Comparison.

16 Under extreme hydrologic and operational conditions where there is not enough  
17 water supply to meet all requirements, CalSim II utilizes a series of operating  
18 rules to reach a solution to allow for the continuation of the simulation. It is  
19 recognized that these operating rules are a simplified version of the very complex  
20 decision processes that CVP and SWP operators would use in actual extreme  
21 conditions. Therefore, model results and potential changes under these extreme  
22 conditions should be evaluated on a comparative basis between alternatives and  
23 are an approximation of extreme operational conditions. As an example, CalSim  
24 II model results show simulated occurrences of extremely low storage conditions  
25 at CVP and SWP reservoirs during critical drought periods when storage is at  
26 dead pool levels at or below the elevation of the lowest level outlet. Simulated  
27 occurrences of reservoir storage conditions at dead pool levels may occur  
28 coincidentally with simulated impacts that are determined to be potentially  
29 significant. When reservoir storage is at dead pool levels, there may be instances  
30 in which flow conditions fall short of minimum flow criteria, salinity conditions  
31 may exceed salinity standards, diversion conditions fall short of allocated  
32 diversion amounts, and operating agreements are not met.

#### 33 **5.4.1.1.2 Analysis of Changes in Reservoir Storage and Downstream** 34 **River Flows**

35 CalSim II outputs for the alternatives are compared to the CalSim II outputs for  
36 the No Action Alternative and the Second Basis of Comparison to evaluate  
37 changes in reservoir storages at Trinity Lake, Shasta Lake, Lake Oroville, Folsom  
38 Lake, New Melones Reservoir, and San Luis Reservoir; flows downstream of  
39 CVP and SWP reservoirs in Trinity, Sacramento, Feather, American, Stanislaus  
40 rivers and Clear Creek; flows from the Sacramento River at Fremont Weir into  
41 the Yolo Bypass; Delta outflow; and reverse flows in Old and Middle rivers  
42 (OMR criteria).

1 The analyses discussed in Chapters 5 through 21 do not include specific analysis  
2 for Millerton Lake and the San Joaquin River between Friant Dam and the  
3 confluence with the Stanislaus River under Alternatives 1 through 5 as compared  
4 to the No Action Alternative and Second Basis of Comparison. The results of  
5 these analyses (presented in Appendix 5A, CalSim II and DSM2 Modeling)  
6 indicated that there were no differences in Millerton Lake storage or San Joaquin  
7 River flows upstream of the confluence with the Stanislaus River between  
8 Alternatives 1 through 5 as compared to the No Action Alternative and Second  
9 Basis of Comparison because implementation of the alternatives would not affect  
10 the operations of Millerton Lake. Therefore, conditions at Millerton Lake and the  
11 San Joaquin River between Friant Dam and the confluence of the Stanislaus River  
12 are not analyzed in this EIS.

13 The analyses discussed in Chapters 5 through 21 do not include specific analysis  
14 for creeks downstream of San Luis Reservoir complex. Unlike the rivers located  
15 downstream of CVP and SWP reservoirs (e.g., Sacramento River downstream of  
16 Shasta Dam), river channels located downstream of the San Luis Reservoir  
17 complex are not used to convey CVP and SWP water. Instream flows in these  
18 rivers would not be affected by changes in CVP and SWP operations. Therefore,  
19 flows in streams downstream of San Luis Reservoir are not analyzed in this EIS.

20 Reservoirs that store CVP and SWP water are also located in the San Francisco  
21 Bay Area, Central Coast, and Southern California regions. Many of these  
22 reservoirs also store water from other water supplies including CVP and SWP  
23 water. These reservoirs are not included in the CalSim II model simulation.  
24 Storage volumes in non-CVP and SWP reservoirs located south of the Delta that  
25 store CVP or SWP water also are affected by the availability local runoff stored in  
26 these reservoirs; and from imported Colorado River water in some Southern  
27 California reservoirs. This EIS does not analyze availability of future local runoff  
28 or imported Colorado River water supplies in 2030. For this EIS, it is assumed  
29 that under a worst-case scenario, changes in CVP and SWP water deliveries  
30 would result in similar changes to storage in these reservoirs. For example,  
31 reductions in CVP or SWP deliveries would result in reductions in storage in  
32 reservoirs located south of the Delta. Generally, river channels located  
33 downstream of these reservoirs are not used to convey CVP and SWP water.  
34 Instream flows in these rivers would not be affected by changes in CVP and SWP  
35 operations. Therefore, flows in these streams are not analyzed in this EIS.

#### 36 **5.4.1.2 Changes in Flows over Fremont Weir into Yolo Bypass**

37 All of the alternatives, including the No Action Alternative and the Second Basis  
38 of Comparison, include operations of an operable gate at Fremont Weir, as  
39 described in Chapter 3, Description of Alternatives. Results of the CalSim II  
40 model were used to assess changes in average monthly flows that would flow into  
41 the Yolo Bypass over an operable gate at Fremont Weir. Operational assumptions  
42 for the operable gate were developed for the purposes of this EIS analysis, and are  
43 the same in all alternatives and the Second Basis of Comparison. Specific  
44 operational assumptions are being developed by Reclamation and others in a  
45 separate analysis that includes separate environmental documentation. Although

1 the operational assumptions for an operable gate at Fremont Weir would be the  
2 same under all alternatives and the Second Basis of Comparison; the flow patterns  
3 into the Yolo Bypass would change based upon the magnitude of flows in the  
4 Sacramento River at Fremont Weir, as evaluated quantitatively using CalSim II  
5 model output. Assumptions used in the CalSim II model are described in  
6 Appendix 5A, CalSim II and DSM2 Modeling.

7 Flows also enter the Yolo Bypass at the Sacramento Weir (downstream of  
8 Fremont Weir) at a lower flow rate. However, the Sacramento Weir operations  
9 are assumed to remain as described in Section 5.3, Affected Environment, in all  
10 alternatives and the Second Basis of Comparison.

#### 11 **5.4.1.3 Changes in Delta Conditions**

12 Changes in CVP and SWP operations under the alternatives as compared to the  
13 No Action Alternative and Second Basis of Comparison would change the Delta  
14 inflows from the tributary watersheds, Delta outflow, and reverse flows in Old  
15 and Middle River (as indicated by OMR flows). Results of the CalSim II model  
16 were used to assess changes in Delta outflow and positive and negative OMR  
17 flows. Assumptions used in the CalSim II model are described in Appendix 5A,  
18 CalSim II and DSM2 Modeling.

#### 19 **5.4.1.4 Changes in Delta Exports and CVP and SWP Deliveries**

20 Changes in CVP and SWP operations under the alternatives as compared to the  
21 No Action Alternative and Second Basis of Comparison would change CVP and  
22 SWP exports and deliveries, as analyzed using the CalSim II model. Assumptions  
23 used in the CalSim II model are described in Appendix 5A, CalSim II and DSM2  
24 Modeling.

25 It should be noted that deliveries to CVP and SWP water users located to the  
26 south of the Delta are not necessarily the same volume as the Delta export  
27 patterns because a portion of the exported water is stored in San Luis Reservoir  
28 and released on a different pattern than Delta exports.

29 It also should be noted that the monthly CalSim II model results do not represent  
30 daily water operations decisions, especially for extreme conditions. For example,  
31 in very dry years, the model simulates minimum reservoir volumes (also known  
32 as “dead pool conditions”) that appear to prevent Reclamation and DWR from  
33 meeting their contractual obligations, including water deliveries to CVP  
34 Sacramento River Settlement Contractors, CVP San Joaquin River Exchange  
35 Contractors, SWP Feather River Service Area Contractors, and Level II refuge  
36 water supplies. Such model results are anomalies that reflect the inability of the  
37 monthly model to make real-time policy decisions under extreme circumstances.  
38 Projected reservoir storage conditions near dead pool conditions should only be  
39 considered as an indicator of stressed water supply conditions, and not necessarily  
40 reflective of actual CVP and SWP operations in the future.

**5.4.1.5 Effects Related to Water Transfers**

Historically water transfer programs have been developed on an annual basis. The demand for water transfers is dependent upon the availability of water supplies to meet water demands. Water transfer transactions have increased over time as CVP and SWP water supply availability has decreased, especially during drier water years.

Parties seeking water transfers generally acquire water from sellers who have available surface water who can make the water available through releasing previously stored water, pumping groundwater instead of using surface water (groundwater substitution), idle crops, or substitute crops that uses less water in order to reduce normal consumptive use of surface water.

Water transfers using CVP and SWP Delta pumping plants and south of Delta canals generally occur when there is unused capacity in these facilities. These conditions generally occur during drier water year types when the flows from upstream reservoirs plus unregulated flows are adequate to meet the Sacramento Valley water demands and the CVP and SWP export allocations (defined as “balanced Delta conditions” in the COA, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations). In nonwet years, the CVP and SWP water allocations would be less than full contract amounts; therefore, capacity may be available in the CVP and SWP conveyance facilities to move water from other sources.

Water transfers using CVP and SWP conveyance facilities frequently do not occur when releases from upstream reservoirs plus unregulated flows are greater than the Sacramento Valley water demands and the CVP and SWP export allocations (defined as “excess Delta conditions in the COA) because the available water is being conveyed to meet the CVP and SWP contract demands. This condition generally occurs in winter and spring months of wet years.

Without implementation of the 2008 USFWS BO and 2009 NMFS BO, water transfers could occur in most months when exports are less than conveyance capacity. The 2008 USFWS BO and 2009 NMFS BO include export restrictions in the winter and spring months that limit use of the conveyance capacity.

Transfers requiring conveyance through the Delta occur when pumping and conveyance capacity at the CVP or SWP export facilities is available. Reclamation and DWR must coordinate review of the transfer proposals and related CVP and SWP operations to assure that the CVP and SWP are not impacted including the ability to exercise their own water rights or to meet their legal and regulatory requirements are not diminished or limited in any way. To avoid impacts to Delta water quality the individual transfer is assessed a carriage water loss to account for flows required to avoid impacts to Delta water quality or flow objectives. All transfers are required to be implemented in accordance with all existing regulations and requirements, including not causing adverse impacts on other water users in accordance with SWRCB requirements.

1 Reclamation recently prepared a long-term regional water transfer environmental  
2 document which evaluated potential changes in surface water conditions related to  
3 water transfer actions (Reclamation 2014i). Results from this analysis were used  
4 to inform the impact assessment of potential effects of water transfers under the  
5 alternatives as compared to the No Action Alternative and the Second Basis of  
6 Comparison.

7 **5.4.2 Conditions in Year 2030 without implementation of**  
8 **Alternatives 1 through 5**

9 The impact analysis in this EIS is based upon the comparison of the alternatives to  
10 the No Action Alternative and the Second Basis of Comparison in the Year 2030.  
11 Changes that would occur over the next 15 years without implementation of the  
12 alternatives are not analyzed in this EIS. However, the changes that are assumed  
13 to occur by 2030 under the No Action Alternative and the Second Basis of  
14 Comparison are summarized in this section.

15 Many of the changed conditions would occur in the same manner under both the  
16 No Action Alternative and the Second Basis of Comparison. Other future  
17 conditions would be different under the No Action Alternative as compared to the  
18 Second Basis of Comparison due to the implementation of the 2008 USFWS BO  
19 and 2009 NMFS BO under the No Action Alternative.

20 This section of Chapter 5 provides qualitative projections of the No Action  
21 Alternative as compared to existing conditions described under the Affected  
22 Environment; and qualitative projections of the Second Basis of Comparison as  
23 compared to “recent historical conditions.” Recent historical conditions are not  
24 the same as existing conditions which include implementation of the 2008  
25 USFWS BO and 2009 NMFS BO; and consider changes that would have occurred  
26 without implementation of the 2008 USFWS BO and the 2009 NMFS BO.

27 **5.4.2.1 Common Changes in Conditions under the No Action**  
28 **Alternative and Second Basis of Comparison**

29 Conditions in 2030 would be different than existing conditions due to:

- 30 • Climate change and sea-level rise  
31 • General plan development throughout California, including increased water  
32 demands in portions of Sacramento Valley  
33 • Implementation of reasonable and foreseeable water resources management  
34 projects to provide water supplies

35 These changes would result in a decline of the long-term average CVP and SWP  
36 water supply deliveries by 2030 as compared to recent historical long-term  
37 average deliveries.

38 **5.4.2.1.1 Changes in Conditions due to Climate Change and Sea-Level Rise**

39 It is anticipated that climate change would result in more short-duration high-  
40 rainfall events and less snowpack in the winter and early spring months. The  
41 reservoirs would be full more frequently by the end of April or May by 2030 than

1 in recent historical conditions. However, as the water is released in the spring,  
2 there would be less snowpack to refill the reservoirs. This condition would  
3 reduce reservoir storage and available water supplies to downstream uses in the  
4 summer. The reduced end-of-September storage also would reduce the ability to  
5 release stored water to downstream regional reservoirs. These conditions would  
6 occur for all reservoirs in the California foothills and mountains, including  
7 non-CVP and SWP reservoirs.

8 Sea level rise also would result in reduced CVP and SWP reservoir storage. As  
9 sea level rise occurs, the location of the salt water-freshwater zone moves further  
10 inland. However, the CVP and SWP must continue to meet the salinity criteria to  
11 protect Delta water users and Delta aquatic resources, including the SWRCB  
12 D-1641 and other salinity criteria to protect Delta water users. To meet these  
13 criteria, the amount of water released from CVP and SWP reservoirs must be  
14 increased as compared to recent historical conditions.

15 Climate change also would cause changes in stream flows. During the storm  
16 events, the flows would be higher than in recent historical conditions because a  
17 larger portion of the precipitation would occur as rainfall instead of snowfall.  
18 Flows would increase in the spring as more water is released from CVP and SWP  
19 reservoirs to meet Delta salinity criteria. In the summer and fall months, flows  
20 could be lower due to reduced amounts of water remaining in reservoir storage.

21 Climate change also would reduce groundwater supplies due to reduced  
22 groundwater recharge potential and increased groundwater overdraft potential as  
23 surface water supplies decline. However, in some locations, sustainable  
24 groundwater supplies could remain similar to recent historical conditions or rise  
25 due to implementation of groundwater management plans to reduce groundwater  
26 overdraft, including the completion of ongoing groundwater recharge and  
27 recovery programs.

#### 28 **5.4.2.1.2 General Plan Development in California**

29 Counties and cities throughout California have adopted general plans which  
30 identify land use classifications including those for municipal and industrial uses  
31 and those for agricultural uses. Preparation of general plans includes an  
32 environmental evaluation under the California Environmental Quality Act to  
33 identify adverse impacts to the physical environment and to provide mitigation  
34 measures to reduce those impacts to a level of less than significance. Most of the  
35 counties where CVP and SWP water supplies are delivered have adopted general  
36 plans following the environmental review of the plans and appropriate  
37 alternatives. Population projections from those general plan evaluations are  
38 provided to the State Department of Finance and are used to project future water  
39 needs and the potential for conversion of existing undeveloped lands and  
40 agricultural lands. Many of the existing general plans for counties with municipal  
41 areas recently have been modified to include land use and population projections  
42 through 2030. The No Action Alternative and the Second Basis of Comparison  
43 assume that land uses will develop through 2030 in accordance with existing  
44 general plans.

1 Development in accordance with the general plans in the Sacramento Valley  
2 would result in increased water demands. By 2030, water demands associated  
3 with water rights and CVP and SWP contracts in the Sacramento Valley is  
4 projected to increase by 443,000 acre-feet per year, especially in the communities  
5 in El Dorado, Placer, and Sacramento Counties. Increased water demands in the  
6 Sacramento Valley would result in reductions in CVP and SWP water supply  
7 availability for other water users under the No Action Alternative and the Second  
8 Basis of Comparison.

9 **5.4.2.1.3 Reasonable and Foreseeable Water Resources Management**  
10 **Projects**

11 The No Action Alternative and the Second Basis of Comparison assumes  
12 completion of water resources management and environmental restoration  
13 projects that would have occurred without implementation of the 2008 USFWS  
14 BO and 2009 NMFS BO by 2030, as described in Chapter 3, Description of  
15 Alternatives.

16 The No Action Alternative and the Second Basis of Comparison would include  
17 the following actions included in the 2008 USFWS BO and 2009 NMFS BO that  
18 are ongoing.

- 19 • Restoration of more than 10,000 acres of intertidal and associated subtidal  
20 wetlands in Suisun Marsh and Cache Slough and at least 17,000 to  
21 20,000 acres of seasonal floodplain restoration in Yolo Bypass
- 22 • Gravel augmentation in the Sacramento Valley watershed
- 23 • Replacement of the Spring Creek Temperature Control Curtain
- 24 • Restoration of Battle Creek
- 25 • Implementation of Red Bluff Pumping Plant
- 26 • Implementation of the CVPIA Anadromous Fish Screen Program
- 27 • Implementation of the American River Flow Management Standard

28 Under the No Action Alternative and Second Basis of Comparison, it is assumed  
29 that water demands would be met on a long-term basis and in dry and critical dry  
30 years using a combination of conservation, CVP and SWP water supplies, other  
31 imported water supplies, groundwater, recycled water, infrastructure  
32 improvements, desalination water treatment, and water transfers and exchanges.  
33 It is anticipated that individual communities or users could be in a situation that  
34 would not allow for affordable water supply options, and that water demands  
35 could not be fully met. However, on a regional scale, it is anticipated that water  
36 demands would be met.

37 The assumptions related to 2030 municipal water demands are based upon a  
38 review of the 2010 Urban Water Management Plans (UWMPs) prepared by CVP  
39 and SWP water users. The No Action Alternative and the Second Basis of  
40 Comparison assumptions related to future water supplies presented in the  
41 UWMPs were evaluated to determine if the projects were reasonable and certain



1 to occur by 2030. Projects that had undergone environmental review, were under  
 2 design, or under construction were included in the future water supply  
 3 assumptions for 2030 in the No Action Alternative and the Second Basis of  
 4 Comparison. Projects described in the UWMPs that currently were under  
 5 evaluation were included in the Cumulative Effects analysis for future water  
 6 supplies. Future water supplies considered for municipalities by 2030 are  
 7 presented in Appendix 5D and summarized in Table 5.10.

8 **Table 5.10 Future Long-Term Average Municipal Water Supply Assumptions for**  
 9 **CVP and SWP Water Users**

	2030 Water Demands and Water Supplies				
	Central Valley Region – Sacramento Valley	Central Valley Region – San Joaquin Valley	San Francisco Bay Area Region	Central Coast and Southern California Regions	Total
2030 Water Demand (after conservation)	747,771	378,999	784,313	5,653,807	7,564,890
CVP Deliveries	214,187	131,150	311,370	–	656,707
SWP Deliveries	88,192	82,946	143,045	1,798,353	2,112,536
Water Rights	724,583	170,600	127,400	240,333	1,262,916
Groundwater	136,759	188,346	101,704	2,216,118	2,642,927
Recycled Wastewater	24,324	25,000	44,270	404,449	498,043
Recycled Stormwater	–	–	–	21,400	21,400
Desalination Water Treatment	–	–	5,100	454,145	459,245
Transfers and Exchanges	156,325	30,000	16,700	–	203,025
Non-CVP and SWP Imported Water Supplies	205,276	–	76,400	1,319,321	1,600,997
<b>Total Supplies</b>	<b>1,549,646</b>	<b>628,042</b>	<b>825,989</b>	<b>6,454,119</b>	<b>9,457,796</b>

Note: Does not include the East Bay Municipal Utility District dry year water supply.

10 The No Action Alternative and the Second Basis of Comparison assume that  
 11 several CVP and SWP water users also rely upon other imported water supplies,  
 12 including water from Solano Project (used by the Solano County Water Agency),  
 13 San Francisco Public Utilities Commission (used by portions of the service areas  
 14 of Alameda County Water District, Santa Clara Valley Water District, and Zone 7  
 15 Water Agency), and the Colorado River (used by portions of the service area of  
 16 the Metropolitan Water District of Southern California).

1 The No Action Alternative and the Second Basis of Comparison assume that  
2 groundwater would continue to be used even if groundwater overdraft conditions  
3 continue or become worse. It is recognized that in September 2014 the  
4 Sustainable Groundwater Management Act (SGMA) was enacted. The SGMA  
5 provides for the establishment of a Groundwater Sustainability Agencies (GSAs)  
6 to prepare Groundwater Sustainability Plans (GSPs) that will include best  
7 management practices for sustainable groundwater management. The SGMA  
8 defines sustainable groundwater management as “the management and use of  
9 groundwater in a manner that can be maintained during the planning and  
10 implementation horizon without causing undesirable results.” Undesirable results  
11 are defined as any of the following effects.

- 12 • Chronic lowering of groundwater levels (not including overdraft during a  
13 drought if a basin is otherwise managed)
- 14 • Significant and unreasonable reduction of groundwater storage
- 15 • Significant and unreasonable seawater intrusion
- 16 • Significant and unreasonable degraded water quality, including the migration  
17 of contaminant plumes that impair water supplies
- 18 • Significant and unreasonable land subsidence that substantially interferes with  
19 surface land uses
- 20 • Depletions of interconnected surface water that have significant and  
21 unreasonable adverse impacts on beneficial uses of the surface water

22 The SGMA requires the formation of GSPs in groundwater basins or subbasins  
23 that DWR designates as medium or high priority based upon groundwater  
24 conditions identified using the CAGESM results by 2022. Sustainable  
25 groundwater operations must be achieved within 20 years following completion  
26 of the GSPs. In some areas with adjudicated groundwater basins, sustainable  
27 groundwater management could be achieved and/or maintained by 2030.  
28 However, to achieve sustainable conditions in many areas, measures could require  
29 several years to design and construct water supply facilities to replace  
30 groundwater, such as seawater desalination. Therefore, it does not appear to be  
31 reasonable and foreseeable that sustainable groundwater management would be  
32 achieved by 2030; and it is assumed that groundwater pumping will continue to  
33 be used to meet water demands not fulfilled with surface water supplies or other  
34 alternative water supplies in 2030.

35 The No Action Alternative and the Second Basis of Comparison assumptions also  
36 include implementation of numerous conservation efforts and major water supply  
37 projects, including regional and local recycling projects, surface water and  
38 groundwater storage projects, conveyance improvement projects, and desalination  
39 projects, as described in Chapter 3, Description of Alternatives. There are over  
40 50 projects considered in the study area to be included in the No Action  
41 Alternative, including the following major water supply projects.

- 1 • Cambria Emergency Water Supply Project desalination project (CCSD 2014)
- 2 • Carlsbad Metropolitan Water District (MWD) water recycling project
- 3 (Carlsbad MWD 2012)
- 4 • Central Basin Municipal Water District Southeast Water Reliability Project
- 5 (CBMWD 2011)
- 6 • City of Los Angeles Department of Water and Power groundwater recharge
- 7 projects (City of Los Angeles 2011, 2013)
- 8 • City of Oxnard GREAT Program Desalter (City of Oxnard 2013)
- 9 • Eastern Municipal Water District (EMWD) water recycling programs
- 10 (EMWD 2014a, 2014b)
- 11 • Fresno Irrigation District (FID) groundwater recharge projects (FID 2015)
- 12 • Inland Empire Utilities Agency (IEUA) groundwater recharge projects
- 13 (IEUA 2015).
- 14 • Kern County and Antelope Valley-East Kern Water Agency (AVEK 2011)
- 15 • Los Angeles County Sanitation District expansion of water recycling
- 16 programs (LACSD 2005)
- 17 • San Benito County Water District (SBCWD) expansion of water treatment
- 18 plant to treat CVP water (SBCWD 2014)
- 19 • San Diego County Water Authority (SDCWA) Carlsbad Seawater
- 20 Desalination Facility (SDCWA 2014)
- 21 • Santa Barbara desalination water treatment plant (KEYT News [KEYT]
- 22 2015).
- 23 • SCVWD wastewater recycling projects (SCVWD 2012a)
- 24 • Victor Valley Wastewater Reclamation Authority (VWVRA) water recycling
- 25 programs (VWVRA 2015)
- 26 • Water Replenishment District (WRD) Groundwater Reliability Improvement
- 27 Program and water recycling programs (WRD 2012, 2015)
- 28 • West Basin Municipal Water District recycling water programs (WBMWD
- 29 2011)
- 30 • Western Development and Storage Antelope Valley Water Bank (Reclamation
- 31 2010b)
- 32 • Western Municipal Water District (WMD) Arlington Desalter Expansion to
- 33 use saline groundwater (WMD 2015)
- 34 • Woodland-Davis Clean Water Agency (WDCWA) water treatment plant
- 35 (WDCWA 2013)

1 Water transfer programs, including those that require Warren Act contracts with  
2 Reclamation to convey non-CVP water in CVP facilities, are anticipated to  
3 continue under the No Action Alternative and the Second Basis of Comparison.  
4 Transfer programs generally involve annual crop changes using temporary crop  
5 idling or shifting, release of stored water in reservoirs on different patterns for the  
6 purchasers' water demands, and/or groundwater substitution (DWR and  
7 Reclamation 2014). The transfers must be approved by the CVP and/or SWP if  
8 the transfer involves CVP or SWP water or utilizes CVP or SWP facilities.  
9 Except for water transfers among CVP water users, water transfers also require  
10 approval from the SWRCB. Environmental documentation is required for all  
11 water transfers involving CVP and/or SWP water supplies or facilities. Under  
12 State law, water transfers cannot result in injury to other legal users of water;  
13 unreasonable impacts on fish and wildlife and instream uses; and unreasonable  
14 economic or environmental impact on the county in which the transfer water  
15 originates. It is assumed that transfers would continue under the No Action  
16 Alternative and the Second Basis of Comparison in a similar manner as have  
17 occurred for the past 10 years. It is anticipated that the number of long-term  
18 transfer agreements could increase to facilitate annual decisions for water  
19 transfers.

20 **5.4.2.2 Changes in Conditions under the No Action Alternative**

21 CVP and SWP operational criteria under the No Action Alternative would be the  
22 same as described under the Affected Environment. However, due to the climate  
23 change and sea-level rise and increased water demands in the Sacramento Valley,  
24 CVP and SWP water deliveries would be less in 2030 than under recent historical  
25 conditions. It is anticipated that climate change and sea level rise conditions  
26 would result in lower reservoir storage and elevations and flows in the rivers by  
27 the end of September.

28 **5.4.2.3 Changes in Conditions under the Second Basis of Comparison**

29 CVP and SWP operational criteria under the Second Basis of Comparison would  
30 not include implementation of the 2008 USFWS BO and 2009 NMFS BO. As  
31 described in Section 5.4.4.1, CVP and SWP water deliveries would higher than  
32 under existing conditions which include implementation of the BOs. However,  
33 due to the climate change and sea level rise and increased water demands in the  
34 Sacramento Valley, CVP and SWP water supply availability and deliveries would  
35 be less in 2030 than under recent historical conditions that existed prior to  
36 implementation of the BOs. It is anticipated that climate change and sea level rise  
37 conditions would result in lower reservoir storage and elevations and flows in the  
38 rivers by the end of September.

39 **5.4.3 Evaluation of Alternatives**

40 As described in Chapter 4, Approach to Environmental Analysis, Alternatives 1  
41 through 5 have been compared to the No Action Alternative; and the No Action  
42 Alternative and Alternatives 1 through 5 have been compared to the Second Basis  
43 of Comparison.

1 During review of the numerical modeling analyses used in this EIS, two issues  
2 were discovered. First, it was discovered that the demands for the El Dorado  
3 Irrigation District (EID) and El Dorado County Water Agency (EDCWA)  
4 contracts were not included in Alternatives 3 and 5, as intended. Second, an error  
5 was determined in the CalSim II model assumptions related to the Stanislaus  
6 River operations for the Second Basis of Comparison, Alternative 1, and  
7 Alternative 4 model runs.

8 With respect to the water demands, the 17 TAF per year Warren Act Contract for  
9 EIS and 15 TAF per year under a CVP water service contract for EDCWA were  
10 not included in Alternatives 3 and 5, as intended. These demands are not included  
11 in the analysis presented in Chapters 5 through 21 of the EIS. A sensitivity  
12 analysis comparing the results of the analysis with and without these demands is  
13 presented in Appendix 5B of this EIS for Alternatives 3 and 5. The sensitivity  
14 analysis focuses on potential changes that would occur within Folsom Lake and  
15 along the American River. The results of this analysis indicate that surface water  
16 and water temperature conditions in Folsom Lake and in the American River  
17 would be similar (within 5 percent or less) in the model run with these demands  
18 as compared to model runs without these demands; except in August of critical  
19 dry years. In August of critical dry years, the American River flows under  
20 Alternative 3 would be 6 percent less with these demands than without these  
21 demands. It is anticipated that similar results would occur under the No Action  
22 Alternative. The results of these model runs indicated that there was not  
23 sensitivity with the addition of these demands in the analyses; therefore, no  
24 further model simulations were necessary to capture potential effects and the  
25 inclusion of these contracts would not change the previous conclusions in  
26 Chapters 5 through 21.

27 With respect to the CalSim II model assumptions related to the Stanislaus River  
28 operations for the Second Basis of Comparison, Alternative 1, and Alternative 4  
29 model runs, a sensitivity analysis was conducted as presented in Appendix 5C.  
30 Appendix 5C includes a comparison of the CalSim II model run results presented  
31 in this chapter and CalSim II model run results with the error corrected.  
32 Appendix 5C also includes a discussion of changes in the comparison of the  
33 following alternative analysis.

- 34 • No Action Alternative compared to the Second Basis of Comparison
- 35 • Alternative 1 compared to the No Action Alternative
- 36 • Alternative 3 compared to the Second Basis of Comparison
- 37 • Alternative 5 compared to the Second Basis of Comparison

38 Model results for Alternatives 1, 4, and Second Basis of Comparison are the  
39 same, therefore Alternative 4 results are not presented separately. Model results  
40 for Alternative 2 and No Action Alternative are the same, therefore Alternative 2  
41 results are not presented separately. Alternative 3 was not compared to the No  
42 Action Alternative because the model error did not occur in either of these  
43 model runs.

1 **5.4.3.1 No Action Alternative**

2 As described in Chapter 4, Approach to Environmental Analysis, the No Action  
3 Alternative is compared to the Second Basis of Comparison.

4 **5.4.3.1.1 Trinity River Region**

5 *Changes in CVP and SWP Reservoir Storage and Downstream River Flows*

6 Changes in Trinity Lake storage and surface water elevations under the No Action  
7 Alternative as compared to the Second Basis of Comparison in Trinity Lake are  
8 summarized in Tables 5.11 and 5.12. A summary of the results is provided  
9 following Table 5.12.

10 **Table 5.11 Changes in Trinity Lake Storage under the No Action Alternative as**  
11 **Compared to the Second Basis of Comparison**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>No Action Alternative</b>												
Wet	1,490	1,516	1,630	1,756	1,921	2,053	2,220	2,245	2,190	2,067	1,939	1,784
Above Normal	1,159	1,178	1,286	1,455	1,658	1,847	2,025	1,999	1,907	1,773	1,619	1,495
Below Normal	1,393	1,400	1,417	1,488	1,575	1,662	1,817	1,743	1,637	1,470	1,304	1,185
Dry	1,152	1,148	1,174	1,182	1,274	1,403	1,539	1,490	1,413	1,253	1,104	1,008
Critical Dry	747	731	746	750	790	872	923	888	862	745	612	536
<b>Second Basis of Comparison</b>												
Wet	1,501	1,535	1,644	1,767	1,931	2,055	2,224	2,250	2,194	2,068	1,939	1,805
Above Normal	1,208	1,245	1,363	1,524	1,718	1,901	2,079	2,053	1,955	1,815	1,647	1,513
Below Normal	1,451	1,472	1,492	1,554	1,641	1,729	1,872	1,799	1,696	1,515	1,337	1,204
Dry	1,178	1,184	1,210	1,230	1,322	1,453	1,586	1,536	1,466	1,302	1,152	1,055
Critical Dry	819	803	813	825	868	949	999	962	929	811	667	598
<b>No Action Alternative as Compared to Second Basis of Comparison</b>												
Wet	-11	-19	-14	-11	-9	-2	-4	-5	-4	0	1	-21
Above Normal	-49	-68	-77	-69	-60	-54	-55	-54	-49	-42	-27	-18
Below Normal	-59	-72	-74	-66	-67	-67	-54	-57	-60	-44	-33	-18
Dry	-26	-36	-36	-48	-48	-49	-47	-46	-53	-48	-48	-48
Critical Dry	-73	-72	-68	-75	-78	-78	-76	-74	-66	-66	-56	-61
<b>No Action Alternative as Compared to Second Basis of Comparison (percent change)</b>												
Wet	-0.7	-1.3	-0.9	-0.6	-0.5	-0.1	-0.2	-0.2	-0.2	0.0	0.0	-1.2
Above Normal	-4.0	-5.4	-5.7	-4.5	-3.5	-2.9	-2.6	-2.7	-2.5	-2.3	-1.7	-1.2
Below Normal	-4.0	-4.9	-5.0	-4.2	-4.1	-3.9	-2.9	-3.1	-3.5	-2.9	-2.5	-1.5
Dry	-2.2	-3.1	-3.0	-3.9	-3.6	-3.4	-3.0	-3.0	-3.6	-3.7	-4.1	-4.5
Critical Dry	-8.9	-9.0	-8.3	-9.1	-8.9	-8.2	-7.6	-7.7	-7.2	-8.1	-8.4	-10.3

1  
2

**Table 5.12 Changes in Trinity Lake Elevation under the No Action Alternative as Compared to the Second Basis of Comparison**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>No Action Alternative</b>												
Wet	2,300	2,303	2,313	2,324	2,338	2,347	2,357	2,358	2,355	2,347	2,338	2,327
Above Normal	2,261	2,264	2,276	2,294	2,314	2,330	2,343	2,341	2,335	2,325	2,313	2,302
Below Normal	2,289	2,289	2,291	2,299	2,307	2,315	2,327	2,321	2,313	2,299	2,283	2,272
Dry	2,263	2,265	2,268	2,269	2,279	2,292	2,305	2,301	2,294	2,279	2,264	2,254
Critical Dry	2,210	2,207	2,210	2,213	2,220	2,235	2,242	2,238	2,235	2,220	2,196	2,182
<b>Second Basis of Comparison</b>												
Wet	2,301	2,305	2,314	2,325	2,339	2,347	2,357	2,358	2,355	2,347	2,338	2,328
Above Normal	2,270	2,273	2,286	2,303	2,320	2,335	2,347	2,346	2,339	2,329	2,315	2,304
Below Normal	2,295	2,296	2,298	2,305	2,313	2,320	2,331	2,326	2,318	2,303	2,287	2,274
Dry	2,266	2,269	2,272	2,274	2,284	2,296	2,309	2,304	2,298	2,284	2,269	2,259
Critical Dry	2,218	2,216	2,217	2,222	2,229	2,243	2,250	2,246	2,243	2,227	2,204	2,191
<b>No Action Alternative as Compared to Second Basis of Comparison</b>												
Wet	-1	-2	-1	-1	-1	0	0	0	0	0	0	-2
Above Normal	-8	-10	-10	-9	-7	-5	-4	-4	-4	-4	-2	-2
Below Normal	-6	-7	-7	-6	-6	-6	-4	-5	-5	-4	-3	-3
Dry	-3	-4	-4	-5	-5	-4	-4	-4	-5	-5	-5	-5
Critical Dry	-8	-8	-8	-9	-8	-8	-8	-8	-7	-8	-8	-9
<b>No Action Alternative as Compared to Second Basis of Comparison (percent change)</b>												
Wet	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
Above Normal	-0.4	-0.4	-0.5	-0.4	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2	-0.1	-0.1
Below Normal	-0.3	-0.3	-0.3	-0.3	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.1
Dry	-0.1	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Critical Dry	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.3	-0.3	-0.3	-0.4	-0.4	-0.4

3 The following changes in Trinity Lake storage and surface water elevation would  
 4 occur under the No Action Alternative as compared to the Second Basis of  
 5 Comparison.

- 6 • In wet years, below normal, and dry years, storage would be similar (within  
 7 5 percent) in all months.
- 8 • In above-normal years, storage would be similar in January through October  
 9 and less in November and December (up to 5.7 percent).
- 10 • In critical dry years, storage would be less in all months (up to 10.3 percent).

- 1 • In all months, in all water year types, surface water elevations would be  
2 similar.
- 3 The following changes would occur on the Trinity River under the No Action  
4 Alternative as compared to the Second Basis of Comparison, as shown on  
5 Figures 5.53 through 5.55.
- 6 • Over long-term conditions (over the 82-year analysis period), flows would be  
7 similar in March through November and reduced in December through  
8 February (up to 9.5 percent).
- 9 • In wet years, flows would be similar in April through November and reduced  
10 in December through March (up to 11.2 percent).
- 11 • In dry years, flows would be similar all months.

12 **5.4.3.1.2 Central Valley Region**

13 *Changes in CVP and SWP Reservoir Storage and Downstream River Flows*  
14 *Shasta Lake and Sacramento River*

15 Storage levels and surface water elevations in Shasta Lake under the No Action  
16 Alternative as compared to the Second Basis of Comparison are summarized in  
17 Tables 5.13 and 5.14. Changes in flows in the Sacramento River downstream of  
18 Keswick Dam and at Freeport are shown on Figures 5.56 through 5.61. The  
19 results are summarized in Table 5.14.



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**Table 5.13 Changes in Shasta Lake Storage under the No Action Alternative as Compared to the Second Basis of Comparison**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>No Action Alternative</b>												
Wet	2,700	2,719	3,077	3,384	3,589	3,836	4,298	4,460	4,242	3,735	3,410	2,985
Above Normal	2,369	2,385	2,600	3,167	3,453	4,021	4,404	4,429	4,039	3,407	3,069	2,834
Below Normal	2,587	2,548	2,686	3,062	3,442	3,814	4,026	3,957	3,588	3,002	2,643	2,608
Dry	2,345	2,283	2,428	2,621	3,034	3,505	3,737	3,668	3,284	2,767	2,496	2,462
Critical Dry	1,702	1,633	1,717	1,871	2,031	2,274	2,202	2,088	1,719	1,253	986	937
<b>Second Basis of Comparison</b>												
Wet	2,817	2,926	3,154	3,406	3,597	3,841	4,301	4,453	4,228	3,733	3,362	3,252
Above Normal	2,499	2,578	2,808	3,313	3,515	4,038	4,416	4,417	3,979	3,347	2,975	2,921
Below Normal	2,826	2,846	2,977	3,299	3,646	3,966	4,164	4,042	3,599	3,010	2,601	2,574
Dry	2,409	2,431	2,578	2,755	3,168	3,644	3,861	3,774	3,333	2,800	2,539	2,496
Critical Dry	1,873	1,826	1,911	2,050	2,222	2,460	2,386	2,270	1,861	1,409	1,151	1,086
<b>No Action Alternative as Compared to Second Basis of Comparison</b>												
Wet	-117	-208	-77	-22	-8	-5	-3	7	14	2	49	-267
Above Normal	-130	-193	-208	-146	-62	-17	-12	11	60	60	94	-87
Below Normal	-239	-298	-291	-237	-204	-152	-138	-86	-10	-8	42	33
Dry	-64	-148	-150	-135	-134	-139	-123	-106	-48	-33	-42	-35
Critical Dry	-171	-193	-194	-179	-190	-186	-184	-183	-142	-155	-165	-149
<b>No Action Alternative as Compared to Second Basis of Comparison (percent change)</b>												
Wet	-4.2	-7.1	-2.4	-0.6	-0.2	-0.1	-0.1	0.2	0.3	0.1	1.4	-8.2
Above Normal	-5.2	-7.5	-7.4	-4.4	-1.8	-0.4	-0.3	0.3	1.5	1.8	3.2	-3.0
Below Normal	-8.5	-10.5	-9.8	-7.2	-5.6	-3.8	-3.3	-2.1	-0.3	-0.3	1.6	1.3
Dry	-2.6	-6.1	-5.8	-4.9	-4.2	-3.8	-3.2	-2.8	-1.5	-1.2	-1.7	-1.4
Critical Dry	-9.1	-10.6	-10.1	-8.7	-8.6	-7.5	-7.7	-8.0	-7.6	-11.0	-14.4	-13.8

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**Table 5.14 Changes in Shasta Lake Elevation under the No Action Alternative as Compared to the Second Basis of Comparison**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>No Action Alternative</b>												
Wet	991	992	1,008	1,023	1,031	1,041	1,058	1,064	1,056	1,037	1,024	1,005
Above Normal	967	968	982	1,012	1,025	1,048	1,062	1,063	1,049	1,024	1,009	999
Below Normal	986	985	991	1,009	1,025	1,040	1,048	1,045	1,031	1,006	989	987
Dry	969	967	975	986	1,006	1,027	1,037	1,034	1,018	995	982	980
Critical Dry	927	923	929	939	951	968	965	958	935	899	876	872
<b>Second Basis of Comparison</b>												
Wet	997	1,002	1,012	1,024	1,032	1,041	1,058	1,063	1,055	1,037	1,022	1,017
Above Normal	974	978	992	1,019	1,028	1,048	1,062	1,062	1,046	1,021	1,005	1,003
Below Normal	997	998	1,004	1,019	1,034	1,046	1,053	1,049	1,031	1,006	987	986
Dry	972	974	982	992	1,012	1,032	1,041	1,038	1,020	997	984	982
Critical Dry	938	935	941	950	961	977	974	967	943	910	889	884
<b>No Action Alternative as Compared to Second Basis of Comparison</b>												
Wet	-6	-10	-4	-1	0	0	0	0	1	0	2	-12
Above Normal	-7	-10	-10	-7	-3	-1	0	0	2	3	4	-4
Below Normal	-11	-14	-13	-10	-9	-6	-5	-4	-1	-1	2	1
Dry	-3	-7	-7	-6	-6	-6	-5	-4	-2	-2	-3	-2
Critical Dry	-11	-12	-12	-11	-10	-9	-9	-9	-8	-11	-13	-12
<b>No Action Alternative as Compared to Second Basis of Comparison (percent change)</b>												
Wet	-0.6	-1.0	-0.4	-0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.2	-1.2
Above Normal	-0.7	-1.0	-1.0	-0.7	-0.3	-0.1	0.0	0.0	0.2	0.3	0.4	-0.4
Below Normal	-1.1	-1.4	-1.3	-1.0	-0.8	-0.6	-0.5	-0.3	-0.1	-0.1	0.2	0.1
Dry	-0.3	-0.7	-0.7	-0.6	-0.6	-0.5	-0.5	-0.4	-0.2	-0.2	-0.3	-0.2
Critical Dry	-1.2	-1.3	-1.3	-1.1	-1.0	-0.9	-1.0	-1.0	-0.8	-1.2	-1.4	-1.4

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The following changes in Shasta Lake storage and surface water elevations would occur under the No Action Alternative as compared to the Second Basis of Comparison.

- In wet years, storage would be similar in October and December through August and reduced in September and November (up to 8.2 percent).
- In above-normal years, storage would be similar in January through September and reduced in October through December (up to 7.5 percent).
- In below-normal years, storage would be similar in March through September and reduced in October through February (up to 10.5 percent).

- 1 • In dry years, storage would be similar in January through October and reduced  
2 in November and December (up to 6.1 percent).
- 3 • In critical dry years, storage would be reduced under all months (up to  
4 14.4 percent).
- 5 • In all months, in all water year types, surface water elevations would be  
6 similar.

7 The following changes in Sacramento River flows would occur under the No  
8 Action Alternative as compared to the Second Basis of Comparison, as shown on  
9 Figures 5.56 through 5.61.

- 10 • Sacramento River downstream of Keswick Dam (Figures 5.56 through 5.58).
  - 11 – Over long-term conditions, similar flows would occur in October,  
12 February through May, July, and August; increased flows in September  
13 and November (up to 37.7 percent); and reduced flows in December,  
14 January, and June (up to 7.8 percent).
  - 15 – In wet years, similar flows would occur in January through July; increased  
16 flows in September through November (up to 77.7 percent); and reduced  
17 flows in December and August (up to 14.6 percent).
  - 18 – In dry years, similar flows would occur in July through October,  
19 December through March, and May; increased flows in November  
20 (33.4 percent); and reduced flows in April and June (up to 7.3 percent).
- 21 • Sacramento River near Freeport (near the northern boundary of the Delta)  
22 (Figures 5.59 through 5.61).
  - 23 – Over long-term conditions, similar flows would occur in October,  
24 December through May, and August; increased flows in September,  
25 November, and July (up to 43.3 percent); and reduced flows in June  
26 (11.4 percent).
  - 27 – In wet years, similar flows would occur in January through June and  
28 October; increased flows in July through September and November (up to  
29 90.3 percent); and reduced flows in December (10.7 percent).
  - 30 – In dry years, similar flows would occur in August through October and  
31 December through April; increased flows in November and July (up to  
32 15.8 percent); and reduced flows in May and June (up to 11.9 percent).

33 *Lake Oroville and Feather River*

34 Storage levels and surface water elevations in Lake Oroville under the No Action  
35 Alternative as compared to the Second Basis of Comparison are summarized in  
36 Tables 5.15 and 5.16. Changes in flows in the Feather River downstream of  
37 Thermalito Complex are shown on Figures 5.62 through 5.64. The results are  
38 summarized in Table 5.16.

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**Table 5.15 Changes in Lake Oroville Storage under the No Action Alternative as Compared to the Second Basis of Comparison**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>No Action Alternative</b>												
Wet	1,691	1,732	2,189	2,554	2,832	2,942	3,300	3,488	3,445	2,964	2,626	2,109
Above Normal	1,279	1,322	1,485	1,959	2,519	2,892	3,247	3,393	3,232	2,600	2,117	1,659
Below Normal	1,542	1,497	1,507	1,719	2,122	2,397	2,653	2,714	2,530	1,923	1,513	1,307
Dry	1,206	1,158	1,177	1,305	1,582	1,938	2,178	2,210	1,951	1,478	1,287	1,144
Critical Dry	1,092	1,029	1,019	1,108	1,223	1,381	1,408	1,392	1,243	1,018	917	865
<b>Second Basis of Comparison</b>												
Wet	1,936	1,984	2,354	2,636	2,871	2,942	3,300	3,477	3,402	2,976	2,728	2,569
Above Normal	1,465	1,523	1,702	2,173	2,648	2,937	3,271	3,357	3,081	2,493	2,087	1,827
Below Normal	1,823	1,783	1,831	2,037	2,361	2,627	2,875	2,836	2,461	1,930	1,637	1,424
Dry	1,371	1,324	1,344	1,473	1,764	2,120	2,363	2,357	2,031	1,688	1,427	1,261
Critical Dry	1,117	1,044	1,041	1,125	1,235	1,406	1,423	1,407	1,219	1,027	911	839
<b>No Action Alternative as Compared to Second Basis of Comparison</b>												
Wet	-245	-252	-165	-82	-39	0	0	10	43	-12	-102	-459
Above Normal	-187	-201	-217	-214	-129	-44	-24	37	150	107	29	-167
Below Normal	-281	-285	-324	-318	-239	-230	-222	-122	69	-7	-125	-117
Dry	-165	-165	-167	-168	-182	-182	-185	-147	-80	-210	-140	-117
Critical Dry	-25	-15	-22	-17	-12	-25	-16	-15	25	-8	6	26
<b>No Action Alternative as Compared to Second Basis of Comparison (percent change)</b>												
Wet	-12.6	-12.7	-7.0	-3.1	-1.4	0.0	0.0	0.3	1.3	-0.4	-3.7	-17.9
Above Normal	-12.7	-13.2	-12.7	-9.9	-4.9	-1.5	-0.7	1.1	4.9	4.3	1.4	-9.2
Below Normal	-15.4	-16.0	-17.7	-15.6	-10.1	-8.8	-7.7	-4.3	2.8	-0.4	-7.6	-8.2
Dry	-12.0	-12.5	-12.4	-11.4	-10.3	-8.6	-7.8	-6.2	-3.9	-12.4	-9.8	-9.3
Critical Dry	-2.2	-1.5	-2.1	-1.5	-1.0	-1.8	-1.1	-1.1	2.0	-0.8	0.7	3.1

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**Table 5.16 Changes in Lake Oroville Elevation under the No Action Alternative as Compared to the Second Basis of Comparison**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>No Action Alternative</b>												
Wet	743	748	794	829	852	859	884	897	894	861	836	790
Above Normal	698	703	722	776	828	856	880	890	879	835	794	746
Below Normal	730	725	726	751	793	818	838	842	828	773	729	704
Dry	688	683	686	704	737	775	798	800	775	724	702	684
Critical Dry	674	667	664	678	693	712	715	712	693	663	648	640
<b>Second Basis of Comparison</b>												
Wet	768	773	810	837	854	859	884	896	891	861	844	831
Above Normal	717	723	745	796	838	859	882	888	869	826	790	763
Below Normal	757	752	757	779	812	834	854	852	823	775	743	719
Dry	706	701	705	721	755	791	814	813	784	748	718	698
Critical Dry	677	668	668	680	694	715	716	714	691	664	647	636
<b>No Action Alternative as Compared to Second Basis of Comparison</b>												
Wet	-24	-25	-16	-8	-3	0	0	1	3	0	-8	-41
Above Normal	-19	-21	-24	-20	-10	-3	-2	3	10	10	4	-18
Below Normal	-27	-27	-31	-28	-20	-17	-16	-9	5	-1	-14	-14
Dry	-18	-18	-18	-17	-18	-16	-15	-14	-9	-24	-17	-15
Critical Dry	-3	-1	-3	-3	-1	-3	-2	-2	2	0	1	4
<b>No Action Alternative as Compared to Second Basis of Comparison (percent change)</b>												
Wet	-3.2	-3.2	-1.9	-0.9	-0.3	0.0	0.0	0.1	0.3	-0.1	-0.9	-5.0
Above Normal	-2.7	-2.9	-3.2	-2.5	-1.2	-0.4	-0.2	0.3	1.2	1.2	0.5	-2.3
Below Normal	-3.6	-3.6	-4.0	-3.6	-2.4	-2.0	-1.9	-1.1	0.6	-0.2	-1.9	-2.0
Dry	-2.5	-2.6	-2.6	-2.4	-2.4	-2.0	-1.9	-1.7	-1.2	-3.2	-2.3	-2.1
Critical Dry	-0.4	-0.2	-0.5	-0.4	-0.2	-0.4	-0.2	-0.3	0.4	0.0	0.2	0.6

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The following changes in Lake Oroville storage and surface water elevations would occur under the No Action Alternative as compared to the Second Basis of Comparison.

- In wet years, storage would be similar in January through August and reduced in September through December (up to 17.9 percent).
- In above-normal years, storage would be similar in February through August and reduced in September through January (up to 13.2 percent).
- In below-normal years, storage would be similar in May through July and reduced in August through April (up to 17.7 percent).

- 1 • In dry years, storage would be similar in June and reduced in all other months  
2 (up to 12.5 percent).
- 3 • In critical dry years, storage would be similar under all months.
- 4 • In all months, in all water year types, surface water elevations would be  
5 similar.

6 The following changes in Feather River flows would occur under the No Action  
7 Alternative as compared to the Second Basis of Comparison, as shown on  
8 Figures 5.62 through 5.64.

- 9 • Over long-term conditions, similar flows would occur in November and April;  
10 increased flows in July through September (up to 76.1 percent); and reduced  
11 flows in October, December through March, May, and June (up to  
12 27.2 percent).
- 13 • In wet years, similar flows would occur in October through November and  
14 March through May; increased flows in July through September (up to  
15 184 percent) and reduced flows in December through February (up to  
16 26.0 percent).
- 17 • In dry years, similar flows would occur in November through March;  
18 increased flows in April and July (up to 52.4 percent); and reduced flows in  
19 August through October and May and June (up to 27.6 percent).

20 *Folsom Lake and American River*

21 Storage levels and surface water elevations in Folsom Lake under the No Action  
22 Alternative as compared to the Second Basis of Comparison are summarized in  
23 Tables 5.17 and 5.18. Changes in flows in the American River downstream of  
24 Nimbus Dam are shown on Figures 5.65 through 5.67. The results are  
25 summarized in Table 5.18.

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**Table 5.17 Changes in Folsom Lake Storage under the No Action Alternative as Compared to the Second Basis of Comparison**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>No Action Alternative</b>												
Wet	454	435	514	518	515	632	785	951	941	800	712	576
Above Normal	377	380	429	513	531	640	787	946	887	621	552	477
Below Normal	446	431	467	484	533	619	757	843	780	527	472	453
Dry	394	383	408	423	479	579	691	760	658	495	443	419
Critical Dry	324	305	315	320	366	432	475	486	415	327	267	231
<b>Second Basis of Comparison</b>												
Wet	483	470	522	524	515	632	785	951	937	793	688	646
Above Normal	390	412	467	537	538	640	787	946	857	591	522	485
Below Normal	506	489	502	514	541	626	761	847	739	475	408	387
Dry	405	399	423	437	486	585	698	769	664	486	432	408
Critical Dry	339	317	323	325	369	436	469	482	430	352	288	258
<b>No Action Alternative as Compared to Second Basis of Comparison</b>												
Wet	-29	-35	-8	-6	0	0	0	0	4	7	25	-70
Above Normal	-13	-33	-38	-24	-7	0	0	1	30	31	30	-8
Below Normal	-59	-58	-35	-30	-8	-7	-4	-4	41	52	64	66
Dry	-12	-16	-15	-14	-7	-6	-7	-9	-5	9	11	11
Critical Dry	-14	-11	-9	-5	-3	-3	6	4	-16	-25	-21	-28
<b>No Action Alternative as Compared to Second Basis of Comparison (percent change)</b>												
Wet	-6.1	-7.4	-1.5	-1.2	0.0	0.0	0.0	0.0	0.5	0.9	3.6	-10.8
Above Normal	-3.4	-7.9	-8.2	-4.5	-1.3	0.0	0.0	0.1	3.5	5.2	5.7	-1.6
Below Normal	-11.7	-11.9	-7.0	-5.8	-1.4	-1.1	-0.5	-0.5	5.5	11.0	15.6	17.1
Dry	-2.9	-4.0	-3.5	-3.2	-1.4	-1.0	-1.1	-1.1	-0.8	1.9	2.5	2.8
Critical Dry	-4.2	-3.6	-2.7	-1.6	-0.7	-0.7	1.2	0.8	-3.6	-7.2	-7.2	-10.8

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**Table 5.18 Changes in Folsom Lake Elevation under the No Action Alternative as Compared to the Second Basis of Comparison**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>No Action Alternative</b>												
Wet	409	407	418	418	418	432	448	464	464	449	440	425
Above Normal	394	395	405	418	420	433	449	464	458	430	422	413
Below Normal	408	406	411	414	420	431	445	454	447	418	411	409
Dry	400	399	403	405	413	426	438	445	434	414	408	405
Critical Dry	386	384	389	390	396	406	411	412	401	386	374	366
<b>Second Basis of Comparison</b>												
Wet	412	412	419	419	418	432	448	465	464	449	438	433
Above Normal	397	400	410	421	421	433	448	465	456	427	419	414
Below Normal	415	414	416	417	421	432	446	455	443	410	401	398
Dry	401	401	405	407	414	427	439	446	435	413	406	403
Critical Dry	389	386	390	391	397	406	410	411	404	391	378	372
<b>No Action Alternative as Compared to Second Basis of Comparison</b>												
Wet	-4	-5	-1	-1	0	0	0	-1	0	1	3	-8
Above Normal	-2	-5	-5	-3	-1	0	0	-1	3	4	4	-1
Below Normal	-7	-7	-4	-4	-1	-1	-1	-1	4	8	10	10
Dry	-1	-2	-2	-2	-1	-1	-1	-1	-1	1	1	1
Critical Dry	-3	-2	-2	-1	0	0	1	0	-2	-5	-4	-6
<b>No Action Alternative as Compared to Second Basis of Comparison (percent change)</b>												
Wet	-0.9	-1.1	-0.2	-0.2	0.0	0.0	0.0	-0.2	-0.1	0.2	0.6	-1.9
Above Normal	-0.6	-1.3	-1.2	-0.7	-0.2	0.0	0.0	-0.1	0.6	0.9	0.8	-0.2
Below Normal	-1.8	-1.8	-1.1	-0.9	-0.2	-0.2	-0.1	-0.2	0.9	1.9	2.5	2.6
Dry	-0.3	-0.5	-0.5	-0.4	-0.2	-0.2	-0.2	-0.3	-0.2	0.3	0.3	0.4
Critical Dry	-0.7	-0.6	-0.4	-0.2	-0.1	-0.1	0.2	0.1	-0.6	-1.2	-1.1	-1.7

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The following changes in Folsom Lake storage would occur under the No Action Alternative as compared to the Second Basis of Comparison.

- In wet years, storage would be similar in December through August and reduced in September through November (up to 10.8 percent).
- In above-normal years, storage would be similar in January through June, September, and October; reduced in November and December (up to 8.2 percent); and increased in July and August (up to 5.7 percent).
- In below-normal years, storage would be similar in February through May; reduced in October through January (up to 11.9 percent); and increased in July through September (up to 17.1 percent).



- 1 • In dry years, storage would be similar in all months.
- 2 • In critical dry years, storage would be similar in October through June and  
3 reduced in July through September (up to 10.8 percent).
- 4 • In all months, in all water year types, surface water elevations would be  
5 similar.
- 6 The following changes in American River flows would occur under the No Action  
7 Alternative as compared to the Second Basis of Comparison, as shown on  
8 Figures 5.65 through 5.67.
- 9 • Over long-term conditions, similar flows would occur in November through  
10 May and July; increased flows in September and October (up to 44.7 percent);  
11 and reduced flows in June and August (up to 6.1 percent).
- 12 • In wet years, similar flows would occur in October through November and  
13 January through July; increased flows in September (91.1 percent) and  
14 reduced flows in December and August (up to 10.7 percent).
- 15 • In dry years, similar flows would occur in all months except October,  
16 February and July; increased flows in October (16.5 percent); and reduced  
17 flows in February and July (up to 7.3 percent).

18 *Clear Creek*

19 Changes in flows in Clear Creek downstream of Whiskeytown Dam are  
20 summarized in Table 5.19. Monthly Clear Creek flows under the No Action  
21 Alternative as compared to the Second Basis of Comparison are identical except  
22 in May. In May, under the No Action Alternative, flows are up to 40.7 percent  
23 higher than under the Second Basis of Comparison in accordance with the 2009  
24 NMFS BO.

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**Table 5.19 Changes in Clear Creek Flows below Whiskeytown Dam under the No Action Alternative as Compared to the Second Basis of Comparison**

Water Year	Average Monthly Flow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>No Action Alternative</b>												
Wet	200	200	200	309	356	272	200	277	200	85	85	150
Above Normal	181	182	188	192	196	196	196	277	200	85	85	150
Below Normal	195	195	195	195	195	195	195	274	191	85	85	150
Dry	175	184	188	190	190	190	190	267	183	85	85	150
Critical Dry	163	167	167	167	167	167	167	214	111	85	85	133
<b>Second Basis of Comparison</b>												
Wet	200	200	200	309	356	272	200	200	200	85	85	150
Above Normal	181	182	188	192	196	196	196	200	200	85	85	150
Below Normal	195	195	195	195	195	195	195	195	191	85	85	150
Dry	178	184	188	190	190	190	190	190	183	85	85	150
Critical Dry	163	167	167	167	167	167	167	167	111	85	85	133
<b>No Action Alternative as Compared to Second Basis of Comparison</b>												
Wet	0	0	0	0	0	0	0	77	0	0	0	0
Above Normal	0	0	0	0	0	0	0	77	0	0	0	0
Below Normal	0	0	0	0	0	0	0	78	0	0	0	0
Dry	-3	0	0	0	0	0	0	77	0	0	0	0
Critical Dry	0	0	0	0	0	0	0	47	0	0	0	0
<b>No Action Alternative as Compared to Second Basis of Comparison (percent change)</b>												
Wet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.7	0.0	0.0	0.0	0.0
Above Normal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.7	0.0	0.0	0.0	0.0
Below Normal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40.1	0.0	0.0	0.0	0.0
Dry	-1.6	0.0	0.0	0.0	0.0	0.0	0.0	40.7	0.0	0.0	0.0	0.0
Critical Dry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.3	0.0	0.0	0.0	0.0

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*New Melones Reservoir and Stanislaus River*  
Storage levels and surface water elevations in New Melones Reservoir under the No Action Alternative as compared to the Second Basis of Comparison, are summarized in Tables 5.20 and 5.21. Changes in flows in the Stanislaus River downstream of Goodwin Dam are shown on Figures 5.68 through 5.70. The results are summarized in Table 5.21.

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**Table 5.20 Changes in New Melones Reservoir Storage under the No Action Alternative as Compared to the Second Basis of Comparison**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>No Action Alternative</b>												
Wet	1,379	1,390	1,454	1,562	1,666	1,724	1,758	1,878	1,968	1,890	1,773	1,703
Above Normal	1,029	1,060	1,125	1,214	1,317	1,406	1,413	1,484	1,467	1,372	1,277	1,232
Below Normal	1,294	1,305	1,326	1,351	1,413	1,438	1,390	1,383	1,359	1,268	1,175	1,133
Dry	1,094	1,094	1,106	1,121	1,156	1,188	1,154	1,132	1,087	997	914	871
Critical Dry	624	623	638	645	661	656	602	554	526	476	431	408
<b>Second Basis of Comparison</b>												
Wet	1,443	1,446	1,502	1,606	1,709	1,794	1,833	1,962	1,994	1,917	1,803	1,731
Above Normal	1,092	1,116	1,175	1,261	1,360	1,455	1,481	1,543	1,516	1,419	1,321	1,274
Below Normal	1,364	1,366	1,378	1,397	1,453	1,479	1,461	1,447	1,415	1,322	1,228	1,183
Dry	1,149	1,143	1,149	1,161	1,191	1,221	1,210	1,176	1,131	1,039	956	912
Critical Dry	667	663	674	680	696	690	646	585	557	498	449	426
<b>No Action Alternative as Compared to Second Basis of Comparison</b>												
Wet	-64	-56	-49	-44	-43	-70	-75	-84	-25	-27	-30	-28
Above Normal	-62	-56	-50	-46	-43	-48	-68	-59	-49	-46	-44	-42
Below Normal	-69	-61	-52	-46	-40	-41	-71	-63	-55	-54	-52	-51
Dry	-55	-49	-43	-40	-35	-33	-56	-45	-44	-43	-42	-42
Critical Dry	-44	-40	-37	-36	-35	-34	-45	-31	-31	-23	-18	-18
<b>No Action Alternative as Compared to Second Basis of Comparison (percent change)</b>												
Wet	-4.4	-3.9	-3.2	-2.7	-2.5	-3.9	-4.1	-4.3	-1.3	-1.4	-1.6	-1.6
Above Normal	-5.7	-5.0	-4.2	-3.7	-3.2	-3.3	-4.6	-3.8	-3.3	-3.3	-3.3	-3.3
Below Normal	-5.1	-4.5	-3.8	-3.3	-2.8	-2.8	-4.9	-4.4	-3.9	-4.1	-4.3	-4.3
Dry	-4.8	-4.3	-3.8	-3.4	-3.0	-2.7	-4.6	-3.8	-3.9	-4.1	-4.4	-4.6
Critical Dry	-6.6	-6.1	-5.4	-5.2	-5.0	-5.0	-6.9	-5.3	-5.5	-4.5	-4.0	-4.2

1 **Table 5.21 Changes in New Melones Reservoir Elevation under the No Action**  
 2 **Alternative as Compared to the Second Basis of Comparison**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>No Action Alternative</b>												
Wet	980	982	990	1,004	1,016	1,023	1,026	1,039	1,047	1,040	1,029	1,022
Above Normal	932	937	945	960	974	986	988	997	996	985	973	967
Below Normal	968	969	972	975	985	988	985	985	983	972	960	955
Dry	943	943	944	947	951	957	955	953	948	934	922	915
Critical Dry	856	856	862	864	870	871	860	848	840	828	818	812
<b>Second Basis of Comparison</b>												
Wet	989	990	997	1,009	1,021	1,030	1,034	1,047	1,050	1,043	1,032	1,025
Above Normal	941	944	951	966	979	992	995	1,003	1,001	990	978	972
Below Normal	977	977	979	982	991	994	994	993	991	980	968	962
Dry	951	950	950	953	957	962	963	960	954	941	929	922
Critical Dry	866	866	870	872	878	879	871	856	850	835	823	817
<b>No Action Alternative as Compared to Second Basis of Comparison</b>												
Wet	-9	-8	-7	-6	-5	-8	-8	-8	-3	-3	-3	-3
Above Normal	-9	-7	-6	-6	-6	-6	-8	-7	-5	-5	-5	-5
Below Normal	-9	-8	-7	-7	-6	-6	-9	-8	-7	-8	-8	-8
Dry	-8	-7	-6	-6	-5	-5	-8	-7	-7	-7	-7	-7
Critical Dry	-10	-10	-9	-8	-8	-8	-11	-8	-10	-6	-5	-6
<b>No Action Alternative as Compared to Second Basis of Comparison (percent change)</b>												
Wet	-0.9	-0.8	-0.7	-0.6	-0.5	-0.7	-0.8	-0.8	-0.3	-0.3	-0.3	-0.3
Above Normal	-0.9	-0.8	-0.7	-0.6	-0.6	-0.6	-0.8	-0.7	-0.5	-0.5	-0.5	-0.5
Below Normal	-0.9	-0.8	-0.7	-0.7	-0.6	-0.6	-0.9	-0.8	-0.7	-0.8	-0.8	-0.8
Dry	-0.8	-0.8	-0.7	-0.7	-0.6	-0.5	-0.9	-0.7	-0.7	-0.7	-0.8	-0.8
Critical Dry	-1.2	-1.1	-1.0	-1.0	-0.9	-0.9	-1.2	-1.0	-1.2	-0.8	-0.6	-0.7

- 3 The following changes in New Melones Reservoir storage would occur under the  
 4 No Action Alternative as compared to the Second Basis of Comparison.
- 5 • In wet, below-normal, and dry years, storage would be similar in all months.
  - 6 • In above-normal years, storage would be similar in all months except October  
 7 when storage would be reduced by 5.7 percent.
  - 8 • In critical dry years, storage would be similar in February, March, and July  
 9 through September and reduced in October through January and April through  
 10 June (up to 6.9 percent).

- 1 • In all months, in all water year types, surface water elevations would be  
2 similar.

3 Flows in the Stanislaus River downstream of Goodwin Dam are shown on  
4 Figures 5.68 to 5.70. Changes in flows in these rivers are summarized below.

- 5 • Over long-term conditions, similar flows would occur in May and July  
6 through September; increased flows in October, March, and April (up to  
7 148.7 percent); and reduced flows in November through February and June  
8 (up to 33.8 percent).
- 9 • In wet years, similar flows would occur in February and April; increased  
10 flows in October, March, May, July, and August (up to 117.1 percent); and  
11 reduced flows in September, November through January, and June (up to  
12 50.8 percent).
- 13 • In dry years, similar flows would occur in July through September; increased  
14 flows in October and April (up to 154.3 percent); and reduced flows in  
15 November through March, May, and June (up to 35.7 percent).

16 *San Joaquin River at Vernalis*

17 Flows in the San Joaquin River at Vernalis are summarized below, as shown on  
18 Figures 5.71 through 5.73.

- 19 • Over long-term conditions, similar flows would occur in July through  
20 September and November through May; increased flows in October  
21 (19 percent); and reduced flows in June (8 percent).
- 22 • In wet years, similar flows would occur in July through September and  
23 November through May; increased flows in October (16.8 percent); and  
24 reduced flows in June (9.4 percent).
- 25 • In dry years, similar flows would occur in November through March and May  
26 through September; and increased flows in October and April (up to  
27 18.3 percent).

28 *San Luis Reservoir*

29 Storage levels and surface water elevations in San Luis Reservoir under the No  
30 Action Alternative as compared to the Second Basis of Comparison are  
31 summarized in Tables 5.22 and 5.23. A summary of the results is provided  
32 following Table 5.23.

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**Table 5.22 Changes in San Luis Reservoir Storage under the No Action Alternative as Compared to the Second Basis of Comparison**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>No Action Alternative</b>												
Wet	555	681	931	1,236	1,526	1,788	1,598	1,251	946	741	628	679
Above Normal	490	649	957	1,223	1,441	1,661	1,444	1,048	666	466	433	513
Below Normal	525	624	907	1,141	1,314	1,473	1,312	967	555	500	426	467
Dry	476	590	867	1,150	1,339	1,494	1,413	1,167	840	763	476	469
Critical Dry	478	556	752	1,040	1,204	1,252	1,192	1,028	739	544	343	323
<b>Second Basis of Comparison</b>												
Wet	790	1,017	1,365	1,748	1,965	2,033	2,031	1,852	1,487	1,167	889	925
Above Normal	658	883	1,213	1,671	1,913	2,001	1,995	1,717	1,263	861	612	631
Below Normal	854	1,064	1,334	1,742	1,908	1,980	1,908	1,628	1,251	964	635	591
Dry	617	764	998	1,427	1,728	1,925	1,870	1,665	1,341	1,007	660	596
Critical Dry	622	709	910	1,257	1,556	1,664	1,623	1,451	1,168	808	545	472
<b>No Action Alternative as Compared to Second Basis of Comparison</b>												
Wet	-234	-336	-433	-513	-439	-245	-433	-601	-541	-426	-261	-245
Above Normal	-168	-234	-257	-448	-471	-341	-551	-669	-598	-395	-179	-117
Below Normal	-329	-439	-427	-601	-594	-507	-596	-660	-696	-465	-209	-124
Dry	-141	-174	-130	-277	-390	-431	-457	-498	-501	-244	-185	-127
Critical Dry	-144	-153	-158	-217	-352	-412	-431	-423	-429	-263	-202	-149
<b>No Action Alternative as Compared to Second Basis of Comparison (percent change)</b>												
Wet	-25.2	-19.8	-21.2	-29.1	-11.8	9.4	-57.2	-51.8	-2.3	5.8	9.6	-3.2
Above Normal	-12.2	-13.6	-12.2	-43.4	-31.3	-12.9	-71.2	-71.0	-24.1	2.6	9.5	-3.5
Below Normal	-29.6	-23.4	-5.3	-42.6	-28.7	-21.2	-60.1	-67.1	-49.5	4.5	20.4	0.7
Dry	-14.0	-16.3	-6.7	-32.3	-39.1	-35.5	-40.7	-44.9	-29.3	34.2	-9.2	-2.8
Critical Dry	-7.7	-15.2	-15.7	-19.4	-38.4	-32.7	-30.7	-25.3	-51.1	60.2	-13.0	-3.0

1 **Table 5.23 Changes in San Luis Reservoir Elevation under the No Action**  
 2 **Alternative as Compared to the Second Basis of Comparison**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>No Action Alternative</b>												
Wet	399	414	443	473	500	523	507	475	444	422	409	416
Above Normal	391	411	445	472	492	512	493	456	415	389	386	398
Below Normal	397	410	442	465	481	496	481	448	400	393	383	389
Dry	391	406	437	466	484	498	490	468	434	426	390	389
Critical Dry	390	400	423	454	470	475	469	453	422	399	369	366
<b>Second Basis of Comparison</b>												
Wet	426	451	485	520	538	543	543	529	497	468	440	443
Above Normal	412	437	470	513	534	541	540	518	477	437	409	411
Below Normal	435	457	483	519	533	539	533	510	476	448	412	406
Dry	407	425	450	492	518	535	530	513	484	453	415	406
Critical Dry	409	419	441	475	502	512	509	494	468	432	400	389
<b>No Action Alternative as Compared to Second Basis of Comparison</b>												
Wet	-26	-37	-42	-46	-38	-20	-36	-53	-53	-46	-30	-27
Above Normal	-21	-26	-25	-41	-41	-29	-47	-61	-62	-48	-23	-14
Below Normal	-38	-47	-42	-54	-52	-43	-52	-62	-76	-56	-30	-17
Dry	-17	-19	-12	-25	-34	-37	-40	-45	-51	-27	-25	-18
Critical Dry	-19	-20	-18	-21	-32	-38	-40	-41	-45	-32	-32	-24
<b>No Action Alternative as Compared to Second Basis of Comparison (percent change)</b>												
Wet	-6.2	-8.2	-8.7	-8.9	-7.0	-3.7	-6.7	-10.1	-10.7	-9.8	-6.9	-6.1
Above Normal	-5.1	-6.0	-5.4	-8.1	-7.7	-5.3	-8.7	-11.8	-13.0	-11.0	-5.7	-3.3
Below Normal	-8.6	-10.2	-8.6	-10.4	-9.8	-8.0	-9.7	-12.1	-16.0	-12.4	-7.2	-4.1
Dry	-4.1	-4.4	-2.8	-5.1	-6.6	-6.9	-7.5	-8.8	-10.4	-5.9	-6.0	-4.3
Critical Dry	-4.7	-4.7	-4.1	-4.5	-6.4	-7.3	-7.8	-8.3	-9.7	-7.4	-7.9	-6.2

3 The following changes in San Luis Reservoir storage would occur under the No  
 4 Action Alternative as compared to the Second Basis of Comparison.

- 5 • In wet years, storage would be similar in June and September; increased in  
 6 March, July, and August (up to 9.6 percent); and reduced in October through  
 7 February, April, and May (up to 57.2 percent).
- 8 • In above-normal years, storage would be similar in July and September;  
 9 increased in August (9.5 percent); and reduced in October through June (up to  
 10 71.2 percent).

- 1 • In below-normal years, storage would be similar in July and September;  
2 increased in August (20.4 percent); and reduced in October through June (up  
3 to 67.1 percent).
- 4 • In dry years, storage would be similar in September; increased in July  
5 (34.2 percent); and reduced in October through June and August (up to  
6 44.0 percent).
- 7 • In critical dry years, storage would be similar in September; increased in July  
8 (60.2 percent); and reduced in August and October through June (up to  
9 51.1 percent).

10 The following changes in San Luis Reservoir surface water elevations would  
11 occur under the No Action Alternative as compared to the Second Basis of  
12 Comparison.

- 13 • In wet years, surface water elevations would be less in all months (up to  
14 10.7 percent).
- 15 • In above-normal years, surface water elevations would be less in all months  
16 (up to 13.0 percent).
- 17 • In below-normal years, surface water elevations would be less in all months  
18 (up to 16.0 percent).
- 19 • In dry years, surface water elevations would be similar in September through  
20 January and less in February through August (up to 10.4 percent).
- 21 • In critical dry years, surface water elevations would be similar in October  
22 through January and reduced in February through September (up to  
23 9.7 percent).

24 *Changes in Flows into the Yolo Bypass at Fremont Weir*

25 Flows from the Sacramento River into the Yolo Bypass at Fremont Weir under  
26 the No Action Alternative as compared to the Second Basis of Comparison are  
27 summarized in Table 5.24. The results are summarized following Table 5.24.



1 **Table 5.24 Changes in Flows into the Yolo Bypass at Fremont Weir under the No**  
 2 **Action Alternative as Compared to the Second Basis of Comparison**

Water Year	Average Monthly Flow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>No Action Alternative</b>												
Wet	183	910	8,420	24,291	29,547	18,493	5,627	289	113	0	0	100
Above Normal	100	100	2,765	5,997	13,013	7,928	1,688	100	100	0	0	100
Below Normal	100	100	242	1,004	3,031	883	293	100	100	0	0	100
Dry	100	100	322	902	2,024	1,393	407	100	100	0	0	100
Critical Dry	100	100	149	528	534	396	106	100	100	0	0	100
<b>Second Basis of Comparison</b>												
Wet	147	996	9,888	25,442	30,547	18,997	5,602	289	113	0	0	100
Above Normal	100	100	2,659	6,349	15,114	8,566	1,765	100	100	0	0	100
Below Normal	100	100	262	1,256	4,057	1,166	292	100	100	0	0	100
Dry	100	100	342	932	2,032	1,411	411	100	100	0	0	100
Critical Dry	100	100	149	542	533	408	106	100	100	0	0	100
<b>No Action Alternative as Compared to Second Basis of Comparison</b>												
Wet	37	-86	-1,468	-1,151	-1,000	-504	25	0	0	0	0	0
Above Normal	0	0	106	-352	-2,102	-638	-77	0	0	0	0	0
Below Normal	0	0	-20	-253	-1,026	-283	1	0	0	0	0	0
Dry	0	0	-20	-30	-7	-17	-4	0	0	0	0	0
Critical Dry	0	0	-1	-15	1	-12	0	0	0	0	0	0
<b>No Action Alternative as Compared to Second Basis of Comparison (percent change)</b>												
Wet	25.0	-8.7	-14.8	-4.5	-3.3	-2.7	0.4	-0.1	-0.1	0.0	0.0	0.0
Above Normal	0.0	0.0	4.0	-5.5	-13.9	-7.4	-4.3	0.0	0.0	0.0	0.0	0.0
Below Normal	0.0	0.0	-7.5	-20.1	-25.3	-24.3	0.3	0.0	0.0	0.0	0.0	0.0
Dry	0.0	0.0	-5.9	-3.2	-0.4	-1.2	-1.0	0.0	0.0	0.0	0.0	0.0
Critical Dry	0.0	0.0	-0.5	-2.7	0.2	-2.9	0.0	0.0	0.0	0.0	0.0	0.0

3 The following changes in flows from the Sacramento River into Yolo Bypass at  
 4 Fremont Weir would occur under the No Action Alternative as compared to the  
 5 Second Basis of Comparison.

- 6 • In wet years, flows into Yolo Bypass would be similar in January through  
 7 September; increased in October (25 percent); and reduced in November and  
 8 December (up to 14.8 percent).
- 9 • In above-normal years, flows into Yolo Bypass would be similar in April  
 10 through December and reduced in January through March (up to  
 11 13.9 percent).

- 1 • In below-normal years, flows into Yolo Bypass would be similar in April  
2 through November and reduced in December through March (up to  
3 25.3 percent).
- 4 • In dry years, flows into Yolo Bypass would be similar in January through  
5 November and reduced in December (5.9 percent).
- 6 • In critical dry years, flows into Yolo Bypass would be similar in all months.

7 *Changes in Delta Conditions*

8 Delta outflow under the No Action Alternative as compared to the Second Basis  
9 of Comparison are summarized below and shown on Figures 5.74 through 5.76.

- 10 • In wet years, average monthly Delta outflow in July through November,  
11 January, April, and May (up to 13,683 cfs) and decrease in December,  
12 February, March, and June (up to 1,590 cfs).
- 13 • In dry years, average monthly Delta outflow would be similar or increase (up  
14 to 3,114 cfs).

15 The OMR conditions under the No Action Alternative as compared to the Second  
16 Basis of Comparison are summarized below and shown on Figures 5.76  
17 through 5.78.

- 18 • Under the No Action Alternative, OMR flows are negative except in April and  
19 May of wet and above normal years and April of below normal years. Under  
20 the Second Basis of Comparison, OMR flows are negative in all months of all  
21 water year types.
- 22 • In wet years, average monthly OMR flows would be more positive in  
23 September through February, April, and May (up to 10,005 cfs) and more  
24 negative in March and June through August (up to 923 cfs).
- 25 • In dry years, average monthly OMR flows would be more positive in August  
26 through June (up to 3,489 cfs) and more negative in June (2,073 cfs).

27 *Changes in CVP and SWP Exports and Deliveries*

28 Delta exports under the No Action Alternative as compared to the Second Basis  
29 of Comparison are summarized in Table 5.25.

1 **Table 5.25 Changes in Exports at Jones and Banks Pumping Plants under the No**  
 2 **Action Alternative as Compared to the Second Basis of Comparison**

Water Year	Monthly Volume (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>No Action Alternative</b>												
Wet	410	497	564	513	537	594	204	207	445	669	717	638
Above Normal	376	450	562	406	401	496	130	105	315	587	709	628
Below Normal	386	456	590	387	354	394	134	100	209	657	622	542
Dry	374	398	510	392	315	318	153	126	194	541	296	426
Critical Dry	314	293	384	349	250	179	93	90	64	223	176	242
<b>Second Basis of Comparison</b>												
Wet	549	619	716	724	609	543	476	430	456	632	655	660
Above Normal	428	521	641	716	584	570	453	363	415	572	647	651
Below Normal	548	595	623	674	497	500	337	304	414	629	517	539
Dry	435	475	546	579	518	493	259	228	274	403	325	438
Critical Dry	340	345	455	433	406	266	134	121	132	139	203	249
<b>No Action Alternative as Compared to Second Basis of Comparison</b>												
Wet	-139	-123	-152	-211	-72	51	-272	-223	-11	37	63	-21
Above Normal	-52	-71	-78	-311	-183	-73	-322	-257	-100	15	61	-23
Below Normal	-162	-139	-33	-287	-143	-106	-203	-204	-205	28	105	4
Dry	-61	-77	-36	-187	-202	-175	-105	-102	-80	138	-30	-12
Critical Dry	-26	-52	-71	-84	-156	-87	-41	-31	-67	84	-26	-8
<b>No Action Alternative as Compared to Second Basis of Comparison (percent change)</b>												
Wet	-25.2	-19.8	-21.2	-29.1	-11.8	9.4	-57.2	-51.8	-2.3	5.8	9.6	-3.2
Above Normal	-12.2	-13.6	-12.2	-43.4	-31.3	-12.9	-71.2	-71.0	-24.1	2.6	9.5	-3.5
Below Normal	-29.6	-23.4	-5.3	-42.6	-28.7	-21.2	-60.1	-67.1	-49.5	4.5	20.4	0.7
Dry	-14.0	-16.3	-6.7	-32.3	-39.1	-35.5	-40.7	-44.9	-29.3	34.2	-9.2	-2.8
Critical Dry	-7.7	-15.2	-15.7	-19.4	-38.4	-32.7	-30.7	-25.3	-51.1	60.2	-13.0	-3.0

- 3 The following changes would occur in CVP and SWP exports under the No  
 4 Action Alternative as compared to the Second Basis of Comparison.
- 5 • Long-term average annual exports would be 1,051 TAF (18 percent) less  
 6 under the No Action Alternative as compared to the Second Basis of  
 7 Comparison.
  - 8 • In wet years, total exports would be similar in June and September; reduced in  
 9 October through February, April, and May (up to 57.2 percent); and increased  
 10 in March, July, and August (up to 9.6 percent).
  - 11 • In above-normal and below-normal years, total exports would be similar in  
 12 July and September; reduced in October through June (up to 71.2 and

1 67.1 percent, respectively); and increased in August (up to 9.5 and  
 2 20.4 percent, respectively).

- 3 • In dry and critical dry years, total exports would be similar in September;  
 4 reduced in October through June and August (up to 44.9 and 51.1 percent,  
 5 respectively); and increased in July (34.2 and 60.2 percent, respectively).

6 Deliveries to CVP and SWP water users decline under the No Action  
 7 Alternative as compared to the Second Basis of Comparison, as summarized in  
 8 Tables 5.26 and 5.27, respectively, due to reduced water supply availability and  
 9 export limitations.

10 **Table 5.26 Changes in CVP Water Deliveries under the No Action Alternative as**  
 11 **Compared to the Second Basis of Comparison**

Annual Average Deliveries (TAF)					
		No Action Alternative	Second Basis of Comparison	No Action Alternative as Compared to the Second Basis of Comparison	
				Difference	Percent Change
<b>North of Delta</b>					
CVP Agricultural Water Service Contractors	Long Term	185	219	-34	-16
	Dry	86	122	-37	-30
	Critical Dry	24	35	-12	-34
CVP Municipal and Industrial (M&I) (Including American River Contractors and CCWD)	Long Term	386	392	-7	-2
	Dry	385	390	-5	-1
	Critical Dry	383	383	1	0
CVP M&I American River Contractors	Long Term	113	120	-7	-6
	Dry	97	105	-8	-8
	Critical Dry	75	79	-5	-6
CVP Sacramento River Settlement Contractors	Long Term	1,859	1,858	1	0
	Dry	1,906	1,905	1	0
	Critical Dry	1,737	1,732	5	0
CVP Refuge Level 2 Deliveries	Long Term	146	155	-8	-5
	Dry	146	151	-5	-3
	Critical Dry	102	105	-3	-3

Annual Average Deliveries (TAF)					
		No Action Alternative	Second Basis of Comparison	No Action Alternative as Compared to the Second Basis of Comparison	
				Difference	Percent Change
Total CVP Agricultural, M&I, Sacramento River Settlement Contractors, and Refuge Level 2 Deliveries	Long Term	2,576	2,624	-48	-2
	Dry	2,523	2,568	-45	-2
	Critical Dry	2,246	2,255	-9	0
<b>South of Delta (Does not include Eastside Contractors)</b>					
CVP Agricultural Water Service Contractors	Long Term	847	1,100	-253	-23
	Dry	445	650	-206	-32
	Critical Dry	131	195	-64	-33
CVP M&I Users	Long Term	112	125	-13	-10
	Dry	99	109	-10	-9
	Critical Dry	80	85	-4	-5
San Joaquin River Exchange Contractors	Long Term	852	852	0	0
	Dry	875	875	0	0
	Critical Dry	741	741	0	0
CVP Refuge Level 2 Deliveries	Long Term	273	272	1	0
	Dry	281	280	1	0
	Critical Dry	234	232	3	1
Total CVP Agricultural, M&I, San Joaquin River Exchange Contractors, and Refuge Level 2 Deliveries	Long Term	2,084	2,349	-266	-11
	Dry	1,700	1,914	-216	-11
	Critical Dry	1,186	1,253	-68	-5
<b>Eastside Contractors Deliveries</b>					
Water Rights	Long Term	508	514	-6	-1
	Dry	524	524	0	0
	Critical Dry	445	486	-42	-9

Annual Average Deliveries (TAF)					
		No Action Alternative	Second Basis of Comparison	No Action Alternative as Compared to the Second Basis of Comparison	
				Difference	Percent Change
CVP Water Service Contracts	Long Term	104	118	-15	-13
	Dry	84	98	-13	-13
	Critical Dry	4	25	-21	-84
Total Water Rights and CVP Service Contracts Deliveries	Long Term	612	632	-21	-3
	Dry	608	622	-13	-2
	Critical Dry	449	511	-63	-12

1 The following changes in CVP water deliveries would occur under the No Action  
 2 Alternative as compared to the Second Basis of Comparison.

- 3 • Deliveries to CVP North of Delta agricultural water service contractors would  
 4 be reduced by 16 percent over the long-term conditions (averaged over the  
 5 82-year period analyzed with CalSim II), 30 percent in dry years, and  
 6 34 percent in critical dry years.
- 7 • Deliveries to CVP North of Delta M&I contractors would be similar in total;  
 8 however, deliveries to the American River CVP contractors would be reduced  
 9 by 6 percent over the long-term conditions, 8 percent in dry years, and 6  
 10 percent in critical dry years.
- 11 • Deliveries to CVP South of Delta agricultural water service contractors would  
 12 be reduced by 23 percent over the long-term conditions, 32 percent in dry  
 13 years, and 33 percent in critical dry years.
- 14 • Deliveries to CVP South of Delta M&I contractors would be reduced by  
 15 10 percent over the long-term conditions, 9 percent in dry years, and 5 percent  
 16 in critical dry years.
- 17 • Deliveries to the Eastside contractors would be similar under the long-term  
 18 conditions and dry years, but reduce by 12 percent in critical dry years.

1 **Table 5.27 Changes in SWP Water Deliveries under the No Action Alternative as**  
 2 **Compared to the Second Basis of Comparison**

Annual Average Deliveries (TAF)					
		No Action Alternative	Second Basis of Comparison	No Action Alternative as Compared to the Second Basis of Comparison	
				Difference	Percent Change
<b>North of Delta</b>					
SWP Agricultural Uses	Long Term	0	0	0	0
	Dry	0	0	0	0
	Critical Dry	0	0	0	0
SWP M&I (without Article 21)	Long Term	68	83	-15	-18
	Dry	51	62	-11	-18
	Critical Dry	43	53	-11	-20
SWP M&I Article 21 Deliveries	Long Term	13	12	1	9
	Dry	14	13	1	7
	Critical Dry	13	12	1	9
Total SWP Agricultural and M&I (without Article 21)	Long Term	68	83	-15	-18
	Dry	51	62	-11	-18
	Critical Dry	43	53	-11	-20
Total SWP Agricultural and M&I Article 21 Deliveries	Long Term	13	12	1	9
	Dry	14	13	1	7
	Critical Dry	13	12	1	9
<b>South of Delta</b>					
SWP Agricultural Users (without Article 21)	Long Term	610	750	-139	-19
	Dry	455	567	-112	-20
	Critical Dry	378	484	-106	-22

Annual Average Deliveries (TAF)					
		No Action Alternative	Second Basis of Comparison	No Action Alternative as Compared to the Second Basis of Comparison	
				Difference	Percent Change
SWP Agricultural Article 21 Deliveries	Long Term	27	178	-152	-85
	Dry	5	143	-138	-96
	Critical Dry	7	100	-93	-93
SWP M&I Users (without Article 21)	Long Term	1,800	2,183	-383	-18
	Dry	1,406	1,732	-327	-19
	Critical Dry	1,173	1,494	-321	-21
SWP M&I Article 21 Deliveries	Long Term	20	104	-84	-81
	Dry	5	86	-82	-95
	Critical Dry	5	58	-53	-91
Total SWP Agricultural and M&I Users (without Article 21)	Long Term	2,410	2,933	-523	-18
	Dry	1,861	2,299	-439	-19
	Critical Dry	1,551	1,978	-427	-22
Total SWP Agricultural and M&I Article 21 Deliveries	Long Term	47	282	-236	-83
	Dry	10	229	-219	-96
	Critical Dry	12	158	-146	-92

- 1 The following changes in SWP water deliveries would occur under the No Action
- 2 Alternative as compared to the Second Basis of Comparison.
- 3 • Deliveries without Article 21 water to SWP North of Delta water contractors
- 4 would be reduced by 18 percent over the long-term conditions; 18 percent in
- 5 dry years; and 20 percent in critical dry years.
- 6 • Deliveries without Article 21 water to SWP South of Delta water contractors
- 7 would be reduced by 18 percent over the long-term conditions; 19 percent in
- 8 dry years; and 22 percent in critical dry years.



- 1 • Deliveries of Article 21 water to SWP North of Delta water contractors would  
2 be increased by 9 percent over the long-term conditions; 7 percent in dry  
3 years; and 9 percent in critical dry years.
- 4 • Deliveries of Article 21 water to SWP South of Delta water contractors would  
5 be reduced by 83 percent over the long-term conditions; 96 percent in dry  
6 years; and 92 percent in critical dry years.

7 *Effects Related to Cross Delta Water Transfers*

8 Potential effects to surface water resources could be similar to those identified in  
9 a recent environmental analysis conducted by Reclamation for long-term water  
10 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014i).  
11 Potential effects were identified as reduced surface water storage in upstream  
12 reservoirs and changes in flow patterns in river downstream of the reservoirs if  
13 water was released from the reservoirs in patterns that were different than would  
14 have been used by the water seller's. Because all water transfers would be  
15 required to avoid adverse impacts to other water users and biological resources  
16 (see Section 3.A.6.3, Transfers), including impacts associated with changes in  
17 reservoir storage and river flow patterns; the analysis indicated that water  
18 transfers would not result in substantial changes in storage or river flows. For the  
19 purposes of this EIS, it is anticipated that similar conditions would occur due to  
20 cross Delta water transfers under the No Action Alternative and the Second Basis  
21 of Comparison.

22 Under the No Action Alternative, the timing of cross Delta water transfers would  
23 be limited to July through September in accordance with the 2008 USFWS BO  
24 and 2009 NMFS BO. The maximum amount of water to be transferred would be  
25 600,000 acre-feet per year in critical dry years or in dry years following a dry or  
26 critical dry year. In all other water year types, the maximum amount of water  
27 would be 360,000 acre-feet per year. The maximum amount of water that can be  
28 exported in the CVP and SWP facilities is approximately 770,000 acre-feet per  
29 month. As indicated in Table 5.25, capacity would be available under the No  
30 Action Alternative between July and September for water transfers in all water  
31 year types.

32 Under the Second Basis of Comparison, water could be transferred throughout the  
33 year. As indicated in Table 5.25, capacity would be available under the Second  
34 Basis of Comparison in all months of all water year types without a maximum  
35 volume of transferred water.

36 Overall, the potential for water transfer conveyance would be less under the No  
37 Action Alternative than under the Second Basis of Comparison.

38 **5.4.3.1.3 San Francisco Bay Area, Central Coast, and Southern California**  
39 **Regions**

40 *Potential Changes in Surface Water Resources at Reservoirs that Store CVP and*  
41 *SWP Water*

42 The San Francisco Bay Area, Central Coast, and Southern California regions  
43 include numerous reservoirs that store CVP and SWP water supplies, including

1 CVP and SWP reservoirs, that primarily provide water supplies for M&I water  
2 users. Changes in the availability of CVP and SWP water supplies for storage in  
3 these reservoirs under the No Action Alternative as compared to the Second Basis  
4 of Comparison would be consistent with the following changes in water deliveries  
5 to M&I water users, as summarized in Tables 5.26 and 5.27.

- 6 • Deliveries to CVP South of Delta M&I contractors and reservoirs in the San  
7 Francisco Bay Area would be reduced by 10 percent over the long-term  
8 conditions; 9 percent in dry years; and 7 percent in critical dry years.
- 9 • Deliveries without Article 21 water to SWP South of Delta water contractors  
10 and reservoirs in the San Francisco Bay Area, Central Coast, and Southern  
11 California regions would be reduced by 18 percent over the long-term  
12 conditions; 19 percent in dry years; and 22 percent in critical dry years.
- 13 • Deliveries of Article 21 water to SWP South of Delta water contractors and  
14 reservoirs in the San Francisco Bay Area, Central Coast, and Southern  
15 California regions would be reduced by 83 percent over the long-term  
16 conditions; 96 percent in dry years; and 92 percent in critical dry years.

17 *Changes in CVP and SWP Deliveries*

18 Deliveries to CVP and SWP water users are described in Section 5.4.3.1.2,  
19 Central Valley Region.

20 **5.4.3.2 Alternative 1**

21 As described in Chapter 3, Description of Alternatives, Alternative 1 is identical  
22 to the Second Basis of Comparison. Alternative 1 is compared to the No Action  
23 Alternative and the Second Basis of Comparison. However, because water  
24 resource conditions under Alternative 1 are identical to water resource conditions  
25 under the Second Basis of Comparison; Alternative 1 is only compared to the No  
26 Action Alternative.

27 **5.4.3.2.1 Alternative 1 Compared to the No Action Alternative**

28 *Trinity River Region*

29 *Changes in CVP and SWP Reservoir Storage and Downstream River Flows*

30 Changes in Trinity Lake storage and surface water elevations under Alternative 1  
31 as compared to the No Action Alternative are summarized in Tables 5.28  
32 and 5.29. A summary of the results is provided following Table 5.29.

1  
2

**Table 5.28 Changes in Trinity Lake Storage under Alternative 1 as Compared to the No Action Alternative**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 1</b>												
Wet	1,501	1,535	1,644	1,767	1,931	2,055	2,224	2,250	2,194	2,068	1,939	1,805
Above Normal	1,208	1,245	1,363	1,524	1,718	1,901	2,079	2,053	1,955	1,815	1,647	1,513
Below Normal	1,451	1,472	1,492	1,554	1,641	1,729	1,872	1,799	1,696	1,515	1,337	1,204
Dry	1,178	1,184	1,210	1,230	1,322	1,453	1,586	1,536	1,466	1,302	1,152	1,055
Critical Dry	819	803	813	825	868	949	999	962	929	811	667	598
<b>No Action Alternative</b>												
Wet	1,490	1,516	1,630	1,756	1,921	2,053	2,220	2,245	2,190	2,067	1,939	1,784
Above Normal	1,159	1,178	1,286	1,455	1,658	1,847	2,025	1,999	1,907	1,773	1,619	1,495
Below Normal	1,393	1,400	1,417	1,488	1,575	1,662	1,817	1,743	1,637	1,470	1,304	1,185
Dry	1,152	1,148	1,174	1,182	1,274	1,403	1,539	1,490	1,413	1,253	1,104	1,008
Critical Dry	747	731	746	750	790	872	923	888	862	745	612	536
<b>Alternative 1 as Compared to No Action Alternative</b>												
Wet	11	19	14	11	9	2	4	5	4	0	-1	21
Above Normal	49	68	77	69	60	54	55	54	49	42	27	18
Below Normal	59	72	74	66	67	67	54	57	60	44	33	18
Dry	26	36	36	48	48	49	47	46	53	48	48	48
Critical Dry	73	72	68	75	78	78	76	74	66	66	56	61
<b>Alternative 1 as Compared to No Action Alternative (percent change)</b>												
Wet	0.7	1.3	0.9	0.6	0.5	0.1	0.2	0.2	0.2	0.0	0.0	1.2
Above Normal	4.2	5.7	6.0	4.7	3.6	2.9	2.7	2.7	2.5	2.4	1.7	1.2
Below Normal	4.2	5.2	5.2	4.4	4.2	4.0	3.0	3.2	3.6	3.0	2.5	1.5
Dry	2.2	3.2	3.1	4.1	3.8	3.5	3.0	3.1	3.7	3.9	4.3	4.7
Critical Dry	9.7	9.9	9.1	10.1	9.8	8.9	8.2	8.4	7.7	8.8	9.1	11.5

1  
2

**Table 5.29 Changes in Trinity Lake Elevation under Alternative 1 as Compared to the No Action Alternative**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 1</b>												
Wet	2,301	2,305	2,314	2,325	2,339	2,347	2,357	2,358	2,355	2,347	2,338	2,328
Above Normal	2,270	2,273	2,286	2,303	2,320	2,335	2,347	2,346	2,339	2,329	2,315	2,304
Below Normal	2,295	2,296	2,298	2,305	2,313	2,320	2,331	2,326	2,318	2,303	2,287	2,274
Dry	2,266	2,269	2,272	2,274	2,284	2,296	2,309	2,304	2,298	2,284	2,269	2,259
Critical Dry	2,218	2,216	2,217	2,222	2,229	2,243	2,250	2,246	2,243	2,227	2,204	2,191
<b>No Action Alternative</b>												
Wet	2,300	2,303	2,313	2,324	2,338	2,347	2,357	2,358	2,355	2,347	2,338	2,327
Above Normal	2,261	2,264	2,276	2,294	2,314	2,330	2,343	2,341	2,335	2,325	2,313	2,302
Below Normal	2,289	2,289	2,291	2,299	2,307	2,315	2,327	2,321	2,313	2,299	2,283	2,272
Dry	2,263	2,265	2,268	2,269	2,279	2,292	2,305	2,301	2,294	2,279	2,264	2,254
Critical Dry	2,210	2,207	2,210	2,213	2,220	2,235	2,242	2,238	2,235	2,220	2,196	2,182
<b>Alternative 1 as Compared to No Action Alternative</b>												
Wet	1	2	1	1	1	0	0	0	0	0	0	2
Above Normal	8	10	10	9	7	5	4	4	4	4	2	2
Below Normal	6	7	7	6	6	6	4	5	5	4	3	3
Dry	3	4	4	5	5	4	4	4	5	5	5	5
Critical Dry	8	8	8	9	8	8	8	8	7	8	8	9
<b>Alternative 1 as Compared to No Action Alternative (percent change)</b>												
Wet	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Above Normal	0.4	0.4	0.5	0.4	0.3	0.2	0.2	0.2	0.2	0.2	0.1	0.1
Below Normal	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.1
Dry	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Critical Dry	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.4	0.4	0.4

1 The following changes in Trinity Lake storage and surface water elevation would  
2 occur under Alternative 1 as compared to the No Action Alternative.

- 3 • In wet years and dry years, storage would be similar in all months.
- 4 • In above-normal years, storage would be similar in January through October  
5 and increased in November and December (up to 6.0 percent).
- 6 • In below-normal years, storage would be similar in January through October  
7 and increased in November and December (up to 5.2 percent).
- 8 • In critical dry years, storage would be increased in all months (up to  
9 11.5 percent).
- 10 • In all months, in all water year types, surface water elevations would be  
11 similar.

12 The following changes would occur on the Trinity River under Alternative 1 as  
13 compared to the No Action Alternative, as shown on Figures 5.53 through 5.55.

- 14 • Over long-term conditions, flows would be similar in March through  
15 November and increased in December through February (up to 10.5 percent).
- 16 • In wet years, flows would be similar in April through November and  
17 increased in December through March (up to 12.6 percent).
- 18 • In dry years, flows would be similar all months.

19 *Central Valley Region*

20 *Changes in CVP and SWP Reservoir Storage and Downstream River Flows*

21 *Shasta Lake and Sacramento River*

22 Storage levels and surface water elevations in Shasta Lake under Alternative 1 as  
23 compared to the No Action Alternative are summarized in Tables 5.30 and 5.31.  
24 Changes in flows in the Sacramento River downstream of Keswick Dam and at  
25 Freeport are shown on Figures 5.56 through 5.61. The results are summarized  
26 following Table 5.31.

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**Table 5.30 Changes in Shasta Lake Storage under Alternative 1 as Compared to the No Action Alternative**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 1</b>												
Wet	2,817	2,926	3,154	3,406	3,597	3,841	4,301	4,453	4,228	3,733	3,362	3,252
Above Normal	2,499	2,578	2,808	3,313	3,515	4,038	4,416	4,417	3,979	3,347	2,975	2,921
Below Normal	2,826	2,846	2,977	3,299	3,646	3,966	4,164	4,042	3,599	3,010	2,601	2,574
Dry	2,409	2,431	2,578	2,755	3,168	3,644	3,861	3,774	3,333	2,800	2,539	2,496
Critical Dry	1,873	1,826	1,911	2,050	2,222	2,460	2,386	2,270	1,861	1,409	1,151	1,086
<b>No Action Alternative</b>												
Wet	2,700	2,719	3,077	3,384	3,589	3,836	4,298	4,460	4,242	3,735	3,410	2,985
Above Normal	2,369	2,385	2,600	3,167	3,453	4,021	4,404	4,429	4,039	3,407	3,069	2,834
Below Normal	2,587	2,548	2,686	3,062	3,442	3,814	4,026	3,957	3,588	3,002	2,643	2,608
Dry	2,345	2,283	2,428	2,621	3,034	3,505	3,737	3,668	3,284	2,767	2,496	2,462
Critical Dry	1,702	1,633	1,717	1,871	2,031	2,274	2,202	2,088	1,719	1,253	986	937
<b>Alternative 1 as Compared to No Action Alternative</b>												
Wet	117	208	77	22	8	5	3	-7	-14	-2	-49	267
Above Normal	130	193	208	146	62	17	12	-11	-60	-60	-94	87
Below Normal	239	298	291	237	204	152	138	86	10	8	-42	-33
Dry	64	148	150	135	134	139	123	106	48	33	42	35
Critical Dry	171	193	194	179	190	186	184	183	142	155	165	149
<b>Alternative 1 as Compared to No Action Alternative (percent change)</b>												
Wet	4.3	7.6	2.5	0.6	0.2	0.1	0.1	-0.2	-0.3	-0.1	-1.4	8.9
Above Normal	5.5	8.1	8.0	4.6	1.8	0.4	0.3	-0.3	-1.5	-1.8	-3.1	3.1
Below Normal	9.3	11.7	10.8	7.7	5.9	4.0	3.4	2.2	0.3	0.3	-1.6	-1.3
Dry	2.7	6.5	6.2	5.1	4.4	4.0	3.3	2.9	1.5	1.2	1.7	1.4
Critical Dry	10.1	11.8	11.3	9.6	9.4	8.2	8.4	8.7	8.3	12.4	16.8	16.0

1 **Table 5.31 Changes in Shasta Lake Elevation under Alternative 1 as Compared to**  
 2 **the No Action Alternative**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 1</b>												
Wet	997	1,002	1,012	1,024	1,032	1,041	1,058	1,063	1,055	1,037	1,022	1,017
Above Normal	974	978	992	1,019	1,028	1,048	1,062	1,062	1,046	1,021	1,005	1,003
Below Normal	997	998	1,004	1,019	1,034	1,046	1,053	1,049	1,031	1,006	987	986
Dry	972	974	982	992	1,012	1,032	1,041	1,038	1,020	997	984	982
Critical Dry	938	935	941	950	961	977	974	967	943	910	889	884
<b>No Action Alternative</b>												
Wet	991	992	1,008	1,023	1,031	1,041	1,058	1,064	1,056	1,037	1,024	1,005
Above Normal	967	968	982	1,012	1,025	1,048	1,062	1,063	1,049	1,024	1,009	999
Below Normal	986	985	991	1,009	1,025	1,040	1,048	1,045	1,031	1,006	989	987
Dry	969	967	975	986	1,006	1,027	1,037	1,034	1,018	995	982	980
Critical Dry	927	923	929	939	951	968	965	958	935	899	876	872
<b>Alternative 1 as Compared to No Action Alternative</b>												
Wet	6	10	4	1	0	0	0	0	-1	0	-2	12
Above Normal	7	10	10	7	3	1	0	0	-2	-3	-4	4
Below Normal	11	14	13	10	9	6	5	4	1	1	-2	-1
Dry	3	7	7	6	6	6	5	4	2	2	3	2
Critical Dry	11	12	12	11	10	9	9	9	8	11	13	12
<b>Alternative 1 as Compared to No Action Alternative (percent change)</b>												
Wet	0.6	1.0	0.4	0.1	0.0	0.0	0.0	0.0	-0.1	0.0	-0.2	1.2
Above Normal	0.7	1.0	1.0	0.7	0.3	0.1	0.0	0.0	-0.2	-0.3	-0.4	0.4
Below Normal	1.1	1.4	1.3	1.0	0.8	0.6	0.5	0.3	0.1	0.1	-0.2	-0.1
Dry	0.3	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.2	0.2	0.3	0.2
Critical Dry	1.2	1.3	1.3	1.2	1.0	0.9	1.0	1.0	0.8	1.2	1.5	1.4

3 The following changes in Shasta Lake storage and surface water elevations would  
 4 occur under Alternative 1 as compared to the No Action Alternative.

- 5 • In wet years, storage would be similar in December through August and  
 6 October and increased in September and November (up to 8.9 percent).
- 7 • In above-normal years, storage would be similar in January through  
 8 September and increased in October through December (up to 8.1 percent).
- 9 • In below-normal years, storage would be similar in March through September  
 10 and increased in October through February (up to 11.7 percent).

- 1 • In dry years, storage would be similar in February through October and  
2 increased in November through January (up to 6.5 percent).
- 3 • In critical dry years, storage would be increased under all months (up to  
4 16.8 percent).
- 5 • In all months, in all water year types, surface water elevations would be  
6 similar.
- 7 The following changes in Sacramento River flows would occur under  
8 Alternative 1 as compared to the No Action Alternative, as shown on Figures 5.56  
9 through 5.61.
- 10 • Sacramento River downstream of Keswick Dam (Figures 5.56 through 5.58).
- 11 – Over long-term conditions, similar flows would occur in October,  
12 February through May, July, and August; reduced flows in September and  
13 November (up to 27.4 percent); and increased flows in December,  
14 January, and June (up to 8.4 percent).
- 15 – In wet years, similar flows would occur in January through July; reduced  
16 flows in September through November (up to 43.7 percent); and increased  
17 flows in December and August (up to 17.0 percent).
- 18 – In dry years, similar flows would occur in July through October,  
19 December through March, and May; reduced flows in November  
20 (25.0 percent); and increased flows in April and June (up to 7.8 percent).
- 21 • Sacramento River near Freeport (near the northern boundary of the Delta)  
22 (Figures 5.59 through 5.61).
- 23 – Over long-term conditions, similar flows would occur in October,  
24 December through May, and August; reduced flows in September,  
25 November, and July (up to 30.2 percent); and increased flows in June  
26 (12.8 percent).
- 27 – In wet years, similar flows would occur in January through June and  
28 October; reduced flows in July through September and November (up to  
29 47.4 percent); and increased flows in December (6.6 percent).
- 30 – In dry years, similar flows would occur in August through October and  
31 December through April; reduced flows in November and July (up to  
32 13.6 percent); and increased flows in May and June (up to 13.5 percent).

33 *Lake Oroville and Feather River*

34 Storage levels and surface water elevations in Lake Oroville under Alternative 1  
35 as compared to the No Action Alternative are summarized in Tables 5.32  
36 and 5.33. Changes in flows in the Feather River downstream of Thermalito  
37 Complex are shown on Figures 5.62 through 5.64. The results are summarized  
38 following Table 5.33.



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**Table 5.32 Changes in Lake Oroville Storage under Alternative 1 as Compared to the No Action Alternative**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 1</b>												
Wet	1,936	1,984	2,354	2,636	2,871	2,942	3,300	3,477	3,402	2,976	2,728	2,569
Above Normal	1,465	1,523	1,702	2,173	2,648	2,937	3,271	3,357	3,081	2,493	2,087	1,827
Below Normal	1,823	1,783	1,831	2,037	2,361	2,627	2,875	2,836	2,461	1,930	1,637	1,424
Dry	1,371	1,324	1,344	1,473	1,764	2,120	2,363	2,357	2,031	1,688	1,427	1,261
Critical Dry	1,117	1,044	1,041	1,125	1,235	1,406	1,423	1,407	1,219	1,027	911	839
<b>No Action Alternative</b>												
Wet	1,691	1,732	2,189	2,554	2,832	2,942	3,300	3,488	3,445	2,964	2,626	2,109
Above Normal	1,279	1,322	1,485	1,959	2,519	2,892	3,247	3,393	3,232	2,600	2,117	1,659
Below Normal	1,542	1,497	1,507	1,719	2,122	2,397	2,653	2,714	2,530	1,923	1,513	1,307
Dry	1,206	1,158	1,177	1,305	1,582	1,938	2,178	2,210	1,951	1,478	1,287	1,144
Critical Dry	1,092	1,029	1,019	1,108	1,223	1,381	1,408	1,392	1,243	1,018	917	865
<b>Alternative 1 as Compared to No Action Alternative</b>												
Wet	245	252	165	82	39	0	0	-10	-43	12	102	459
Above Normal	187	201	217	214	129	44	24	-37	-150	-107	-29	167
Below Normal	281	285	324	318	239	230	222	122	-69	7	125	117
Dry	165	165	167	168	182	182	185	147	80	210	140	117
Critical Dry	25	15	22	17	12	25	16	15	-25	8	-6	-26
<b>Alternative 1 as Compared to No Action Alternative (percent change)</b>												
Wet	14.5	14.6	7.6	3.2	1.4	0.0	0.0	-0.3	-1.2	0.4	3.9	21.8
Above Normal	14.6	15.2	14.6	10.9	5.1	1.5	0.8	-1.1	-4.6	-4.1	-1.4	10.1
Below Normal	18.2	19.1	21.5	18.5	11.2	9.6	8.4	4.5	-2.7	0.4	8.2	8.9
Dry	13.7	14.3	14.2	12.9	11.5	9.4	8.5	6.6	4.1	14.2	10.8	10.2
Critical Dry	2.3	1.5	2.2	1.5	1.0	1.8	1.1	1.1	-2.0	0.8	-0.7	-3.0

1 **Table 5.33 Changes in Lake Oroville Elevation under Alternative 1 as Compared to**  
 2 **the No Action Alternative**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 1</b>												
Wet	768	773	810	837	854	859	884	896	891	861	844	831
Above Normal	717	723	745	796	838	859	882	888	869	826	790	763
Below Normal	757	752	757	779	812	834	854	852	823	775	743	719
Dry	706	701	705	721	755	791	814	813	784	748	718	698
Critical Dry	677	668	668	680	694	715	716	714	691	664	647	636
<b>No Action Alternative</b>												
Wet	743	748	794	829	852	859	884	897	894	861	836	790
Above Normal	698	703	722	776	828	856	880	890	879	835	794	746
Below Normal	730	725	726	751	793	818	838	842	828	773	729	704
Dry	688	683	686	704	737	775	798	800	775	724	702	684
Critical Dry	674	667	664	678	693	712	715	712	693	663	648	640
<b>Alternative 1 as Compared to No Action Alternative</b>												
Wet	24	25	16	8	3	0	0	-1	-3	0	8	41
Above Normal	19	21	24	20	10	3	2	-3	-10	-10	-4	18
Below Normal	27	27	31	28	20	17	16	9	-5	1	14	14
Dry	18	18	18	17	18	16	15	14	9	24	17	15
Critical Dry	3	1	3	3	1	3	2	2	-2	0	-1	-4
<b>Alternative 1 as Compared to No Action Alternative (percent change)</b>												
Wet	3.3	3.3	2.0	0.9	0.3	0.0	0.0	-0.1	-0.3	0.1	1.0	5.2
Above Normal	2.7	2.9	3.3	2.6	1.2	0.4	0.2	-0.3	-1.2	-1.1	-0.5	2.4
Below Normal	3.7	3.8	4.2	3.7	2.5	2.0	1.9	1.1	-0.6	0.2	2.0	2.0
Dry	2.6	2.6	2.7	2.5	2.5	2.1	1.9	1.7	1.2	3.3	2.4	2.1
Critical Dry	0.4	0.2	0.5	0.4	0.2	0.4	0.2	0.3	-0.4	0.0	-0.2	-0.6

3 The following changes in Lake Oroville storage and surface water elevations  
 4 would occur under Alternative 1 as compared to the No Action Alternative.

- 5 • In wet years, storage would be similar in January through August and reduced  
 6 in September through December (up to 21.8 percent).
- 7 • In above-normal years, storage would be similar in February through August  
 8 and reduced in September through January (up to 15.2 percent).
- 9 • In below-normal years, storage would be similar in May through July and  
 10 reduced in August through April (up to 21.5 percent).

- 1 • In dry years, storage would be similar in June and reduced in all other months  
2 (up to 14.2 percent).
- 3 • In critical dry years, storage would be similar under all months.
- 4 • In all months, in all water year types, surface water elevations would be  
5 similar.

6 The following changes in Feather River flows would occur under Alternative 1 as  
7 compared to the No Action Alternative, as shown in Figures 5.62 through 5.64.

- 8 • Over long-term conditions, similar flows would occur in November and April;  
9 reduced flows in July through September (up to 43.2 percent); and increased  
10 flows in October, December through March, May, and June (up to  
11 37.4 percent).
- 12 • In wet years, similar flows would occur in October, November, and March  
13 through May; reduced flows in July through September (up to 64.9 percent);  
14 and increased flows in December through February and June (up to  
15 35.1 percent).
- 16 • In dry years, similar flows would occur in December through April; reduced  
17 flows in July (34.4 percent); and increased flows in August through October,  
18 May, and June (up to 38.1 percent).

19 *Folsom Lake and American River*

20 Storage levels and surface water elevations in Folsom Lake under Alternative 1 as  
21 compared to the No Action Alternative are summarized in Tables 5.34 and 5.35.  
22 Changes in flows in the American River downstream of Nimbus Dam are shown  
23 on Figures 5.65 through 5.67. The results are summarized following Table 5.35.

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**Table 5.34 Changes in Folsom Lake Storage under Alternative 1 as Compared to the No Action Alternative**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 1</b>												
Wet	483	470	522	524	515	632	785	951	937	793	688	646
Above Normal	390	412	467	537	538	640	787	946	857	591	522	485
Below Normal	506	489	502	514	541	626	761	847	739	475	408	387
Dry	405	399	423	437	486	585	698	769	664	486	432	408
Critical Dry	339	317	323	325	369	436	469	482	430	352	288	258
<b>No Action Alternative</b>												
Wet	29	35	8	6	0	0	0	0	-4	-7	-25	70
Above Normal	13	33	38	24	7	0	0	-1	-30	-31	-30	8
Below Normal	59	58	35	30	8	7	4	4	-41	-52	-64	-66
Dry	12	16	15	14	7	6	7	9	5	-9	-11	-11
Critical Dry	14	11	9	5	3	3	-6	-4	16	25	21	28
<b>Alternative 1 as Compared to No Action Alternative</b>												
Wet	29	35	8	6	0	0	0	0	-4	-7	-25	70
Above Normal	13	33	38	24	7	0	0	-1	-30	-31	-30	8
Below Normal	59	58	35	30	8	7	4	4	-41	-52	-64	-66
Dry	12	16	15	14	7	6	7	9	5	-9	-11	-11
Critical Dry	14	11	9	5	3	3	-6	-4	16	25	21	28
<b>Alternative 1 as Compared to No Action Alternative (percent change)</b>												
Wet	6.5	8.0	1.5	1.2	0.0	0.0	0.0	0.0	-0.5	-0.9	-3.5	12.1
Above Normal	3.5	8.6	8.9	4.7	1.3	0.0	0.0	-0.1	-3.4	-5.0	-5.4	1.7
Below Normal	13.3	13.5	7.5	6.1	1.4	1.1	0.5	0.5	-5.2	-9.9	-13.5	-14.6
Dry	2.9	4.2	3.6	3.3	1.4	1.0	1.1	1.2	0.8	-1.8	-2.5	-2.7
Critical Dry	4.4	3.7	2.8	1.6	0.7	0.7	-1.2	-0.8	3.8	7.7	7.8	12.1

1 **Table 5.35 Changes in Folsom Lake Elevation under Alternative 1 as Compared to**  
 2 **the No Action Alternative**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 1</b>												
Wet	412	412	419	419	418	432	448	465	464	449	438	433
Above Normal	397	400	410	421	421	433	448	465	456	427	419	414
Below Normal	415	414	416	417	421	432	446	455	443	410	401	398
Dry	401	401	405	407	414	427	439	446	435	413	406	403
Critical Dry	389	386	390	391	397	406	410	411	404	391	378	372
<b>No Action Alternative</b>												
Wet	409	407	418	418	418	432	448	464	464	449	440	425
Above Normal	394	395	405	418	420	433	449	464	458	430	422	413
Below Normal	408	406	411	414	420	431	445	454	447	418	411	409
Dry	400	399	403	405	413	426	438	445	434	414	408	405
Critical Dry	386	384	389	390	396	406	411	412	401	386	374	366
<b>Alternative 1 as Compared to No Action Alternative</b>												
Wet	4	5	1	1	0	0	0	1	0	-1	-3	8
Above Normal	2	5	5	3	1	0	0	1	-3	-4	-4	1
Below Normal	7	7	4	4	1	1	1	1	-4	-8	-10	-10
Dry	1	2	2	2	1	1	1	1	1	-1	-1	-1
Critical Dry	3	2	2	1	0	0	-1	0	2	5	4	6
<b>Alternative 1 as Compared to No Action Alternative (percent change)</b>												
Wet	0.9	1.1	0.2	0.2	0.0	0.0	0.0	0.2	0.1	-0.2	-0.6	1.9
Above Normal	0.6	1.4	1.3	0.7	0.2	0.0	0.0	0.1	-0.6	-0.8	-0.8	0.2
Below Normal	1.8	1.8	1.1	0.9	0.2	0.2	0.1	0.2	-0.9	-1.9	-2.5	-2.6
Dry	0.3	0.5	0.5	0.5	0.2	0.2	0.2	0.3	0.2	-0.3	-0.3	-0.4
Critical Dry	0.7	0.6	0.4	0.2	0.1	0.1	-0.2	-0.1	0.6	1.2	1.1	1.8

3 The following changes in Folsom Lake storage would occur under Alternative 1  
 4 as compared to the No Action Alternative.

- 5 • In wet years, storage would be similar in December through August and  
 6 increased in September through December (up to 12.1 percent).
- 7 • In above-normal years, storage would be similar in January through July and  
 8 September through October; increased in November and December (up to  
 9 8.9 percent); and reduced in August (5.4 percent).
- 10 • In below-normal years, storage would be similar in February through May;  
 11 reduced in June through September (up to 14.6 percent); and increased in  
 12 October through January (up to 13.5 percent).

- 1 • In dry years, storage would be similar in all months.
- 2 • In critical dry years, storage would be similar in October through June and  
3 increased in July through September (up to 12.1 percent).
- 4 • In all months, in all water year types, surface water elevations would be  
5 similar.
- 6 The following changes in American River flows would occur under Alternative 1  
7 as compared to the No Action Alternative, as shown on Figures 5.65  
8 through 5.67.
- 9 • Over long-term conditions, similar flows would occur in November through  
10 May and July; reduced flows in September and October (up to 30.9 percent);  
11 and increased flows in June (5.4 percent).
- 12 • In wet years, similar flows would occur in October, November, and January  
13 through July; reduced flows in September (47.7 percent); and increased flows  
14 in August (12.0 percent).
- 15 • In dry years, similar flows would occur in November through January, March  
16 through June, August, and September; reduced flows in October  
17 (14.1 percent); and increased flows in February and July (up to 7.9 percent).

18 *Clear Creek*

19 Changes in flows in Clear Creek downstream of Whiskeytown Dam are  
20 summarized in Table 5.36.

21 Monthly Clear Creek flows under Alternative 1 as compared to the No Action  
22 Alternative are identical except in May. In May, under Alternative 1, flows are  
23 up to 28.9 percent lower than under the No Action Alternative.

1 **Table 5.36 Changes in Clear Creek Flows below Whiskeytown Dam under the**  
 2 **Alternative 1 as Compared to the No Action Alternative**

Water Year	Average Monthly Flow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 1</b>												
Wet	200	200	200	309	356	272	200	200	200	85	85	150
Above Normal	181	182	188	192	196	196	196	200	200	85	85	150
Below Normal	195	195	195	195	195	195	195	195	191	85	85	150
Dry	178	184	188	190	190	190	190	190	183	85	85	150
Critical Dry	163	167	167	167	167	167	167	167	111	85	85	133
<b>No Action Alternative</b>												
Wet	200	200	200	309	356	272	200	277	200	85	85	150
Above Normal	181	182	188	192	196	196	196	277	200	85	85	150
Below Normal	195	195	195	195	195	195	195	274	191	85	85	150
Dry	175	184	188	190	190	190	190	267	183	85	85	150
Critical Dry	163	167	167	167	167	167	167	214	111	85	85	133
<b>Alternative 1 as Compared to No Action Alternative</b>												
Wet	0	0	0	0	0	0	0	-77	0	0	0	0
Above Normal	0	0	0	0	0	0	0	-77	0	0	0	0
Below Normal	0	0	0	0	0	0	0	-78	0	0	0	0
Dry	3	0	0	0	0	0	0	-77	0	0	0	0
Critical Dry	0	0	0	0	0	0	0	-47	0	0	0	0
<b>Alternative 1 as Compared to No Action Alternative (percent change)</b>												
Wet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-27.9	0.0	0.0	0.0	0.0
Above Normal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-27.9	0.0	0.0	0.0	0.0
Below Normal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-28.6	0.0	0.0	0.0	0.0
Dry	1.6	0.0	0.0	0.0	0.0	0.0	0.0	-28.9	0.0	0.0	0.0	0.0
Critical Dry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-22.1	0.0	0.0	0.0	0.0

3 *New Melones Reservoir and Stanislaus River*  
 4 Storage levels and surface water elevations in New Melones Reservoir under  
 5 Alternative 1 as compared to the No Action Alternative are summarized in  
 6 Tables 5.37 and 5.38. Changes in flows in the Stanislaus River downstream of  
 7 Goodwin Dam are shown on Figures 5.68 through 5.70. The results are  
 8 summarized following Table 5.38.

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**Table 5.37 Changes in New Melones Reservoir Storage under the Alternative 1 as Compared to the No Action Alternative**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 1</b>												
Wet	1,443	1,446	1,502	1,606	1,709	1,794	1,833	1,962	1,994	1,917	1,803	1,731
Above Normal	1,092	1,116	1,175	1,261	1,360	1,455	1,481	1,543	1,516	1,419	1,321	1,274
Below Normal	1,364	1,366	1,378	1,397	1,453	1,479	1,461	1,447	1,415	1,322	1,228	1,183
Dry	1,149	1,143	1,149	1,161	1,191	1,221	1,210	1,176	1,131	1,039	956	912
Critical Dry	667	663	674	680	696	690	646	585	557	498	449	426
<b>No Action Alternative</b>												
Wet	1,379	1,390	1,454	1,562	1,666	1,724	1,758	1,878	1,968	1,890	1,773	1,703
Above Normal	1,029	1,060	1,125	1,214	1,317	1,406	1,413	1,484	1,467	1,372	1,277	1,232
Below Normal	1,294	1,305	1,326	1,351	1,413	1,438	1,390	1,383	1,359	1,268	1,175	1,133
Dry	1,094	1,094	1,106	1,121	1,156	1,188	1,154	1,132	1,087	997	914	871
Critical Dry	624	623	638	645	661	656	602	554	526	476	431	408
<b>Alternative 1 as Compared to No Action Alternative</b>												
Wet	64	56	49	44	43	70	75	84	25	27	30	28
Above Normal	62	56	50	46	43	48	68	59	49	46	44	42
Below Normal	69	61	52	46	40	41	71	63	55	54	52	51
Dry	55	49	43	40	35	33	56	45	44	43	42	42
Critical Dry	44	40	37	36	35	34	45	31	31	23	18	18
<b>Alternative 1 as Compared to No Action Alternative (percent change)</b>												
Wet	4.7	4.0	3.3	2.8	2.6	4.1	4.3	4.5	1.3	1.4	1.7	1.6
Above Normal	6.0	5.3	4.4	3.8	3.3	3.4	4.8	4.0	3.4	3.4	3.5	3.4
Below Normal	5.4	4.7	4.0	3.4	2.8	2.9	5.1	4.6	4.1	4.2	4.5	4.5
Dry	5.0	4.5	3.9	3.5	3.1	2.7	4.8	3.9	4.0	4.3	4.6	4.8
Critical Dry	7.0	6.4	5.8	5.5	5.2	5.2	7.5	5.6	5.9	4.8	4.2	4.4



1 **Table 5.38 Changes in New Melones Reservoir Elevation under the Alternative 1 as**  
 2 **Compared to the No Action Alternative**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 1</b>												
Wet	989	990	997	1,009	1,021	1,030	1,034	1,047	1,050	1,043	1,032	1,025
Above Normal	941	944	951	966	979	992	995	1,003	1,001	990	978	901
Below Normal	977	977	979	982	991	994	994	993	991	980	968	962
Dry	951	950	950	953	957	962	963	960	954	941	929	922
Critical Dry	866	866	870	872	878	879	871	856	850	835	823	817
<b>No Action Alternative</b>												
Wet	980	982	990	1,004	1,016	1,023	1,026	1,039	1,047	1,040	1,029	1,022
Above Normal	932	937	945	960	974	986	988	997	996	985	973	897
Below Normal	968	969	972	975	985	988	985	985	983	972	960	955
Dry	943	943	944	947	951	957	955	953	948	934	922	915
Critical Dry	856	856	862	864	870	871	860	848	840	828	818	812
<b>Alternative 1 as Compared to No Action Alternative</b>												
Wet	9	8	7	6	5	8	8	8	3	3	3	3
Above Normal	9	7	6	6	6	6	8	7	5	5	5	5
Below Normal	9	8	7	7	6	6	9	8	7	8	8	8
Dry	8	7	6	6	5	5	8	7	7	7	7	7
Critical Dry	10	10	9	8	8	8	11	8	10	6	5	6
<b>Alternative 1 as Compared to No Action Alternative (percent change)</b>												
Wet	0.9	0.8	0.7	0.6	0.5	0.8	0.8	0.8	0.3	0.3	0.3	0.3
Above Normal	1.0	0.8	0.7	0.6	0.6	0.6	0.8	0.7	0.5	0.6	0.5	0.5
Below Normal	1.0	0.9	0.7	0.7	0.6	0.6	0.9	0.8	0.7	0.8	0.8	0.8
Dry	0.9	0.8	0.7	0.7	0.6	0.5	0.9	0.7	0.7	0.7	0.8	0.8
Critical Dry	1.2	1.1	1.0	1.0	0.9	0.9	1.3	1.0	1.2	0.8	0.6	0.7

3 The following changes in New Melones Reservoir storage would occur under  
 4 Alternative 1 as compared to the No Action Alternative.

- 5 • In wet years, storage would be similar in all months.
- 6 • In above-normal years, storage would be similar in December through  
 7 September and increased in October and November (up to 6.0 percent).
- 8 • In below-normal years, storage would be similar in November through  
 9 September and increased in October (5.4 percent).
- 10 • In dry years, storage would be similar in all months.

1 • In critical dry years, storage would be similar in July through September and  
2 increased in October through June (up to 7.5 percent).

3 • In all months, in all water year types, surface water elevations would be  
4 similar.

5 Flows in the Stanislaus River downstream of Goodwin Dam are shown on  
6 Figures 5.68 to 5.70. Changes in flows in these rivers are summarized below.

7 • Over long-term conditions, similar flows would occur in July through  
8 September; reduced flows in October, March, and April (up to 59.8 percent);  
9 and increased flows in November through February and June (up to  
10 51.1 percent).

11 • In wet years, similar flows would occur in February and April; reduced flows  
12 in October, March, May, July, and August (up to 53.9 percent); and increased  
13 flows in September, November through January, and June (up to  
14 103.2 percent).

15 • In dry years, similar flows would occur in July through September; reduced  
16 flows in October and April (up to 60.7 percent); and increased flows in  
17 November through March, May, and June (up to 55.5 percent).

18 *San Joaquin River at Vernalis*

19 Flows in the San Joaquin River at Vernalis are summarized below, as shown on  
20 Figures 5.71 through 5.73.

21 • Over long-term conditions, similar flows would occur in July through  
22 September and November through May; reduced flows in October  
23 (16.1 percent); and increased flows in June (8.4 percent).

24 • In wet years, similar flows would occur in July through September and  
25 November through May; reduced flows in October (14.4 percent); and  
26 increased flows in June (10.4 percent).

27 • In dry years, similar flows would occur in November through March and May  
28 through September; and reduced flows in October and April (up to  
29 15.3 percent).

30 *San Luis Reservoir*

31 Storage levels and surface water elevations in San Luis Reservoir under  
32 Alternative 1 as compared to the No Action Alternative are summarized in  
33 Tables 5.39 and 5.40. The results are summarized following Table 5.40.

1 **Table 5.39 Changes in San Luis Reservoir Storage under the Alternative 1 as**  
 2 **Compared to the No Action Alternative**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 1</b>												
Wet	790	1,017	1,365	1,748	1,965	2,033	2,031	1,852	1,487	1,167	889	925
Above Normal	658	883	1,213	1,671	1,913	2,001	1,995	1,717	1,263	861	612	631
Below Normal	854	1,064	1,334	1,742	1,908	1,980	1,908	1,628	1,251	964	635	591
Dry	617	764	998	1,427	1,728	1,925	1,870	1,665	1,341	1,007	660	596
Critical Dry	622	709	910	1,257	1,556	1,664	1,623	1,451	1,168	808	545	472
<b>No Action Alternative</b>												
Wet	555	681	931	1,236	1,526	1,788	1,598	1,251	946	741	628	679
Above Normal	490	649	957	1,223	1,441	1,661	1,444	1,048	666	466	433	513
Below Normal	525	624	907	1,141	1,314	1,473	1,312	967	555	500	426	467
Dry	476	590	867	1,150	1,339	1,494	1,413	1,167	840	763	476	469
Critical Dry	478	556	752	1,040	1,204	1,252	1,192	1,028	739	544	343	323
<b>Alternative 1 as Compared to No Action Alternative</b>												
Wet	234	336	433	513	439	245	433	601	541	426	261	245
Above Normal	168	234	257	448	471	341	551	669	598	395	179	117
Below Normal	329	439	427	601	594	507	596	660	696	465	209	124
Dry	141	174	130	277	390	431	457	498	501	244	185	127
Critical Dry	144	153	158	217	352	412	431	423	429	263	202	149
<b>Alternative 1 as Compared to No Action Alternative (percent change)</b>												
Wet	59.8	81.8	84.4	64.5	40.1	18.2	35.5	74.9	108.8	88.0	53.1	41.5
Above Normal	38.9	62.8	46.6	55.6	43.8	26.0	45.6	90.9	151.4	110.8	53.6	20.2
Below Normal	91.6	125.0	85.3	85.6	66.4	45.6	56.5	93.5	203.1	136.2	61.6	35.9
Dry	29.4	34.9	15.4	31.1	38.5	35.4	37.2	52.7	70.3	26.1	33.5	18.8
Critical Dry	38.7	39.5	25.0	24.4	37.8	39.5	40.3	43.8	57.1	38.6	46.2	20.1

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**Table 5.40 Changes in San Luis Reservoir Elevation under the Alternative 1 as Compared to the No Action Alternative**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 1</b>												
Wet	426	451	485	520	538	543	543	529	497	468	440	443
Above Normal	412	437	470	513	534	541	540	518	477	437	409	411
Below Normal	435	457	483	519	533	539	533	510	476	448	412	406
Dry	407	425	450	492	518	535	530	513	484	453	415	406
Critical Dry	409	419	441	475	502	512	509	494	468	432	400	389
<b>No Action Alternative</b>												
Wet	399	414	443	473	500	523	507	475	444	422	409	416
Above Normal	391	411	445	472	492	512	493	456	415	389	386	398
Below Normal	397	410	442	465	481	496	481	448	400	393	383	389
Dry	391	406	437	466	484	498	490	468	434	426	390	389
Critical Dry	390	400	423	454	470	475	469	453	422	399	369	366
<b>Alternative 1 as Compared to No Action Alternative</b>												
Wet	26	37	42	46	38	20	36	53	53	46	30	27
Above Normal	21	26	25	41	41	29	47	61	62	48	23	14
Below Normal	38	47	42	54	52	43	52	62	76	56	30	17
Dry	17	19	12	25	34	37	40	45	51	27	25	18
Critical Dry	19	20	18	21	32	38	40	41	45	32	32	24
<b>Alternative 1 as Compared to No Action Alternative (percent change)</b>												
Wet	6.6	8.9	9.6	9.8	7.5	3.9	7.2	11.2	12.0	10.9	7.4	6.6
Above Normal	5.4	6.4	5.7	8.8	8.4	5.6	9.5	13.4	15.0	12.3	6.0	3.4
Below Normal	9.5	11.4	9.4	11.6	10.8	8.7	10.8	13.8	19.0	14.2	7.8	4.3
Dry	4.2	4.6	2.8	5.4	7.1	7.4	8.1	9.7	11.6	6.3	6.3	4.5
Critical Dry	4.9	4.9	4.2	4.7	6.8	7.9	8.4	9.0	10.8	8.0	8.6	6.6

1 The following changes in San Luis Reservoir storage would occur under  
2 Alternative 1 as compared to the No Action Alternative.

- 3 • In wet years, storage would be increased in all months (up to 108.8 percent).  
4 Water storage elevations would be increased in all months (up to  
5 12.0 percent).
- 6 • In above-normal years, storage would be increased in all months (up to  
7 151.4 percent). Water storage elevations would be increased in all months (up  
8 to 15.0 percent).
- 9 • In below-normal years, storage would be increased in all months (up to  
10 203.1 percent). Water storage elevations would be increased in all months (up  
11 to 19.0 percent).
- 12 • In dry years, storage would be increased in all months (up to 70.3 percent).  
13 Water storage elevations would be increased in all months (up to  
14 11.6 percent).
- 15 • In critical dry years, storage would be increased in all months (up to  
16 57.1 percent). Water storage elevations would be increased in all months (up  
17 to 10.8 percent).

18 *Changes in Flows into the Yolo Bypass*

19 Flows from the Sacramento River into the Yolo Bypass at Fremont Weir under  
20 Alternative 1 as compared to the No Action Alternative are summarized in  
21 Table 5.41. The results are summarized following Table 5.41.

1 **Table 5.41 Changes in Flows into the Yolo Bypass at Fremont Weir under the**  
 2 **Alternative 1 as Compared to the No Action Alternative**

Water Year	Average Monthly Flow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 1</b>												
Wet	147	996	9,888	25,442	30,547	18,997	5,602	289	113	0	0	100
Above Normal	100	100	2,659	6,349	15,114	8,566	1,765	100	100	0	0	100
Below Normal	100	100	262	1,256	4,057	1,166	292	100	100	0	0	100
Dry	100	100	342	932	2,032	1,411	411	100	100	0	0	100
Critical Dry	100	100	149	542	533	408	106	100	100	0	0	100
<b>No Action Alternative</b>												
Wet	183	910	8,420	24,291	29,547	18,493	5,627	289	113	0	0	100
Above Normal	100	100	2,765	5,997	13,013	7,928	1,688	100	100	0	0	100
Below Normal	100	100	242	1,004	3,031	883	293	100	100	0	0	100
Dry	100	100	322	902	2,024	1,393	407	100	100	0	0	100
Critical Dry	100	100	149	528	534	396	106	100	100	0	0	100
<b>Alternative 1 as Compared to No Action Alternative</b>												
Wet	-37	86	1,468	1,151	1,000	504	-25	0	0	0	0	0
Above Normal	0	0	-106	352	2,102	638	77	0	0	0	0	0
Below Normal	0	0	20	253	1,026	283	-1	0	0	0	0	0
Dry	0	0	20	30	7	17	4	0	0	0	0	0
Critical Dry	0	0	1	15	-1	12	0	0	0	0	0	0
<b>Alternative 1 as Compared to No Action Alternative (percent change)</b>												
Wet	-20.0	9.5	17.4	4.7	3.4	2.7	-0.4	0.1	0.1	0.0	0.0	0.0
Above Normal	0.0	0.0	-3.8	5.9	16.2	8.0	4.5	0.0	0.0	0.0	0.0	0.0
Below Normal	0.0	0.0	8.1	25.2	33.9	32.1	-0.3	0.0	0.0	0.0	0.0	0.0
Dry	0.0	0.0	6.2	3.3	0.4	1.2	1.0	0.0	0.0	0.0	0.0	0.0
Critical Dry	0.0	0.0	0.5	2.8	-0.2	3.0	0.0	0.0	0.0	0.0	0.0	0.0

3 The following changes in flows from the Sacramento River into Yolo Bypass at  
 4 Fremont Weir would occur under Alternative 1 as compared to the No Action  
 5 Alternative.

- 6 • In wet years, flows into Yolo Bypass would be similar in January through  
 7 September; reduced in October (20 percent); and increased in November and  
 8 December (up to 17.4 percent).
- 9 • In above-normal years, flows into Yolo Bypass would be similar in April  
 10 through December; and increased in January through March (up to  
 11 16.2 percent).

- 1 • In below-normal years, flows into Yolo Bypass would be similar in April  
2 through November; and increased in December through March (up to  
3 33.9 percent).
- 4 • In dry years, flows into Yolo Bypass would be similar in January through  
5 November; and increased in December (6.2 percent).
- 6 • In critical dry years, flows into Yolo Bypass would be similar in all months.

7 *Changes in Delta Conditions*

8 Delta outflow under Alternative 1 as compared to the No Action Alternative are  
9 summarized below and shown on Figures 5.74 through 5.76.

- 10 • In wet years, average monthly Delta outflow would increase in December,  
11 February, March, and June (up to 1,492 cfs) and decrease in July through  
12 November, January, April, and May (up to 13,683 cfs).
- 13 • In dry years, average monthly Delta outflow would be similar in September;  
14 decrease in July, August, and October through May (up to 3,114 cfs); and  
15 increase in June (385 cfs).

16 The OMR conditions under Alternative 1 are shown on Figures 5.77 through 5.79.

- 17 • In all water years, average monthly OMR flows would be negative in all  
18 months under Alternative 1. Under the No Action Alternative, OMR flows  
19 would be positive only in wet and above normal years in April and May and  
20 April in above normal years.
- 21 • In wet years, average monthly OMR flows, would be more positive in June  
22 through August and March (up to 923 cfs); and more negative in April  
23 through June and September through February (up to 10,005 cfs).
- 24 • In dry years, average monthly OMR flows would be positive in July (up to  
25 2,073 cfs), and more negative in August through June (up to 3,489 cfs).

26 *Changes in CVP and SWP Exports and Deliveries*

27 Delta exports under Alternative 1 as compared to the No Action Alternative are  
28 summarized in Table 5.42.

1 **Table 5.42 Changes in Exports at Jones and Banks Pumping Plants under the**  
 2 **Alternative 1 as Compared to the No Action Alternative**

Water Year	Monthly Volume (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 1</b>												
Wet	549	619	716	724	609	543	476	430	456	632	655	660
Above Normal	428	521	641	716	584	570	453	363	415	572	647	651
Below Normal	548	595	623	674	497	500	337	304	414	629	517	539
Dry	435	475	546	579	518	493	259	228	274	403	325	438
Critical Dry	340	345	455	433	406	266	134	121	132	139	203	249
<b>No Action Alternative</b>												
Wet	410	497	564	513	537	594	204	207	445	669	717	638
Above Normal	376	450	562	406	401	496	130	105	315	587	709	628
Below Normal	386	456	590	387	354	394	134	100	209	657	622	542
Dry	374	398	510	392	315	318	153	126	194	541	296	426
Critical Dry	314	293	384	349	250	179	93	90	64	223	176	242
<b>Alternative 1 as Compared to No Action Alternative</b>												
Wet	139	123	152	211	72	-51	272	223	11	-37	-63	21
Above Normal	52	71	78	311	183	73	322	257	100	-15	-61	23
Below Normal	162	139	33	287	143	106	203	204	205	-28	-105	-4
Dry	61	77	36	187	202	175	105	102	80	-138	30	12
Critical Dry	26	52	71	84	156	87	41	31	67	-84	26	8
<b>Alternative 1 as Compared to No Action Alternative (percent change)</b>												
Wet	33.8	24.7	26.9	41.1	13.3	-8.6	133.6	107.5	2.4	-5.5	-8.7	3.4
Above Normal	13.8	15.8	13.9	76.6	45.5	14.8	247.0	244.4	31.8	-2.5	-8.7	3.6
Below Normal	42.0	30.5	5.5	74.3	40.3	26.9	150.9	203.9	98.1	-4.3	-16.9	-0.6
Dry	16.2	19.4	7.1	47.7	64.2	55.1	68.7	81.5	41.4	-25.5	10.1	2.8
Critical Dry	8.4	17.9	18.6	24.1	62.2	48.5	44.3	33.9	104.4	-37.6	14.9	3.1

3 The following changes would occur in CVP and SWP exports under Alternative 1  
 4 as compared to the No Action Alternative.

- 5 • Long-term average annual exports would be 1,051 TAF (22 percent) more  
 6 under Alternative 1 as compared to the No Action Alternative.
- 7 • In wet years, total exports would be similar in June and September; increased  
 8 in October through February, April through May (up to 133.6 percent); and  
 9 reduced in March, July, and August (up to 8.7 percent).
- 10 • In above-normal years, total exports would be similar in July and September;  
 11 increased in October through June (up to 244 percent); and reduced in August  
 12 (8.7 percent).



- 1 • In below-normal years, total exports would be similar in July and September;  
2 increased in October through June (up to 203.9 percent); and reduced in  
3 August (16.9 percent).
- 4 • In dry years, total exports would be similar in September; increased in  
5 October through June and August (up to 81.5 percent); and reduced in July  
6 (25.5 percent).
- 7 • In critical dry years, total exports would be similar in September; increased in  
8 October through June and August (up to 104.4 percent); and reduced in July  
9 (37.6 percent).

10 Deliveries to CVP and SWP water users increase under Alternative 1 as compared  
11 to the No Action Alternative, as summarized in Tables 5.43 and 5.44,  
12 respectively, due to increased water supply availability and less export limitations.

13 **Table 5.43 Changes CVP Water Deliveries under the Alternative 1 as Compared to**  
14 **the No Action Alternative**

Annual Average Deliveries (TAF)					
		Alternative 1	No Action Alternative	Alternative 1 as compared to the No Action Alternative	
				Difference	Percent Change
<b>North of Delta</b>					
CVP Agricultural Water Service Contractors	Long Term	219	185	34	18
	Dry	122	86	37	43
	Critical Dry	35	24	12	50
CVPM&I (Including American River Contractors and Contra Costa Water District)	Long Term	392	386	7	2
	Dry	390	385	5	1
	Critical Dry	383	383	-1	0
CVP M&I American River Contractors	Long Term	120	113	7	6
	Dry	105	97	8	8
	Critical Dry	79	75	5	7
CVP Sacramento River Settlement Contractors	Long Term	1,858	1,859	-1	0
	Dry	1,905	1,906	-1	0
	Critical Dry	1,732	1,737	-5	0
CVP Refuge Level 2 Deliveries	Long Term	155	146	8	5
	Dry	151	146	5	3
	Critical Dry	105	102	3	3

Chapter 5: Surface Water Resources and Water Supplies

Annual Average Deliveries (TAF)					
		Alternative 1	No Action Alternative	Alternative 1 as compared to the No Action Alternative	
				Difference	Percent Change
Total CVP Agricultural, M&I, Sacramento River Settlement Contractors, and Refuge Level 2 Deliveries	Long Term	2,624	2,576	48	2
	Dry	2,568	2,523	45	2
	Critical Dry	2,255	2,246	9	0
<b>South of Delta (Does not include Eastside Contractors)</b>					
CVP Agricultural Water Service Contractors	Long Term	1,100	847	253	30
	Dry	650	445	206	46
	Critical Dry	195	131	64	49
CVP M&I Users	Long Term	125	112	13	12
	Dry	109	99	10	10
	Critical Dry	85	80	4	5
San Joaquin River Exchange Contractors	Long Term	852	852	0	0
	Dry	875	875	0	0
	Critical Dry	741	741	0	0
CVP Refuge Level 2 Deliveries	Long Term	272	273	-1	0
	Dry	280	281	-1	0
	Critical Dry	232	234	-3	-1
Total CVP Agricultural, M&I, San Joaquin River Exchange Contractors, and Refuge Level 2 Deliveries	Long Term	2,349	2,084	265	13
	Dry	1,914	1,700	214	13
	Critical Dry	1,253	1,186	67	6
<b>Eastside Contractors Deliveries</b>					
Water Rights	Long Term	514	508	6	1
	Dry	524	524	0	0
	Critical Dry	486	445	42	9
CVP Water Service Contracts	Long Term	118	104	15	14
	Dry	98	84	13	15
	Critical Dry	25	4	21	525

Annual Average Deliveries (TAF)					
		Alternative 1	No Action Alternative	Alternative 1 as compared to the No Action Alternative	
				Difference	Percent Change
Total Water Rights and CVP Service Contracts Deliveries	Long Term	632	612	20	3
	Dry	622	608	14	2
	Critical Dry	511	449	62	14

- 1 The following changes in CVP water deliveries would occur under Alternative 1  
2 as compared to the No Action Alternative.
- 3 • Deliveries to CVP North of Delta agricultural water service contractors would  
4 be increased by 18 percent over the long-term conditions, 43 percent in dry  
5 years, and 50 percent in critical dry years.
  - 6 • Deliveries to CVP North of Delta M&I contractors would be similar in total,  
7 however, deliveries to the American River CVP contractors would be  
8 increased by 6 percent over the long-term conditions, 8 percent in dry years,  
9 and 7 percent in critical dry years.
  - 10 • Deliveries to CVP South of Delta agricultural water service contractors would  
11 be increased by 30 percent over the long-term conditions, 46 percent in dry  
12 years, and 49 percent in critical dry years.
  - 13 • Deliveries to CVP South of Delta M&I contractors would be increased by  
14 12 percent over the long-term conditions, 10 percent in dry years, and  
15 5 percent in critical dry years.
  - 16 • Deliveries to the Eastside contractors would be similar under long-term  
17 conditions and in dry years and increase by 14 percent in critical dry years.

1 **Table 5.44 Changes SWP Water Deliveries under the Alternative 1 as Compared to**  
 2 **the No Action Alternative**

Annual Average Deliveries (TAF)					
		Alternative 1	No Action Alternative	Alternative 1 as compared to the No Action Alternative	
				Difference	Percent Change
<b>North of Delta</b>					
SWP Agricultural Uses	Long Term	0	0	0	0
	Dry	0	0	0	0
	Critical Dry	0	0	0	0
SWP M&I (without Article 21)	Long Term	83	68	15	22
	Dry	62	51	11	22
	Critical Dry	53	43	11	25
SWP M&I Article 21 Deliveries	Long Term	12	13	-1	-9
	Dry	13	14	-1	-6
	Critical Dry	12	13	-1	-9
Total SWP Agricultural and M&I (without Article 21)	Long Term	83	68	15	22
	Dry	62	51	11	22
	Critical Dry	53	43	11	25
Total SWP Agricultural and M&I Article 21 Deliveries	Long Term	12	13	-1	-9
	Dry	13	14	-1	-6
	Critical Dry	12	13	-1	-9
<b>South of Delta</b>					
SWP Agricultural Users (without Article 21)	Long Term	750	610	139	23
	Dry	567	455	112	25
	Critical Dry	484	378	106	28
SWP Agricultural Article 21 Deliveries	Long Term	178	27	152	569
	Dry	143	5	138	2690
	Critical Dry	100	7	93	1339
SWP M&I Users (without Article 21)	Long Term	2,183	1,800	383	21
	Dry	1,732	1,406	327	23
	Critical Dry	1,494	1,173	321	27

Annual Average Deliveries (TAF)					
		Alternative 1	No Action Alternative	Alternative 1 as compared to the No Action Alternative	
				Difference	Percent Change
SWP M&I Article 21 Deliveries	Long Term	104	20	84	418
	Dry	86	5	82	1788
	Critical Dry	58	5	53	1054
Total SWP Agricultural and M&I Users (without Article 21)	Long Term	2,933	2,410	523	22
	Dry	2,299	1,861	439	24
	Critical Dry	1,978	1,551	427	28
Total SWP Agricultural and M&I Article 21 Deliveries	Long Term	282	47	236	504
	Dry	229	10	219	2265
	Critical Dry	158	12	146	1219

1 The following changes in SWP water deliveries would occur under Alternative 1  
 2 as compared to the No Action Alternative.

- 3 • Deliveries without Article 21 water to SWP North of Delta water contractors  
 4 would be increased by 22 percent over the long-term conditions; 22 percent in  
 5 dry years; and 25 percent in critical dry years.
- 6 • Deliveries without Article 21 water to SWP South of Delta water contractors  
 7 would be increased by 22 percent over the long-term conditions; 24 percent in  
 8 dry years; and 28 percent in critical dry years.
- 9 • Deliveries of Article 21 water to SWP North of Delta water contractors would  
 10 be reduced by 9 percent over the long-term conditions; 6 percent in dry years;  
 11 and 9 percent in critical dry years.
- 12 • Deliveries of Article 21 water to SWP South of Delta water contractors would  
 13 be increased by 504 percent over the long-term conditions; 2,265 percent in  
 14 dry years; and 1,219 percent in critical dry years.

15 *Effects Related to Cross Delta Water Transfers*

16 Potential effects to surface water resources could be similar to those identified in  
 17 a recent environmental analysis conducted by Reclamation for long-term water  
 18 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014i).  
 19 Potential effects were identified as reduced surface water storage in upstream  
 20 reservoirs and changes in flow patterns in river downstream of the reservoirs if  
 21 water was released from the reservoirs in patterns that were different than would

1 have been used by the water seller's. Because all water transfers would be  
2 required to avoid adverse impacts to other water users and biological resources  
3 (see Section 3.A.6.3, Transfers), including impacts associated with changes in  
4 reservoir storage and river flow patterns; the analysis indicated that water  
5 transfers would not result in substantial changes in storage or river flows. For the  
6 purposes of this EIS, it is anticipated that similar conditions would occur due to  
7 cross Delta water transfers under Alternative 1 and the No Action Alternative.

8 Under Alternative 1, water could be transferred throughout the year. As indicated  
9 in Table 5.42, capacity would be available under Alternative 1 in all months of all  
10 water year types without a maximum volume of transferred water. Under the No  
11 Action Alternative, the timing of cross Delta water transfers would be limited to  
12 July through September, and the volume would be limited to 600,000 acre-feet  
13 per year in drier years and 360,000 acre-feet in all other years, in accordance with  
14 the 2008 USFWS BO and 2009 NMFS BO. As indicated in Table 5.42, capacity  
15 would be available under the No Action Alternative between July and September  
16 for water transfers in all water year types.

17 Overall, the potential for water transfer conveyance would be greater under  
18 Alternative 1 as compared to the No Action Alternative.

19 *San Francisco Bay Area, Central Coast, and Southern California Regions*

20 *Potential Changes in Surface Water Resources at Reservoirs that Store CVP*  
21 *and SWP Water*

22 The San Francisco Bay Area, Central Coast, and Southern California regions  
23 include numerous reservoirs that store CVP and SWP water supplies, including  
24 CVP and SWP reservoirs, that primarily provide water supplies for M&I water  
25 users. Changes in the availability CVP and SWP water supplies for storage in  
26 these reservoirs under Alternative 1 as compared to the No Action  
27 Alternative would be consistent with the following changes in water deliveries to  
28 M&I water users, as summarized in Tables 5.43 and 5.44.

- 29 • Deliveries to CVP South of Delta M&I contractors would be increased by  
30 11 percent over the long-term conditions; 10 percent in dry years; and  
31 7 percent in critical dry years.
- 32 • Deliveries without Article 21 water to SWP South of Delta water contractors  
33 would be increased by 22 percent over the long-term conditions; 24 percent in  
34 dry years; and 28 percent in critical dry years.
- 35 • Deliveries of Article 21 water to SWP South of Delta water contractors would  
36 be increased by 504 percent over the long-term conditions; 2,265 percent in  
37 dry years; and 1,219 percent in critical dry years.

38 *Changes in CVP and SWP Exports and Deliveries*

39 Deliveries to CVP and SWP water users are described above in the Central Valley  
40 Region.

1 **5.4.3.2.2 Alternative 1 Compared to the Second Basis of Comparison**

2 Alternative 1 is identical to the Second Basis of Comparison.

3 **5.4.3.3 Alternative 2**

4 Surface water resources conditions under Alternative 2 would be identical to the  
5 surface water resources conditions under the No Action Alternative; therefore,  
6 Alternative 2 is only compared to the Second Basis of Comparison.

7 **5.4.3.3.1 Alternative 2 Compared to the Second Basis of Comparison**

8 Changes to surface water resources conditions under Alternatives 2 as compared  
9 to the Second Basis of Comparison would be the same as the impacts described in  
10 Section 5.4.3.1, No Action Alternative.

11 **5.4.3.4 Alternative 3**

12 CVP and SWP operations under Alternative 3 are similar to the Second Basis of  
13 Comparison with modified OMR flow criteria and New Melones Reservoir  
14 operations. Alternative 3 would include changed water demands for American  
15 River water supplies as compared to the No Action Alternative or Second Basis of  
16 Comparison. Alternative 3 would provide water supplies of up to 17 TAF per  
17 year under a Warren Act Contract for El Dorado Irrigation District and 15 TAF  
18 per year under a CVP water service contract for El Dorado County Water Agency.  
19 These demands are not included in the analysis presented in this section of the  
20 EIS. A sensitivity analysis comparing the results of the analysis with and without  
21 these demands is presented in Appendix 5B of this EIS.

22 **5.4.3.4.1 Alternative 3 Compared to the No Action Alternative**

23 *Trinity River Region*

24 *Changes in CVP and SWP Reservoir Storage and Downstream River Flows*

25 Changes in Trinity Lake storage and surface water elevations under Alternative 3  
26 as compared to the No Action Alternative are summarized in Tables 5.45  
27 and 5.45. The results are summarized following Table 5.45.

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**Table 5.45 Changes in Trinity Lake Storage under Alternative 3 as Compared to the No Action Alternative**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 3</b>												
Wet	1,502	1,537	1,643	1,766	1,928	2,053	2,224	2,248	2,192	2,067	1,936	1,805
Above Normal	1,197	1,230	1,349	1,511	1,707	1,891	2,071	2,045	1,949	1,806	1,646	1,513
Below Normal	1,434	1,457	1,477	1,542	1,629	1,717	1,858	1,786	1,680	1,509	1,334	1,199
Dry	1,173	1,179	1,206	1,226	1,318	1,450	1,585	1,537	1,468	1,301	1,152	1,056
Critical Dry	829	803	817	829	871	952	1,003	968	936	813	664	600
<b>No Action Alternative</b>												
Wet	1,490	1,516	1,630	1,756	1,921	2,053	2,220	2,245	2,190	2,067	1,939	1,784
Above Normal	1,159	1,178	1,286	1,455	1,658	1,847	2,025	1,999	1,907	1,773	1,619	1,495
Below Normal	1,393	1,400	1,417	1,488	1,575	1,662	1,817	1,743	1,637	1,470	1,304	1,185
Dry	1,152	1,148	1,174	1,182	1,274	1,403	1,539	1,490	1,413	1,253	1,104	1,008
Critical Dry	747	731	746	750	790	872	923	888	862	745	612	536
<b>Alternative 3 as Compared to No Action Alternative</b>												
Wet	11	21	13	10	7	0	3	4	3	0	-3	21
Above Normal	38	53	63	56	49	45	46	46	42	33	27	18
Below Normal	41	57	60	54	55	55	40	43	43	38	30	13
Dry	21	31	32	45	44	47	46	47	55	48	48	48
Critical Dry	82	73	71	79	81	81	80	80	73	68	53	64
<b>Alternative 3 as Compared to No Action Alternative (percent change)</b>												
Wet	0.7	1.4	0.8	0.6	0.4	0.0	0.1	0.2	0.1	0.0	-0.2	1.2
Above Normal	3.3	4.5	4.9	3.8	2.9	2.4	2.3	2.3	2.2	1.8	1.7	1.2
Below Normal	3.0	4.1	4.2	3.6	3.5	3.3	2.2	2.5	2.6	2.6	2.3	1.1
Dry	1.8	2.7	2.7	3.8	3.5	3.4	3.0	3.1	3.9	3.9	4.3	4.8
Critical Dry	11.0	10.0	9.5	10.5	10.2	9.3	8.7	9.0	8.5	9.1	8.6	11.9



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**Table 5.46 Changes in Trinity Lake Elevation under Alternative 3 as Compared to the No Action Alternative**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 3</b>												
Wet	2,301	2,305	2,314	2,325	2,339	2,347	2,357	2,358	2,355	2,347	2,338	2,328
Above Normal	2,268	2,271	2,284	2,301	2,319	2,334	2,347	2,345	2,339	2,328	2,315	2,304
Below Normal	2,293	2,295	2,297	2,304	2,312	2,319	2,330	2,325	2,317	2,302	2,286	2,274
Dry	2,265	2,268	2,271	2,273	2,283	2,296	2,309	2,305	2,299	2,284	2,269	2,260
Critical Dry	2,226	2,220	2,222	2,225	2,231	2,244	2,252	2,248	2,244	2,229	2,204	2,193
<b>No Action Alternative</b>												
Wet	2,300	2,303	2,313	2,324	2,338	2,347	2,357	2,358	2,355	2,347	2,338	2,327
Above Normal	2,261	2,264	2,276	2,294	2,314	2,330	2,343	2,341	2,335	2,325	2,313	2,302
Below Normal	2,289	2,289	2,291	2,299	2,307	2,315	2,327	2,321	2,313	2,299	2,283	2,272
Dry	2,263	2,265	2,268	2,269	2,279	2,292	2,305	2,301	2,294	2,279	2,264	2,254
Critical Dry	2,210	2,207	2,210	2,213	2,220	2,235	2,242	2,238	2,235	2,220	2,196	2,182
<b>Alternative 3 as Compared to No Action Alternative</b>												
Wet	1	2	1	1	1	0	0	0	0	0	0	2
Above Normal	7	8	8	7	5	4	4	4	4	3	2	2
Below Normal	4	5	6	5	5	5	3	4	4	3	3	2
Dry	3	3	3	4	4	4	4	4	5	5	5	6
Critical Dry	16	13	13	12	11	10	9	9	9	9	8	11
<b>Alternative 3 as Compared to No Action Alternative (percent change)</b>												
Wet	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Above Normal	0.3	0.3	0.4	0.3	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1
Below Normal	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.1	0.1	0.1
Dry	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3
Critical Dry	0.7	0.6	0.6	0.6	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.5

1 The following changes in Trinity Lake storage would occur under Alternative 3 as  
2 compared to the No Action Alternative.

- 3 • In wet, above-normal years, below-normal, and dry years, storage would be  
4 similar in all months.
- 5 • In critical dry years, storage would be increased in all months (up to  
6 11.9 percent).
- 7 • In all months, in all water year types, surface water elevations would be  
8 similar.

9 The following changes would occur on the Trinity River under Alternative 3 as  
10 compared to the No Action Alternative, as summarized in Figures 5.53  
11 through 5.55.

- 12 • Over long-term conditions, flows would be similar in March through  
13 November and increased in December through February (up to 11.8 percent).
- 14 • In wet years, flows would be similar in April through October; reduced in  
15 November (7.0 percent) and increased in December through March (up to  
16 15.1 percent).
- 17 • In dry years, flows would be similar in all months.

18 *Central Valley Region*

19 *Changes in CVP and SWP Reservoir Storage and Downstream River Flows*  
20 *Shasta Lake and Sacramento River*

21 Storage levels and surface water elevations in Shasta Lake under Alternative 3 as  
22 compared to the No Action Alternative are summarized in Tables 5.47 and 5.48.  
23 Changes in flows in the Sacramento River downstream of Keswick Dam and at  
24 Freeport are shown on Figures 5.56 through 5.61. The results are summarized  
25 following Table 5.48.

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**Table 5.47 Changes in Shasta Lake Storage under Alternative 3 as Compared to the No Action Alternative**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 3</b>												
Wet	2,816	2,932	3,161	3,408	3,597	3,841	4,301	4,453	4,221	3,720	3,370	3,244
Above Normal	2,475	2,555	2,783	3,303	3,509	4,023	4,403	4,401	3,975	3,350	2,998	2,946
Below Normal	2,818	2,851	2,983	3,302	3,650	3,971	4,176	4,056	3,631	3,036	2,669	2,562
Dry	2,431	2,451	2,590	2,770	3,189	3,662	3,885	3,798	3,359	2,826	2,542	2,500
Critical Dry	1,833	1,793	1,877	2,024	2,184	2,424	2,354	2,237	1,836	1,406	1,129	1,066
<b>No Action Alternative</b>												
Wet	2,700	2,719	3,077	3,384	3,589	3,836	4,298	4,460	4,242	3,735	3,410	2,985
Above Normal	2,369	2,385	2,600	3,167	3,453	4,021	4,404	4,429	4,039	3,407	3,069	2,834
Below Normal	2,587	2,548	2,686	3,062	3,442	3,814	4,026	3,957	3,588	3,002	2,643	2,608
Dry	2,345	2,283	2,428	2,621	3,034	3,505	3,737	3,668	3,284	2,767	2,496	2,462
Critical Dry	1,702	1,633	1,717	1,871	2,031	2,274	2,202	2,088	1,719	1,253	986	937
<b>Alternative 3 as Compared to No Action Alternative</b>												
Wet	116	214	84	24	8	5	2	-7	-21	-16	-41	260
Above Normal	106	170	183	136	56	2	-1	-27	-64	-57	-71	112
Below Normal	231	302	296	240	208	157	150	99	42	34	26	-46
Dry	86	168	162	149	155	156	148	130	74	58	45	38
Critical Dry	131	160	160	153	152	149	152	149	117	153	143	129
<b>Alternative 3 as Compared to No Action Alternative (percent change)</b>												
Wet	4.3	7.9	2.7	0.7	0.2	0.1	0.1	-0.2	-0.5	-0.4	-1.2	8.7
Above Normal	4.5	7.1	7.0	4.3	1.6	0.1	0.0	-0.6	-1.6	-1.7	-2.3	4.0
Below Normal	8.9	11.9	11.0	7.9	6.0	4.1	3.7	2.5	1.2	1.1	1.0	-1.8
Dry	3.7	7.4	6.7	5.7	5.1	4.5	4.0	3.5	2.3	2.1	1.8	1.6
Critical Dry	7.7	9.8	9.3	8.2	7.5	6.6	6.9	7.1	6.8	12.2	14.5	13.8

1 **Table 5.48 Changes in Shasta Lake Elevation under Alternative 3 as Compared to**  
 2 **the No Action Alternative**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 3</b>												
Wet	997	1,002	1,012	1,024	1,032	1,041	1,058	1,063	1,055	1,036	1,022	1,017
Above Normal	973	976	990	1,018	1,028	1,048	1,062	1,062	1,046	1,021	1,006	1,004
Below Normal	997	998	1,004	1,019	1,034	1,046	1,054	1,049	1,032	1,008	991	986
Dry	974	976	983	993	1,013	1,033	1,042	1,039	1,021	998	985	983
Critical Dry	935	933	939	948	960	975	972	966	941	910	888	882
<b>No Action Alternative</b>												
Wet	991	992	1,008	1,023	1,031	1,041	1,058	1,064	1,056	1,037	1,024	1,005
Above Normal	967	968	982	1,012	1,025	1,048	1,062	1,063	1,049	1,024	1,009	999
Below Normal	986	985	991	1,009	1,025	1,040	1,048	1,045	1,031	1,006	989	987
Dry	969	967	975	986	1,006	1,027	1,037	1,034	1,018	995	982	980
Critical Dry	927	923	929	939	951	968	965	958	935	899	876	872
<b>Alternative 3 as Compared to No Action Alternative</b>												
Wet	6	10	4	1	0	0	0	0	-1	-1	-2	12
Above Normal	5	8	8	6	2	0	0	-1	-2	-2	-3	5
Below Normal	11	14	13	10	9	6	6	4	2	2	2	-2
Dry	5	9	8	7	7	6	6	5	3	3	3	2
Critical Dry	8	10	10	9	8	7	8	8	7	11	11	11
<b>Alternative 3 as Compared to No Action Alternative (percent change)</b>												
Wet	0.6	1.0	0.4	0.1	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.2	1.2
Above Normal	0.6	0.8	0.9	0.6	0.2	0.0	0.0	-0.1	-0.2	-0.2	-0.3	0.5
Below Normal	1.1	1.4	1.3	1.0	0.9	0.6	0.5	0.4	0.2	0.2	0.2	-0.2
Dry	0.5	0.9	0.8	0.7	0.7	0.6	0.6	0.5	0.3	0.3	0.3	0.2
Critical Dry	0.9	1.1	1.0	1.0	0.9	0.8	0.8	0.8	0.7	1.2	1.3	1.2

3 The following changes in Shasta Lake storage and surface water elevations would  
 4 occur under Alternative 3 as compared to the No Action Alternative.

- 5 • In wet years, storage would be similar in December through August and  
 6 increased in September and November (up to 8.7 percent).
- 7 • In above-normal years, storage would be similar in January through October  
 8 and increased in November and December (up to 7.1 percent).
- 9 • In below-normal years, storage would be similar in March through September  
 10 and increased in October through February (up to 11.9 percent).

- 1 • In dry years, storage would be similar in March through October and  
2 increased in November through January (up to 7.4 percent).
- 3 • In critical dry years, storage would increase in all months (up to 12.2 percent).
- 4 • In all months, in all water year types, surface water elevations would be  
5 similar.

6 The following changes in Sacramento River flows would occur under  
7 Alternative 3 as compared to the No Action Alternative, as shown on Figures 5.56  
8 through 5.61.

- 9 • Sacramento River downstream of Keswick Dam (Figures 5.56 through 5.58).
  - 10 – Over long-term conditions, similar flows would occur in October,  
11 February through May, July, and August; reduced flows in September and  
12 November (up to 20.1 percent); and increased flows in December,  
13 January, and June (up to 8.9 percent).
  - 14 – In wet years, similar flows would occur in February through August;  
15 reduced flows in September through November (up to 42.1 percent); and  
16 increased flows in December and January (up to 16.9 percent).
  - 17 – In dry years, similar flows would occur in July through September and  
18 December through May; reduced flows in November (24.6 percent); and  
19 increased flows in January and June (up to 7.3 percent).
- 20 • Sacramento River near Freeport (near the northern boundary of the Delta)  
21 (Figures 5.59 through 5.61).
  - 22 – Over long-term conditions, similar flows would occur in October,  
23 December through May, July, and August; reduced flows in September  
24 and November (up to 30.1 percent); and increased flows in June  
25 (12.1 percent).
  - 26 – In wet years, similar flows would occur in January through May, July, and  
27 October; reduced flows in August, September, and November (up to  
28 48.1 percent); and increased flows in December and June (up to  
29 6.6 percent).
  - 30 – In dry years, similar flows would occur in July through October and  
31 December through April; reduced flows in November (14.2 percent); and  
32 increased flows in May and June (up to 15.7 percent).

33 *Lake Oroville and Feather River*

34 Storage levels and surface water elevations in Lake Oroville under Alternative 3  
35 as compared to the No Action Alternative are summarized in Tables 5.49  
36 and 5.50. Changes in flows in the Feather River downstream of Thermalito  
37 Complex are shown on Figures 5.62 through 5.64. The results are summarized  
38 following Table 5.50.

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**Table 5.49 Changes in Lake Oroville Storage under Alternative 3 as Compared to the No Action Alternative**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 3</b>												
Wet	1,893	1,931	2,315	2,608	2,854	2,942	3,300	3,473	3,375	2,902	2,630	2,499
Above Normal	1,405	1,448	1,623	2,109	2,623	2,945	3,280	3,371	3,129	2,494	2,039	1,778
Below Normal	1,839	1,801	1,846	2,054	2,370	2,636	2,879	2,883	2,610	1,971	1,520	1,354
Dry	1,332	1,288	1,322	1,454	1,733	2,088	2,329	2,319	1,980	1,548	1,343	1,198
Critical Dry	1,129	1,067	1,067	1,156	1,275	1,429	1,449	1,437	1,236	1,029	918	862
<b>No Action Alternative</b>												
Wet	1,691	1,732	2,189	2,554	2,832	2,942	3,300	3,488	3,445	2,964	2,626	2,109
Above Normal	1,279	1,322	1,485	1,959	2,519	2,892	3,247	3,393	3,232	2,600	2,117	1,659
Below Normal	1,542	1,497	1,507	1,719	2,122	2,397	2,653	2,714	2,530	1,923	1,513	1,307
Dry	1,206	1,158	1,177	1,305	1,582	1,938	2,178	2,210	1,951	1,478	1,287	1,144
Critical Dry	1,092	1,029	1,019	1,108	1,223	1,381	1,408	1,392	1,243	1,018	917	865
<b>Alternative 3 as Compared to No Action Alternative</b>												
Wet	201	199	126	54	23	0	0	-15	-70	-62	4	390
Above Normal	126	127	138	151	105	53	33	-22	-102	-106	-78	118
Below Normal	297	303	339	335	248	240	225	169	80	48	8	47
Dry	127	130	145	149	151	150	151	109	29	70	55	55
Critical Dry	37	38	48	48	52	48	41	45	-8	10	1	-3
<b>Alternative 3 as Compared to No Action Alternative (percent change)</b>												
Wet	11.9	11.5	5.8	2.1	0.8	0.0	0.0	-0.4	-2.0	-2.1	0.1	18.5
Above Normal	9.9	9.6	9.3	7.7	4.2	1.8	1.0	-0.7	-3.2	-4.1	-3.7	7.1
Below Normal	19.3	20.2	22.5	19.5	11.7	10.0	8.5	6.2	3.2	2.5	0.5	3.6
Dry	10.5	11.2	12.3	11.4	9.6	7.7	6.9	4.9	1.5	4.7	4.3	4.8
Critical Dry	3.4	3.7	4.7	4.3	4.2	3.5	2.9	3.2	-0.6	1.0	0.1	-0.3

1 **Table 5.50 Changes in Lake Oroville Elevation under Alternative 3 as Compared to**  
 2 **the No Action Alternative**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 3</b>												
Wet	763	767	805	834	853	859	884	895	889	856	836	825
Above Normal	711	717	738	791	836	859	882	889	872	827	786	758
Below Normal	758	754	759	781	813	835	854	855	836	780	730	710
Dry	702	697	703	720	752	789	811	810	779	733	709	691
Critical Dry	679	671	671	684	699	718	719	718	693	665	648	640
<b>No Action Alternative</b>												
Wet	743	748	794	829	852	859	884	897	894	861	836	790
Above Normal	698	703	722	776	828	856	880	890	879	835	794	746
Below Normal	730	725	726	751	793	818	838	842	828	773	729	704
Dry	688	683	686	704	737	775	798	800	775	724	702	684
Critical Dry	674	667	664	678	693	712	715	712	693	663	648	640
<b>Alternative 3 as Compared to No Action Alternative</b>												
Wet	19	19	11	5	2	0	0	-1	-5	-5	0	35
Above Normal	13	14	16	15	9	4	2	-2	-7	-9	-9	13
Below Normal	28	29	32	30	21	17	16	13	8	6	1	6
Dry	14	14	16	16	15	13	13	10	3	8	7	7
Critical Dry	5	5	7	7	6	6	5	6	0	2	0	0
<b>Alternative 3 as Compared to No Action Alternative (percent change)</b>												
Wet	2.6	2.6	1.4	0.6	0.2	0.0	0.0	-0.1	-0.5	-0.6	0.0	4.4
Above Normal	1.9	2.0	2.2	1.9	1.0	0.4	0.3	-0.2	-0.8	-1.0	-1.1	1.7
Below Normal	3.9	4.0	4.5	4.0	2.6	2.1	1.9	1.5	1.0	0.8	0.2	0.8
Dry	2.0	2.1	2.4	2.2	2.1	1.7	1.6	1.2	0.4	1.2	1.0	1.0
Critical Dry	0.7	0.7	1.0	1.0	0.9	0.8	0.6	0.8	0.0	0.3	0.1	0.0

- 3 The following changes in Lake Oroville storage and surface water elevations  
 4 would occur under Alternative 3 as compared to the No Action Alternative.
- 5 • In wet years, storage would be similar in January through August and  
 6 increased in September through December (up to 18.5 percent).
  - 7 • In above-normal years, storage would be similar in February through August  
 8 and increased in September through January (up to 18.5 percent).
  - 9 • In below-normal years, storage would be similar in June through September  
 10 and increased in October through May (up to 22.5 percent).

- 1 • In dry years, storage would be similar in May through September and  
2 increased in October through April (up to 12.3 percent).
- 3 • In critical dry years, storage would be similar under all months.
- 4 • In all months, in all water year types, surface water elevations would be  
5 similar.

6 The following changes in Feather River flows would occur under Alternative 3 as  
7 compared to the No Action Alternative, as shown on Figures 5.62 through 5.64.

- 8 • Over long-term conditions, similar flows would occur in October, November,  
9 March, April, and July; reduced flows in August and September (up to  
10 49.4 percent); and increased flows in December through February, May, and  
11 June (up to 33.9 percent).
- 12 • In wet years, similar flows would occur in October, November, February  
13 through May, and July; reduced flows in August and September (up to  
14 70.0 percent) and increased flows in December, January, and June (up to  
15 28.1 percent).
- 16 • In dry years, similar flows would occur in September and January through  
17 April; reduced flows in October through December and July (up to  
18 14.5 percent); and increased flows in May, June, and August (36.9 percent).

19 *Folsom Lake and American River*

20 Storage levels and surface water elevations in Folsom Lake under Alternative 3 as  
21 compared to the No Action Alternative are summarized in Tables 5.51 and 5.52.  
22 Changes in flows in the American River downstream of Nimbus Dam are shown  
23 on Figures 5.65 through 5.67. The results are summarized following Table 5.52.



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**Table 5.51 Changes in Folsom Lake Storage under Alternative 3 as Compared to the No Action Alternative**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 3</b>												
Wet	486	473	525	524	515	632	785	951	929	790	690	645
Above Normal	388	404	454	537	539	640	787	946	851	580	516	479
Below Normal	513	496	505	514	542	627	764	844	766	506	436	407
Dry	405	398	420	434	482	580	692	761	654	491	436	411
Critical Dry	331	314	322	325	370	436	474	485	431	343	291	257
<b>No Action Alternative</b>												
Wet	454	435	514	518	515	632	785	951	941	800	712	576
Above Normal	377	380	429	513	531	640	787	946	887	621	552	477
Below Normal	446	431	467	484	533	619	757	843	780	527	472	453
Dry	394	383	408	423	479	579	691	760	658	495	443	419
Critical Dry	324	305	315	320	366	432	475	486	415	327	267	231
<b>Alternative 3 as Compared to No Action Alternative</b>												
Wet	33	38	11	6	0	0	0	0	-12	-10	-22	69
Above Normal	11	24	25	25	8	0	0	0	-36	-41	-36	2
Below Normal	67	64	38	30	9	8	6	1	-14	-21	-36	-45
Dry	11	15	12	11	3	1	1	1	-4	-4	-7	-8
Critical Dry	7	8	8	5	3	3	-1	-1	16	16	25	27
<b>Alternative 3 as Compared to No Action Alternative (percent change)</b>												
Wet	7.2	8.8	2.1	1.2	0.0	0.0	0.0	0.0	-1.3	-1.3	-3.1	12.0
Above Normal	2.8	6.3	5.8	4.8	1.5	0.0	0.0	0.0	-4.1	-6.7	-6.6	0.5
Below Normal	15.0	14.9	8.2	6.2	1.6	1.3	0.8	0.1	-1.8	-3.9	-7.6	-10.0
Dry	2.8	3.9	2.9	2.6	0.6	0.2	0.1	0.2	-0.6	-0.8	-1.6	-1.9
Critical Dry	2.1	2.7	2.5	1.6	0.9	0.7	-0.2	-0.1	3.9	4.9	9.2	11.6

1 **Table 5.52 Changes in Folsom Lake Elevation under Alternative 3 as Compared to**  
 2 **the No Action Alternative**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 3</b>												
Wet	413	412	419	419	418	432	448	465	463	448	438	433
Above Normal	395	397	408	421	421	433	448	465	455	425	418	413
Below Normal	416	415	416	417	421	432	446	454	446	415	404	401
Dry	401	401	405	407	414	426	438	445	434	414	407	404
Critical Dry	388	386	390	390	396	406	411	411	403	389	379	372
<b>No Action Alternative</b>												
Wet	409	407	418	418	418	432	448	464	464	449	440	425
Above Normal	394	395	405	418	420	433	449	464	458	430	422	413
Below Normal	408	406	411	414	420	431	445	454	447	418	411	409
Dry	400	399	403	405	413	426	438	445	434	414	408	405
Critical Dry	386	384	389	390	396	406	411	412	401	386	374	366
<b>Alternative 3 as Compared to No Action Alternative</b>												
Wet	4	5	1	1	0	0	0	1	-1	-1	-3	8
Above Normal	0	2	3	3	1	0	0	1	-3	-5	-4	0
Below Normal	8	8	5	4	1	1	1	1	-1	-3	-7	-8
Dry	1	2	1	1	0	0	0	0	0	-1	-1	-1
Critical Dry	2	2	1	1	0	0	0	0	2	3	5	6
<b>Alternative 3 as Compared to No Action Alternative (percent change)</b>												
Wet	1.0	1.2	0.3	0.2	0.0	0.0	0.0	0.2	-0.1	-0.3	-0.6	1.9
Above Normal	0.1	0.6	0.6	0.7	0.2	0.0	0.0	0.1	-0.7	-1.2	-1.0	0.1
Below Normal	2.1	2.0	1.2	0.9	0.3	0.2	0.2	0.1	-0.3	-0.7	-1.6	-1.9
Dry	0.3	0.5	0.3	0.3	0.1	0.0	0.0	0.1	-0.1	-0.1	-0.2	-0.3
Critical Dry	0.4	0.5	0.4	0.2	0.1	0.0	-0.1	-0.1	0.5	0.7	1.5	1.7

3 The following changes in Folsom Lake storage would occur under Alternative 3  
 4 as compared to the No Action Alternative.

- 5 • In wet years, storage would be similar in December through August and  
 6 increased in September through December (up to 12.1 percent).
- 7 • In above-normal years, storage would be similar in January through June,  
 8 September, and October; and increased in November and December (up to  
 9 6.3 percent); and reduced in July and August (up to 6.7 percent).
- 10 • In below-normal years, storage would be similar in February through July;  
 11 reduced in August and September (up to 10.0 percent); and increased in  
 12 October through January (up to 15.0 percent).

- 1 • In dry years, storage would be similar in all months.
- 2 • In critical dry years, storage would be similar in October through July and  
3 increased in August and September (up to 11.6 percent).
- 4 • In all months, in all water year types, surface water elevations would be  
5 similar.
- 6 The following changes in American River flows would occur under Alternative 3  
7 as compared to the No Action Alternative, as shown on Figures 5.65  
8 through 5.67.
- 9 • Over long-term conditions, similar flows would occur in November, January  
10 through May, July, and August; reduced flows in September and October (up  
11 to 28.7 percent); and increased flows in June (5.8 percent).
- 12 • In wet years, similar flows would occur in October, November, and January  
13 through July; reduced flows in September (45.9 percent); and increased flows  
14 in August and December (up to 8.5 percent).
- 15 • In dry years, similar flows would occur in November through January and  
16 March through September; reduced flows in October (11.2 percent); and  
17 increased flows in February (6.1 percent).

18 *Clear Creek*

19 Changes in flows in Clear Creek downstream of Whiskeytown Dam are  
20 summarized in Table 5.53.

21 Monthly Clear Creek flows under Alternative 3 as compared to the No Action  
22 Alternative are identical except in May. In May, under Alternative 3, flows are  
23 up to 28.9 percent lower than under the No Action Alternative.

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**Table 5.53 Changes in Clear Creek Flows below Whiskeytown Dam under Alternative 3 as Compared to the No Action Alternative**

Water Year	Average Monthly Flow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 3</b>												
Wet	200	200	200	309	356	272	200	200	200	85	85	150
Above Normal	181	182	188	192	196	196	196	200	200	85	85	150
Below Normal	195	195	195	195	195	195	195	195	191	85	85	150
Dry	178	184	188	190	190	190	190	190	183	85	85	150
Critical Dry	163	167	167	167	167	167	167	167	111	85	85	133
<b>No Action Alternative</b>												
Wet	200	200	200	309	356	272	200	277	200	85	85	150
Above Normal	181	182	188	192	196	196	196	277	200	85	85	150
Below Normal	195	195	195	195	195	195	195	274	191	85	85	150
Dry	175	184	188	190	190	190	190	267	183	85	85	150
Critical Dry	163	167	167	167	167	167	167	214	111	85	85	133
<b>Alternative 3 as Compared to No Action Alternative</b>												
Wet	0	0	0	0	0	0	0	-77	0	0	0	0
Above Normal	0	0	0	0	0	0	0	-77	0	0	0	0
Below Normal	0	0	0	0	0	0	0	-78	0	0	0	0
Dry	3	0	0	0	0	0	0	-77	0	0	0	0
Critical Dry	0	0	0	0	0	0	0	-47	0	0	0	0
<b>Alternative 3 as Compared to No Action Alternative (percent change)</b>												
Wet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-27.9	0.0	0.0	0.0	0.0
Above Normal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-27.9	0.0	0.0	0.0	0.0
Below Normal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-28.6	0.0	0.0	0.0	0.0
Dry	1.6	0.0	0.0	0.0	0.0	0.0	0.0	-28.9	0.0	0.0	0.0	0.0
Critical Dry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-22.1	0.0	0.0	0.0	0.0

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*New Melones Reservoir and Stanislaus River*

Storage levels and surface water elevations in New Melones Reservoir under Alternative 3 as compared to the No Action Alternative are summarized in Tables 5.54 and 5.55. Changes in flows in the Stanislaus River downstream of Goodwin Dam are shown on Figures 5.68 through 5.70. The results are summarized following Table 5.55.

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**Table 5.54 Changes in New Melones Reservoir Storage under Alternative 3 as Compared to the No Action Alternative**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 3</b>												
Wet	1,562	1,567	1,618	1,720	1,792	1,871	1,906	2,049	2,146	2,057	1,934	1,855
Above Normal	1,269	1,295	1,356	1,442	1,530	1,620	1,634	1,713	1,720	1,627	1,529	1,481
Below Normal	1,530	1,536	1,550	1,570	1,620	1,650	1,614	1,617	1,599	1,501	1,403	1,357
Dry	1,327	1,320	1,326	1,342	1,378	1,409	1,380	1,360	1,319	1,224	1,137	1,091
Critical Dry	828	824	836	846	866	860	803	751	719	653	593	563
<b>No Action Alternative</b>												
Wet	1,379	1,390	1,454	1,562	1,666	1,724	1,758	1,878	1,968	1,890	1,773	1,703
Above Normal	1,029	1,060	1,125	1,214	1,317	1,406	1,413	1,484	1,467	1,372	1,277	1,232
Below Normal	1,294	1,305	1,326	1,351	1,413	1,438	1,390	1,383	1,359	1,268	1,175	1,133
Dry	1,094	1,094	1,106	1,121	1,156	1,188	1,154	1,132	1,087	997	914	871
Critical Dry	624	623	638	645	661	656	602	554	526	476	431	408
<b>Alternative 3 as Compared to No Action Alternative</b>												
Wet	183	177	165	158	126	147	149	172	178	168	161	152
Above Normal	239	235	231	228	213	213	220	229	253	255	252	250
Below Normal	236	231	224	219	207	212	224	234	239	233	228	224
Dry	232	226	220	220	222	221	226	228	232	228	223	221
Critical Dry	205	201	198	201	204	204	202	197	193	177	162	154
<b>Alternative 3 as Compared to No Action Alternative (percent change)</b>												
Wet	13.3	12.7	11.3	10.1	7.6	8.5	8.4	9.1	9.0	8.9	9.1	8.9
Above Normal	23.3	22.1	20.5	18.7	16.2	15.2	15.6	15.4	17.2	18.6	19.7	20.3
Below Normal	18.2	17.7	16.9	16.2	14.7	14.7	16.1	16.9	17.6	18.4	19.4	19.8
Dry	21.2	20.7	19.9	19.7	19.2	18.6	19.5	20.1	21.3	22.8	24.4	25.3
Critical Dry	32.8	32.3	31.1	31.1	30.9	31.1	33.6	35.5	36.7	37.3	37.6	37.8

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**Table 5.55 Changes in New Melones Reservoir Elevation under Alternative 3 as Compared to the No Action Alternative**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 3</b>												
Wet	1,003	1,004	1,010	1,022	1,030	1,038	1,042	1,055	1,064	1,056	1,045	1,037
Above Normal	964	967	974	987	999	1,009	1,012	1,021	1,022	1,013	1,002	924
Below Normal	998	998	1,000	1,002	1,011	1,014	1,011	1,012	1,010	1,000	989	983
Dry	974	973	974	977	981	985	983	982	978	966	954	948
Critical Dry	899	899	902	904	909	909	899	889	883	870	858	852
<b>No Action Alternative</b>												
Wet	980	982	990	1,004	1,016	1,023	1,026	1,039	1,047	1,040	1,029	1,022
Above Normal	932	937	945	960	974	986	988	997	996	985	973	897
Below Normal	968	969	972	975	985	988	985	985	983	972	960	955
Dry	943	943	944	947	951	957	955	953	948	934	922	915
Critical Dry	856	856	862	864	870	871	860	848	840	828	818	812
<b>Alternative 3 as Compared to No Action Alternative</b>												
Wet	23	22	20	18	14	16	15	16	17	16	16	16
Above Normal	32	30	29	28	25	23	24	24	27	28	29	27
Below Normal	30	29	28	27	26	26	26	27	27	28	28	28
Dry	32	31	30	30	30	29	29	29	31	31	32	33
Critical Dry	43	43	40	40	38	38	39	41	43	41	40	40
<b>Alternative 3 as Compared to No Action Alternative (percent change)</b>												
Wet	2.3	2.2	2.0	1.8	1.4	1.5	1.5	1.6	1.6	1.5	1.6	1.5
Above Normal	3.4	3.2	3.1	2.9	2.6	2.4	2.4	2.4	2.7	2.9	3.0	3.0
Below Normal	3.1	3.0	2.9	2.8	2.6	2.6	2.7	2.7	2.8	2.9	3.0	3.0
Dry	3.3	3.3	3.2	3.2	3.2	3.0	3.0	3.1	3.2	3.4	3.5	3.6
Critical Dry	5.1	5.0	4.7	4.6	4.4	4.3	4.5	4.9	5.1	5.0	4.9	4.9

1 The following changes in New Melones Reservoir storage would occur under  
2 Alternative 3 as compared to the No Action Alternative.

- 3 • In wet years, storage would be increased in all months (up to 13.3 percent).
- 4 • In above-normal years, storage would be increased in all months (up to  
5 23.3 percent).
- 6 • In below-normal years, storage would be increased in all months (up to  
7 19.8 percent).
- 8 • In dry years, storage would be increased in all months (up to 25.3 percent).
- 9 • In critical dry years, storage would be increased in all months (up to  
10 37.8 percent).
- 11 • In all months, in all water year types, surface water elevations would be  
12 similar.

13 Flows in the Stanislaus River downstream of Goodwin Dam are shown on  
14 Figures 5.68 to 5.70. Changes in flows in these rivers are summarized below.

- 15 • Over long-term conditions, reduced flows would occur in October and March  
16 through June (up to 58.3 percent); and increased flows in November through  
17 February and July through September (up to 36.81 percent).
- 18 • In wet years, similar flows would occur in April; reduced flows in October,  
19 March, and May (up to 52.9 percent); and increased flows in June through  
20 September and November through February (up to 67.8 percent).
- 21 • In dry years, similar flows would occur in March and July through September;  
22 reduced flows in October and April through June (up to 59.6 percent); and  
23 increased flows in November through February (up to 37.0 percent).

24 *San Joaquin River at Vernalis*

25 Flows in the San Joaquin River at Vernalis under Alternative 3 as compared to the  
26 No Action Alternative are summarized below, as shown on Figures 5.71  
27 through 5.73.

- 28 • Over long-term conditions, similar flows would occur in November through  
29 September and reduced flows in October (15.7 percent).
- 30 • In wet years, similar flows would occur in November through August;  
31 reduced flows in October (14.1 percent); and increased flows in September  
32 (5.7 percent).
- 33 • In dry years, similar flows would occur in November through March and July  
34 through September and reduced flows in October and April through June (up  
35 to 15.2 percent).

36 *San Luis Reservoir*

37 Storage levels and surface water elevations in San Luis Reservoir under  
38 Alternative 3 as compared to the No Action Alternative are summarized in  
39 Tables 5.56 and 5.57. The results are summarized following Table 5.57.

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**Table 5.56 Changes in San Luis Reservoir Storage under Alternative 3 as Compared to the No Action Alternative**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 3</b>												
Wet	810	1,033	1,276	1,555	1,810	1,957	1,975	1,851	1,540	1,228	961	980
Above Normal	619	844	1,109	1,342	1,571	1,756	1,763	1,575	1,155	830	674	703
Below Normal	834	1,043	1,305	1,489	1,623	1,736	1,651	1,338	899	737	585	561
Dry	634	804	1,052	1,302	1,455	1,608	1,593	1,413	1,128	926	590	535
Critical Dry	548	632	804	1,076	1,216	1,256	1,227	1,069	838	572	380	351
<b>No Action Alternative</b>												
Wet	555	681	931	1,236	1,526	1,788	1,598	1,251	946	741	628	679
Above Normal	490	649	957	1,223	1,441	1,661	1,444	1,048	666	466	433	513
Below Normal	525	624	907	1,141	1,314	1,473	1,312	967	555	500	426	467
Dry	476	590	867	1,150	1,339	1,494	1,413	1,167	840	763	476	469
Critical Dry	478	556	752	1,040	1,204	1,252	1,192	1,028	739	544	343	323
<b>Alternative 3 as Compared to No Action Alternative</b>												
Wet	255	351	345	320	284	170	377	599	593	487	334	300
Above Normal	130	194	153	119	129	95	319	526	489	363	241	190
Below Normal	309	419	399	348	309	263	339	371	344	237	160	94
Dry	158	214	185	152	117	114	180	246	288	163	114	66
Critical Dry	70	76	53	37	12	4	35	40	99	28	38	28
<b>Alternative 3 as Compared to No Action Alternative (percent change)</b>												
Wet	55.3	76.6	58.4	38.6	25.4	12.5	31.2	68.0	96.3	84.6	58.6	43.5
Above Normal	30.9	56.4	31.9	21.8	20.6	11.1	31.0	71.0	111.4	93.4	63.4	34.8
Below Normal	73.2	106.9	71.2	45.4	32.8	23.5	31.7	45.1	81.6	69.1	59.6	30.0
Dry	39.1	52.1	30.6	18.3	11.8	10.0	14.5	24.2	38.5	19.4	18.5	4.4
Critical Dry	28.6	28.3	10.8	5.5	1.9	0.8	2.5	2.9	16.3	10.1	25.1	29.2



1 **Table 5.57 Changes in San Luis Reservoir Elevation under Alternative 3 as**  
 2 **Compared to the No Action Alternative**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 3</b>												
Wet	427	452	477	503	525	537	539	529	502	473	447	449
Above Normal	406	431	459	482	504	520	521	505	467	433	417	420
Below Normal	431	454	480	497	509	519	512	484	440	423	405	401
Dry	410	430	456	480	494	508	506	490	464	444	405	397
Critical Dry	399	409	430	458	472	475	473	457	434	403	375	371
<b>No Action Alternative</b>												
Wet	399	414	443	473	500	523	507	475	444	422	409	416
Above Normal	391	411	445	472	492	512	493	456	415	389	386	398
Below Normal	397	410	442	465	481	496	481	448	400	393	383	389
Dry	391	406	437	466	484	498	490	468	434	426	390	389
Critical Dry	390	400	423	454	470	475	469	453	422	399	369	366
<b>Alternative 3 as Compared to No Action Alternative</b>												
Wet	28	38	34	29	24	14	32	53	58	52	38	33
Above Normal	14	21	15	11	11	8	28	49	51	44	31	23
Below Normal	33	44	39	32	28	23	30	36	40	30	23	12
Dry	19	24	18	14	10	10	16	23	30	18	15	9
Critical Dry	9	10	6	4	2	1	4	4	12	4	6	5
<b>Alternative 3 as Compared to No Action Alternative (percent change)</b>												
Wet	6.9	9.1	7.6	6.2	4.9	2.7	6.2	11.2	13.0	12.2	9.3	7.9
Above Normal	3.7	5.0	3.3	2.3	2.3	1.6	5.6	10.6	12.4	11.3	8.1	5.7
Below Normal	8.4	10.7	8.8	6.9	5.8	4.6	6.3	8.0	10.1	7.6	5.9	3.2
Dry	4.9	5.8	4.2	3.0	2.2	2.0	3.2	4.8	6.8	4.2	3.9	2.2
Critical Dry	2.3	2.4	1.5	0.9	0.4	0.2	0.8	1.0	2.8	0.9	1.7	1.4

1 The following changes in San Luis Reservoir storage would occur under  
2 Alternative 3 as compared to the No Action Alternative.

- 3 • In wet years, storage would be increased in all months (up to 96.3 percent).  
4 Water storage elevations would be increased in all months (up to  
5 13.0 percent).
- 6 • In above-normal years, storage would be increased in all months (up to  
7 111.4 percent). Water storage elevations would be similar in October through  
8 March and increased in April through September (up to 11.3 percent).
- 9 • In below-normal years, storage would be increased in all months (up to  
10 106.9 percent). Water storage elevations would be similar in September and  
11 increased in October through August (up to 10.7 percent).
- 12 • In dry years, storage would be similar in September and increased in October  
13 through August (up to 52.1 percent). Water storage elevations would be  
14 similar December through May and July through October and increased in  
15 November and June (up to 6.8 percent).
- 16 • In critical dry years, storage would be similar in February through May and  
17 increased in June through January (up to 29.2 percent). Water storage  
18 elevations would be similar in all months.

19 *Changes in Flows into the Yolo Bypass*

20 Flows from the Sacramento River into the Yolo Bypass at Fremont Weir under  
21 Alternative 3 as compared to the No Action Alternative are summarized in  
22 Table 5.58. The results are summarized following Table 5.58.

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**Table 5.58 Changes in Flows into the Yolo Bypass at Fremont Weir under Alternative 3 as Compared to the No Action Alternative**

Water Year	Average Monthly Flow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 3</b>												
Wet	139	973	9,693	25,241	30,361	18,837	5,617	289	113	0	0	100
Above Normal	100	100	2,686	6,188	14,531	8,490	1,768	100	100	0	0	100
Below Normal	100	100	262	1,250	4,001	1,153	293	100	100	0	0	100
Dry	100	100	342	923	2,007	1,406	410	100	100	0	0	100
Critical Dry	100	100	150	534	545	397	106	100	100	0	0	100
<b>No Action Alternative</b>												
Wet	183	910	8,420	24,291	29,547	18,493	5,627	289	113	0	0	100
Above Normal	100	100	2,765	5,997	13,013	7,928	1,688	100	100	0	0	100
Below Normal	100	100	242	1,004	3,031	883	293	100	100	0	0	100
Dry	100	100	322	902	2,024	1,393	407	100	100	0	0	100
Critical Dry	100	100	149	528	534	396	106	100	100	0	0	100
<b>Alternative 3 as Compared to No Action Alternative</b>												
Wet	-45	64	1,273	950	813	344	-10	1	0	0	0	0
Above Normal	0	0	-78	192	1,519	562	80	0	0	0	0	0
Below Normal	0	0	20	247	970	271	-1	0	0	0	0	0
Dry	0	0	19	22	-17	13	3	0	0	0	0	0
Critical Dry	0	0	1	7	11	1	0	0	0	0	0	0
<b>Alternative 3 as Compared to No Action Alternative (percent change)</b>												
Wet	-24.5	7.0	15.1	3.9	2.8	1.9	-0.2	0.2	0.1	0.0	0.0	0.0
Above Normal	0.0	0.0	-2.8	3.2	11.7	7.1	4.8	0.0	0.0	0.0	0.0	0.0
Below Normal	0.0	0.0	8.3	24.6	32.0	30.7	-0.3	0.0	0.0	0.0	0.0	0.0
Dry	0.0	0.0	6.0	2.4	-0.8	0.9	0.6	0.0	0.0	0.0	0.0	0.0
Critical Dry	0.0	0.0	0.8	1.2	2.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0

- 1 The following changes in flows from the Sacramento River into Yolo Bypass at  
2 Fremont Weir would occur under Alternative 3 as compared to the No Action  
3 Alternative.
- 4 • In wet years, flows into Yolo Bypass would be similar in January through  
5 September; reduced in October (24.5 percent) and increased in November and  
6 December (up to 15.1 percent).
  - 7 • In above-normal years, storage would be similar in April through January and  
8 increased in February and March (up to 11.7 percent).
  - 9 • In below-normal years, flows into Yolo Bypass would be similar in April  
10 through November and increased in December through March (up to  
11 32.0 percent).
  - 12 • In dry years, flows into Yolo Bypass would be similar in January through  
13 November and increased in December (6.0 percent).
  - 14 • In critical dry years, flows into Yolo Bypass would be similar in all months.

15 *Changes in Delta Conditions*

16 Delta outflow under Alternative 3 as compared to the No Action Alternative are  
17 summarized below and shown on Figures 5.74 through 5.76.

- 18 • In wet years, average monthly Delta outflow would increase in December  
19 through March (up to 3,307 cfs) and decrease in April through November (up  
20 to 13,678 cfs).
- 21 • In dry years, average monthly Delta outflow would increase January,  
22 February, June, and July (up to 277 cfs) and decrease in August through  
23 December and March through May (up to 2,902 cfs).

24 The OMR conditions under Alternative 3 as compared to the No Action  
25 Alternative are shown on Figures 5.77 through 5.79.

- 26 • Under Alternative 3, OMR flows are negative in all months of all water year  
27 types except in April in a wet year (405 cfs). Under the No Action  
28 Alternative, OMR flows are negative except in April and May of wet and  
29 above-normal years and April of below-normal years.
- 30 • In wet years, average monthly OMR flows would be more positive in July and  
31 August (up to 800 cfs) and more negative in September through June (up to  
32 4,477 cfs).
- 33 • In dry years, average monthly OMR flows would be more positive in July and  
34 January (up to 728 cfs) and more negative in August through December and  
35 February through June (up to 1,847 cfs).

36 *Changes in CVP and SWP Exports and Deliveries*

37 Delta exports under Alternative 3 as compared to the No Action Alternative are  
38 summarized in Table 5.59.

1 **Table 5.59 Changes in Exports at Jones and Banks Pumping Plants under**  
 2 **Alternative 3 as Compared to the No Action Alternative**

Water Year	Monthly Volume (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 3</b>												
Wet	544	615	601	559	594	589	494	490	519	648	667	654
Above Normal	430	533	574	414	469	566	441	413	397	586	680	647
Below Normal	524	587	607	394	373	448	312	266	330	683	650	588
Dry	440	471	523	389	314	337	270	242	292	492	318	426
Critical Dry	321	319	401	355	251	180	127	100	131	158	196	245
<b>No Action Alternative</b>												
Wet	410	497	564	513	537	594	204	207	445	669	717	638
Above Normal	376	450	562	406	401	496	130	105	315	587	709	628
Below Normal	386	456	590	387	354	394	134	100	209	657	622	542
Dry	374	398	510	392	315	318	153	126	194	541	296	426
Critical Dry	314	293	384	349	250	179	93	90	64	223	176	242
<b>Alternative 3 as Compared to No Action Alternative</b>												
Wet	134	118	37	45	57	-4	290	283	74	-21	-51	16
Above Normal	54	83	12	8	68	69	311	308	81	-2	-28	19
Below Normal	138	132	17	8	19	54	178	166	121	26	27	45
Dry	66	74	14	-3	-1	19	117	116	98	-49	22	0
Critical Dry	7	27	18	6	0	1	35	10	67	-64	19	3
<b>Alternative 3 as Compared to No Action Alternative (percent change)</b>												
Wet	32.7	23.8	6.6	8.8	10.6	-0.7	142.4	136.5	16.7	-3.1	-7.1	2.5
Above Normal	14.4	18.4	2.2	2.0	16.9	13.9	238.3	292.1	25.9	-0.3	-4.0	3.0
Below Normal	35.8	28.9	2.9	2.0	5.3	13.7	132.2	166.5	58.2	3.9	4.4	8.4
Dry	17.7	18.5	2.7	-0.7	-0.3	6.1	76.2	92.5	50.5	-9.0	7.6	0.1
Critical Dry	2.2	9.2	4.6	1.7	0.1	0.4	37.3	11.0	104.1	-28.9	10.9	1.4

- 1 The following changes would occur in CVP and SWP exports under Alternative 3  
2 as compared to the No Action Alternative.
- 3 • Long-term average annual exports would be 726 TAF (15 percent) more  
4 under Alternative 3 as compared to the No Action Alternative.
  - 5 • In wet years, total exports would be similar in March, July, and September;  
6 increased in October, February and April through June (up to 142.4 percent);  
7 and reduced in August (7.1 percent).
  - 8 • In above-normal years, total exports would be similar in December, January,  
9 and July through September and increased in October, November, and  
10 February through June (up to 292 percent).
  - 11 • In below-normal years, total exports would be similar in December, January,  
12 July, and August and increased in September through November and February  
13 through June (up to 166.5 percent).
  - 14 • In dry years, total exports would be similar in September and December, and  
15 July; increased in October, November, March through June, and August (up to  
16 92.5 percent); and reduced in July (7.6 percent).
  - 17 • In critical dry years, total exports would be similar in September, October, and  
18 December through March; increased in November, April through June and  
19 August (up to 104.1 percent); and reduced in July (28.9 percent).
- 20 Deliveries to CVP and SWP water users increase under Alternative 3 as compared  
21 to the No Action Alternative, as summarized in Tables 5.60 and 5.61,  
22 respectively, due to increased water supply availability and export limitations.

1 **Table 5.60 Changes CVP Water Deliveries under Alternative 3 as Compared to the**  
 2 **No Action Alternative**

Annual Average Deliveries (TAF)					
		Alternative 3	No Action Alternative	Alternative 3 as compared to the No Action Alternative	
				Difference	Percent Change
<b>North of Delta</b>					
CVP Agricultural Water Service Contractors	Long Term	209	185	24	13
	Dry	111	86	25	29
	Critical Dry	31	24	7	29
CVP M&I (Including American River Contractors and Contra Costa Water District)	Long Term	392	386	6	2
	Dry	390	385	6	2
	Critical Dry	384	383	1	0
CVP M&I American River Contractors	Long Term	118	113	6	5
	Dry	104	97	7	7
	Critical Dry	78	75	3	4
CVP Sacramento River Settlement Contractors	Long Term	1,860	1,859	1	0
	Dry	1,906	1,906	0	0
	Critical Dry	1,742	1,737	5	0
CVP Refuge Level 2 Deliveries	Long Term	153	146	7	5
	Dry	149	146	4	3
	Critical Dry	103	102	1	1
Total CVP Agricultural, M&I, Sacramento River Settlement Contractors, and Refuge Level 2 Deliveries	Long Term	2,614	2,576	38	1
	Dry	2,556	2,523	33	1
	Critical Dry	2,260	2,246	14	1
<b>South of Delta (Does not include Eastside Contractors)</b>					
CVP Agricultural Water Service Contractors	Long Term	1,079	847	233	28
	Dry	596	445	151	34
	Critical Dry	168	131	36	27

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Annual Average Deliveries (TAF)					
		Alternative 3	No Action Alternative	Alternative 3 as compared to the No Action Alternative	
				Difference	Percent Change
CVP M&I Users	Long Term	122	112	11	10
	Dry	108	99	8	8
	Critical Dry	83	80	2	3
San Joaquin River Exchange Contractors	Long Term	852	852	0	0
	Dry	875	875	0	0
	Critical Dry	741	741	0	0
CVP Refuge Level 2 Deliveries	Long Term	273	273	0	0
	Dry	281	281	0	0
	Critical Dry	234	234	0	0
Total CVP Agricultural, M&I, San Joaquin River Exchange Contractors, and Refuge Level 2 Deliveries	Long Term	2,326	2,084	242	12
	Dry	1,860	1,700	160	9
	Critical Dry	1,226	1,186	40	3
<b>Eastside Contractors Deliveries</b>					
Water Rights	Long Term	513	508	5	1
	Dry	524	524	0	0
	Critical Dry	478	445	33	7
CVP Water Service Contracts	Long Term	123	104	20	19
	Dry	109	84	25	30
	Critical Dry	36	4	32	800
Total Water Rights and CVP Service Contracts Deliveries	Long Term	636	612	24	4
	Dry	633	608	25	4
	Critical Dry	514	449	65	14

- 1 The following changes in CVP water deliveries would occur under Alternative 3
- 2 as compared to the No Action Alternative.



- 1 • Deliveries to CVP North of Delta agricultural water service contractors would  
2 be increased by 13 percent over the long-term conditions and 29 percent in  
3 dry and critical dry years.
- 4 • Deliveries to CVP North of Delta M&I contractors would be similar in total;  
5 however, deliveries to the American River CVP contractors would increase by  
6 5 percent over the long-term conditions and 7 percent in dry years, and remain  
7 similar in critical dry years.
- 8 • Deliveries to CVP South of Delta agricultural water service contractors would  
9 be increased by 28 percent over the long-term conditions, 34 percent in dry  
10 years, and 27 percent in critical dry years.
- 11 • Deliveries to CVP South of Delta M&I contractors would be similar in critical  
12 dry years and increased by 10 percent over the long-term conditions and 8  
13 percent in dry years.
- 14 • Deliveries to the Eastside contractors would be similar under long-term  
15 conditions and dry years and increased by 14 percent in critical dry years.

16 **Table 5.61 Changes SWP Water Deliveries under Alternative 3 as Compared to the**  
17 **No Action Alternative**

Annual Average Deliveries (TAF)					
		Alternative 3	No Action Alternative	Alternative 3 as compared to the No Action Alternative	
				Difference	Percent Change
<b>North of Delta</b>					
SWP Agricultural Uses	Long Term	0	0	0	0
	Dry	0	0	0	0
	Critical Dry	0	0	0	0
SWP M&I (without Article 21)	Long Term	80	68	11	17
	Dry	60	51	8	17
	Critical Dry	48	43	5	13
SWP M&I Article 21 Deliveries	Long Term	12	13	-1	-4
	Dry	13	14	-1	-5
	Critical Dry	12	13	-1	-5
Total SWP Agricultural and M&I (without Article 21)	Long Term	80	68	11	17
	Dry	60	51	8	17
	Critical Dry	48	43	5	13

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Annual Average Deliveries (TAF)					
		Alternative 3	No Action Alternative	Alternative 3 as compared to the No Action Alternative	
				Difference	Percent Change
Total SWP Agricultural and M&I Article 21 Deliveries	Long Term	12	13	-1	-4
	Dry	13	14	-1	-5
	Critical Dry	12	13	-1	-5
<b>South of Delta</b>					
SWP Agricultural Users (without Article 21)	Long Term	716	610	106	17
	Dry	533	455	78	17
	Critical Dry	430	378	52	14
SWP Agricultural Article 21 Deliveries	Long Term	73	27	47	175
	Dry	36	5	31	604
	Critical Dry	27	7	21	296
SWP M&I Users (without Article 21)	Long Term	2,106	1,800	306	17
	Dry	1,649	1,406	243	17
	Critical Dry	1,340	1,173	167	14
SWP M&I Article 21 Deliveries	Long Term	33	20	13	65
	Dry	11	5	6	137
	Critical Dry	10	5	5	101
Total SWP Agricultural and M&I Users (without Article 21)	Long Term	2,822	2,410	412	17
	Dry	2,182	1,861	321	17
	Critical Dry	1,770	1,551	219	14
Total SWP Agricultural and M&I Article 21 Deliveries	Long Term	106	47	60	128
	Dry	47	10	37	384
	Critical Dry	38	12	26	214

1 The following changes in SWP water deliveries would occur under Alternative 3  
2 as compared to the No Action Alternative.

- 3 • Deliveries without Article 21 water to SWP North of Delta water contractors  
4 would be increased by 17 percent over the long-term conditions and in dry  
5 years and 13 percent in critical dry years.
- 6 • Deliveries without Article 21 water to SWP South of Delta water contractors  
7 would be increased by 17 percent over the long-term conditions and in dry  
8 years and 14 percent in critical dry years.
- 9 • Deliveries of Article 21 water to SWP North of Delta water contractors would  
10 be similar over the long-term conditions and in dry and critical dry years.
- 11 • Deliveries of Article 21 water to SWP South of Delta water contractors would  
12 be increased by 128 percent over the long-term conditions, 384 percent in dry  
13 years, and 214 percent in critical dry years.

14 *Effects Related to Cross Delta Water Transfers*

15 Potential effects to surface water resources could be similar to those identified in  
16 a recent environmental analysis conducted by Reclamation for long-term water  
17 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014i).

18 Potential effects were identified as reduced surface water storage in upstream  
19 reservoirs and changes in flow patterns in river downstream of the reservoirs if  
20 water was released from the reservoirs in patterns that were different than would  
21 have been used by the water seller's. Because all water transfers would be  
22 required to avoid adverse impacts to other water users and biological resources  
23 (see Section 3.A.6.3, Transfers), including impacts associated with changes in  
24 reservoir storage and river flow patterns, the analysis indicated that water  
25 transfers would not result in substantial changes in storage or river flows. For the  
26 purposes of this EIS, it is anticipated that similar conditions would occur due to  
27 cross Delta water transfers under Alternative 3 and the No Action Alternative.

28 Under Alternative 3, water could be transferred throughout the year. As indicated  
29 in Table 5.59, capacity would be available under Alternative 3 in all months of all  
30 water year types without a maximum volume of transferred water. Under the No  
31 Action Alternative, the timing of cross Delta water transfers would be limited to  
32 July through September, and the volume would be limited to 600,000 acre-feet  
33 per year in drier years and 360,000 acre-feet in all other years, in accordance with  
34 the 2008 USFWS BO and 2009 NMFS BO. As indicated in Table 5.59, capacity  
35 would be available under the No Action Alternative between July and September  
36 for water transfers in all water year types.

37 Overall, the potential for water transfer conveyance would be greater under  
38 Alternative 3 as compared to the No Action Alternative.

1 *San Francisco Bay Area, Central Coast, and Southern California Regions*  
2 *Potential Changes in Surface Water Resources at Reservoirs that Store CVP*  
3 *and SWP Water*

4 The San Francisco Bay Area, Central Coast, and Southern California regions  
5 include numerous reservoirs that store CVP and SWP water supplies, including  
6 CVP and SWP reservoirs, that primarily provide water supplies for M&I water  
7 users. Changes in the availability CVP and SWP water supplies for storage in  
8 these reservoirs under Alternative 3 as compared to the No Action  
9 Alternative would be consistent with the following changes in water deliveries to  
10 M&I water users, as summarized in Tables 5.60 and 5.61.

- 11 • Deliveries to CVP South of Delta M&I contractors would be similar in critical  
12 dry years; and increased by 9 percent over the long-term conditions and  
13 8 percent in dry years.
- 14 • Deliveries without Article 21 water to SWP South of Delta water contractors  
15 would be increased by 17 percent over the long-term conditions and in dry  
16 years and 14 percent in critical dry years.
- 17 • Deliveries of Article 21 water to SWP South of Delta water contractors would  
18 be increased by 128 percent over the long-term conditions, 384 percent in dry  
19 years, and 214 percent in critical dry years.

20 *Changes in CVP and SWP Exports and Deliveries*

21 Deliveries to CVP and SWP water users are described above in the Central Valley  
22 Region.

23 **5.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison**

24 *Trinity River Region*

25 *Changes in CVP and SWP Reservoir Storage and Downstream River Flows*

26 Changes in Trinity Lake storage and surface water elevations under Alternative 3  
27 as compared to the Second Basis of Comparison are summarized in Tables 5.62  
28 and 5.63. The results are summarized following Table 5.63.

1 **Table 5.62 Changes in Trinity Lake Storage under Alternative 3 as Compared to the**  
 2 **Second Basis of Comparison**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 3</b>												
Wet	1,502	1,537	1,643	1,766	1,928	2,053	2,224	2,248	2,192	2,067	1,936	1,805
Above Normal	1,197	1,230	1,349	1,511	1,707	1,891	2,071	2,045	1,949	1,806	1,646	1,513
Below Normal	1,434	1,457	1,477	1,542	1,629	1,717	1,858	1,786	1,680	1,509	1,334	1,199
Dry	1,173	1,179	1,206	1,226	1,318	1,450	1,585	1,537	1,468	1,301	1,152	1,056
Critical Dry	829	803	817	829	871	952	1,003	968	936	813	664	600
<b>Second Basis of Comparison</b>												
Wet	1,501	1,535	1,644	1,767	1,931	2,055	2,224	2,250	2,194	2,068	1,939	1,805
Above Normal	1,208	1,245	1,363	1,524	1,718	1,901	2,079	2,053	1,955	1,815	1,647	1,513
Below Normal	1,451	1,472	1,492	1,554	1,641	1,729	1,872	1,799	1,696	1,515	1,337	1,204
Dry	1,178	1,184	1,210	1,230	1,322	1,453	1,586	1,536	1,466	1,302	1,152	1,055
Critical Dry	819	803	813	825	868	949	999	962	929	811	667	598
<b>Alternative 3 as Compared to Second Basis of Comparison</b>												
Wet	0	1	-1	-1	-2	-1	-1	-2	-1	0	-3	0
Above Normal	-11	-15	-14	-13	-11	-10	-8	-8	-7	-9	0	0
Below Normal	-17	-15	-15	-12	-12	-12	-14	-13	-16	-6	-3	-5
Dry	-5	-5	-4	-4	-4	-2	-1	0	2	0	0	1
Critical Dry	10	1	3	3	3	3	4	6	7	2	-3	2
<b>Alternative 3 as Compared to Second Basis of Comparison (percent change)</b>												
Wet	0.0	0.1	-0.1	0.0	-0.1	-0.1	0.0	-0.1	-0.1	0.0	-0.2	0.0
Above Normal	-0.9	-1.2	-1.1	-0.8	-0.7	-0.5	-0.4	-0.4	-0.3	-0.5	0.0	0.0
Below Normal	-1.2	-1.0	-1.0	-0.8	-0.7	-0.7	-0.8	-0.7	-1.0	-0.4	-0.2	-0.4
Dry	-0.4	-0.4	-0.4	-0.3	-0.3	-0.1	0.0	0.0	0.1	0.0	0.0	0.1
Critical Dry	1.2	0.1	0.4	0.4	0.3	0.3	0.4	0.6	0.7	0.3	-0.5	0.4

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**Table 5.63 Changes in Trinity Lake Elevation under Alternative 3 as Compared to the Second Basis of Comparison**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 3</b>												
Wet	2,301	2,305	2,314	2,325	2,339	2,347	2,357	2,358	2,355	2,347	2,338	2,328
Above Normal	2,268	2,271	2,284	2,301	2,319	2,334	2,347	2,345	2,339	2,328	2,315	2,304
Below Normal	2,293	2,295	2,297	2,304	2,312	2,319	2,330	2,325	2,317	2,302	2,286	2,274
Dry	2,265	2,268	2,271	2,273	2,283	2,296	2,309	2,305	2,299	2,284	2,269	2,260
Critical Dry	2,226	2,220	2,222	2,225	2,231	2,244	2,252	2,248	2,244	2,229	2,204	2,193
<b>Second Basis of Comparison</b>												
Wet	2,301	2,305	2,314	2,325	2,339	2,347	2,357	2,358	2,355	2,347	2,338	2,328
Above Normal	2,270	2,273	2,286	2,303	2,320	2,335	2,347	2,346	2,339	2,329	2,315	2,304
Below Normal	2,295	2,296	2,298	2,305	2,313	2,320	2,331	2,326	2,318	2,303	2,287	2,274
Dry	2,266	2,269	2,272	2,274	2,284	2,296	2,309	2,304	2,298	2,284	2,269	2,259
Critical Dry	2,218	2,216	2,217	2,222	2,229	2,243	2,250	2,246	2,243	2,227	2,204	2,191
<b>Alternative 3 as Compared to Second Basis of Comparison</b>												
Wet	0	0	0	0	0	0	0	0	0	0	0	0
Above Normal	-2	-2	-2	-2	-1	-1	-1	-1	0	-1	0	0
Below Normal	-2	-2	-1	-1	-1	-1	-1	-1	-1	-1	0	-1
Dry	0	0	0	0	0	0	0	0	0	0	0	0
Critical Dry	8	5	5	4	3	2	1	2	2	1	0	2
<b>Alternative 3 as Compared to Second Basis of Comparison (percent change)</b>												
Wet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Above Normal	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Below Normal	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0
Dry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Critical Dry	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1

3 In all months, in all water year types, Trinity Lake storage and surface water  
 4 elevations would be similar under Alternative 3 as compared to the Second Basis  
 5 of Comparison. Trinity River flows would be similar in all months under long-  
 6 term conditions and wet and dry years, as shown on Figures 5.53 through 5.55.

7 *Central Valley Region*

8 *Changes in CVP and SWP Reservoir Storage and Downstream River Flows*  
 9 *Shasta Lake and Sacramento River*

10 Storage levels and surface water elevations in Shasta Lake under Alternative 3 as  
 11 compared to the Second Basis of Comparison are summarized in Tables 5.64  
 12 and 5.65. Changes in flows in the Sacramento River downstream of Keswick

1 Dam and at Freeport are shown on Figures 5.56 through 5.61. The results are  
 2 summarized following Table 5.65.

3 **Table 5.64 Changes in Shasta Lake Storage under Alternative 3 as Compared to the**  
 4 **Second Basis of Comparison**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 3</b>												
Wet	2,816	2,932	3,161	3,408	3,597	3,841	4,301	4,453	4,221	3,720	3,370	3,244
Above Normal	2,475	2,555	2,783	3,303	3,509	4,023	4,403	4,401	3,975	3,350	2,998	2,946
Below Normal	2,818	2,851	2,983	3,302	3,650	3,971	4,176	4,056	3,631	3,036	2,669	2,562
Dry	2,431	2,451	2,590	2,770	3,189	3,662	3,885	3,798	3,359	2,826	2,542	2,500
Critical Dry	1,833	1,793	1,877	2,024	2,184	2,424	2,354	2,237	1,836	1,406	1,129	1,066
<b>Second Basis of Comparison</b>												
Wet	2,817	2,926	3,154	3,406	3,597	3,841	4,301	4,453	4,228	3,733	3,362	3,252
Above Normal	2,499	2,578	2,808	3,313	3,515	4,038	4,416	4,417	3,979	3,347	2,975	2,921
Below Normal	2,826	2,846	2,977	3,299	3,646	3,966	4,164	4,042	3,599	3,010	2,601	2,574
Dry	2,409	2,431	2,578	2,755	3,168	3,644	3,861	3,774	3,333	2,800	2,539	2,496
Critical Dry	1,873	1,826	1,911	2,050	2,222	2,460	2,386	2,270	1,861	1,409	1,151	1,086
<b>Alternative 3 as Compared to Second Basis of Comparison</b>												
Wet	-1	6	7	2	0	0	0	0	-7	-13	8	-8
Above Normal	-24	-23	-25	-11	-6	-15	-13	-16	-4	3	23	25
Below Normal	-9	5	5	3	4	5	12	13	32	26	68	-13
Dry	22	21	12	15	22	17	24	24	26	25	3	4
Critical Dry	-40	-33	-34	-26	-38	-36	-32	-33	-25	-2	-22	-20
<b>Alternative 3 as Compared to Second Basis of Comparison (percent change)</b>												
Wet	0.0	0.2	0.2	0.1	0.0	0.0	0.0	0.0	-0.2	-0.4	0.2	-0.2
Above Normal	-1.0	-0.9	-0.9	-0.3	-0.2	-0.4	-0.3	-0.4	-0.1	0.1	0.8	0.9
Below Normal	-0.3	0.2	0.2	0.1	0.1	0.1	0.3	0.3	0.9	0.9	2.6	-0.5
Dry	0.9	0.9	0.5	0.5	0.7	0.5	0.6	0.6	0.8	0.9	0.1	0.1
Critical Dry	-2.1	-1.8	-1.8	-1.3	-1.7	-1.5	-1.3	-1.5	-1.3	-0.2	-1.9	-1.9

1 **Table 5.65 Changes in Shasta Lake Elevation under Alternative 3 as Compared to**  
 2 **the Second Basis of Comparison**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 3</b>												
Wet	997	1,002	1,012	1,024	1,032	1,041	1,058	1,063	1,055	1,036	1,022	1,017
Above Normal	973	976	990	1,018	1,028	1,048	1,062	1,062	1,046	1,021	1,006	1,004
Below Normal	997	998	1,004	1,019	1,034	1,046	1,054	1,049	1,032	1,008	991	986
Dry	974	976	983	993	1,013	1,033	1,042	1,039	1,021	998	985	983
Critical Dry	935	933	939	948	960	975	972	966	941	910	888	882
<b>Second Basis of Comparison</b>												
Wet	997	1,002	1,012	1,024	1,032	1,041	1,058	1,063	1,055	1,037	1,022	1,017
Above Normal	974	978	992	1,019	1,028	1,048	1,062	1,062	1,046	1,021	1,005	1,003
Below Normal	997	998	1,004	1,019	1,034	1,046	1,053	1,049	1,031	1,006	987	986
Dry	972	974	982	992	1,012	1,032	1,041	1,038	1,020	997	984	982
Critical Dry	938	935	941	950	961	977	974	967	943	910	889	884
<b>Alternative 3 as Compared to Second Basis of Comparison</b>												
Wet	0	0	0	0	0	0	0	0	0	-1	0	0
Above Normal	-2	-2	-2	-1	0	-1	0	-1	0	0	1	1
Below Normal	0	0	0	0	0	0	0	1	1	1	4	0
Dry	2	2	1	1	1	1	1	1	1	1	0	0
Critical Dry	-3	-2	-2	-2	-2	-2	-1	-1	-1	0	-1	-1
<b>Alternative 3 as Compared to Second Basis of Comparison (percent change)</b>												
Wet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0
Above Normal	-0.2	-0.2	-0.2	-0.1	0.0	-0.1	0.0	-0.1	0.0	0.0	0.1	0.1
Below Normal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.4	0.0
Dry	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0
Critical Dry	-0.3	-0.3	-0.3	-0.2	-0.2	-0.2	-0.2	-0.1	-0.1	0.0	-0.2	-0.1

3 Shasta Lake storage and surface water elevation would be similar under  
 4 Alternative 3 as compared to the Second Basis of Comparison in all months and  
 5 all water years.

6 The following changes in Sacramento River flows would occur under  
 7 Alternative 3 as compared to the Second Basis of Comparison, as shown on  
 8 Figures 5.56 through 5.61.

- 9 • Sacramento River downstream of Keswick Dam (Figures 5.56 through 5.58)  
 10 would be similar in all months over the long-term conditions and in wet and  
 11 dry years.



- 1 • Sacramento River near Freeport (near the northern boundary of the Delta)
- 2 (Figures 5.59 through 5.61).
- 3 – Over long-term conditions and in wet years, flows would be similar in all
- 4 months.
- 5 – In dry years, similar flows would occur in July through May; and
- 6 increased flows in June (11 percent).

7 *Lake Oroville and Feather River*

8 Storage levels and surface water elevations in Lake Oroville under Alternative 3  
 9 as compared to the Second Basis of Comparison are summarized in Tables 5.66  
 10 and 5.67. Changes in flows in the Feather River downstream of Thermalito  
 11 Complex are shown on Figures 5.62 through 5.64. The results are summarized  
 12 following Table 5.67.

13 **Table 5.66 Changes in Lake Oroville Storage under Alternative 3 as Compared to**  
 14 **the Second Basis of Comparison**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 3</b>												
Wet	1,893	1,931	2,315	2,608	2,854	2,942	3,300	3,473	3,375	2,902	2,630	2,499
Above Normal	1,405	1,448	1,623	2,109	2,623	2,945	3,280	3,371	3,129	2,494	2,039	1,778
Below Normal	1,839	1,801	1,846	2,054	2,370	2,636	2,879	2,883	2,610	1,971	1,520	1,354
Dry	1,332	1,288	1,322	1,454	1,733	2,088	2,329	2,319	1,980	1,548	1,343	1,198
Critical Dry	1,129	1,067	1,067	1,156	1,275	1,429	1,449	1,437	1,236	1,029	918	862
<b>Second Basis of Comparison</b>												
Wet	1,936	1,984	2,354	2,636	2,871	2,942	3,300	3,477	3,402	2,976	2,728	2,569
Above Normal	1,465	1,523	1,702	2,173	2,648	2,937	3,271	3,357	3,081	2,493	2,087	1,827
Below Normal	1,823	1,783	1,831	2,037	2,361	2,627	2,875	2,836	2,461	1,930	1,637	1,424
Dry	1,371	1,324	1,344	1,473	1,764	2,120	2,363	2,357	2,031	1,688	1,427	1,261
Critical Dry	1,117	1,044	1,041	1,125	1,235	1,406	1,423	1,407	1,219	1,027	911	839
<b>Alternative 3 as Compared to Second Basis of Comparison</b>												
Wet	-43	-53	-39	-28	-17	0	0	-5	-27	-73	-98	-70
Above Normal	-61	-75	-78	-64	-24	8	8	14	48	1	-49	-49
Below Normal	16	18	15	17	9	9	3	47	150	41	-117	-70
Dry	-38	-35	-22	-19	-31	-32	-34	-38	-51	-140	-84	-62
Critical Dry	12	23	25	31	39	23	25	30	17	2	7	23
<b>Alternative 3 as Compared to Second Basis of Comparison (percent change)</b>												
Wet	-2.2	-2.7	-1.7	-1.1	-0.6	0.0	0.0	-0.1	-0.8	-2.5	-3.6	-2.7
Above Normal	-4.1	-4.9	-4.6	-2.9	-0.9	0.3	0.3	0.4	1.6	0.0	-2.3	-2.7
Below Normal	0.9	1.0	0.8	0.8	0.4	0.4	0.1	1.7	6.1	2.1	-7.2	-4.9
Dry	-2.8	-2.7	-1.6	-1.3	-1.8	-1.5	-1.4	-1.6	-2.5	-8.3	-5.9	-5.0
Critical Dry	1.1	2.2	2.4	2.8	3.2	1.6	1.8	2.1	1.4	0.2	0.8	2.8

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**Table 5.67 Changes in Lake Oroville Elevation under Alternative 3 as Compared to the Second Basis of Comparison**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 3</b>												
Wet	763	767	805	834	853	859	884	895	889	856	836	825
Above Normal	711	717	738	791	836	859	882	889	872	827	786	758
Below Normal	758	754	759	781	813	835	854	855	836	780	730	710
Dry	702	697	703	720	752	789	811	810	779	733	709	691
Critical Dry	679	671	671	684	699	718	719	718	693	665	648	640
<b>Second Basis of Comparison</b>												
Wet	768	773	810	837	854	859	884	896	891	861	844	831
Above Normal	717	723	745	796	838	859	882	888	869	826	790	763
Below Normal	757	752	757	779	812	834	854	852	823	775	743	719
Dry	706	701	705	721	755	791	814	813	784	748	718	698
Critical Dry	677	668	668	680	694	715	716	714	691	664	647	636
<b>Alternative 3 as Compared to Second Basis of Comparison</b>												
Wet	-5	-6	-4	-2	-1	0	0	0	-2	-5	-8	-6
Above Normal	-6	-7	-8	-5	-2	1	1	1	3	1	-5	-5
Below Normal	1	2	2	2	1	1	0	3	13	5	-13	-8
Dry	-4	-4	-2	-2	-3	-3	-3	-4	-6	-16	-10	-7
Critical Dry	2	3	3	4	5	3	3	4	2	1	1	4
<b>Alternative 3 as Compared to Second Basis of Comparison (percent change)</b>												
Wet	-0.6	-0.7	-0.5	-0.3	-0.1	0.0	0.0	0.0	-0.2	-0.6	-0.9	-0.8
Above Normal	-0.8	-1.0	-1.0	-0.7	-0.2	0.1	0.1	0.1	0.4	0.1	-0.6	-0.6
Below Normal	0.2	0.3	0.2	0.3	0.1	0.1	0.0	0.4	1.6	0.6	-1.8	-1.2
Dry	-0.6	-0.5	-0.3	-0.2	-0.4	-0.4	-0.3	-0.5	-0.7	-2.1	-1.4	-1.1
Critical Dry	0.3	0.5	0.5	0.6	0.7	0.4	0.4	0.5	0.3	0.2	0.2	0.6

1 Lake Oroville storage and surface water elevation would be similar under  
2 Alternative 3 as compared to the Second Basis of Comparison in all months and  
3 all water years.

4 The following changes in Feather River flows would occur under Alternative 3 as  
5 compared to the Second Basis of Comparison, as shown on Figures 5.62  
6 through 5.64.

- 7 • Over long-term conditions, similar flows would occur in November and  
8 January through June; reduced flows in October, December, and September  
9 (up to 12.5 percent); and increased flows in July and August (up to  
10 17.0 percent).
- 11 • In wet years, similar flows would occur in November and January through  
12 May; reduced flows in October, December, and September (up to  
13 14.6 percent); and increased flows in June through August (up to  
14 10.9 percent).
- 15 • In dry years, similar flows would occur in November and January through  
16 June; reduced flows in August through October (up to 21.2 percent); and  
17 increased flows in July (37.1 percent).

18 *Folsom Lake and American River*

19 Storage levels and surface water elevations in Folsom Lake under Alternative 3 as  
20 compared to the Second Basis of Comparison are summarized in Tables 5.68  
21 and 5.69. Changes in flows in the American River downstream of Nimbus Dam  
22 are shown on Figures 5.65 through 5.67. The results are summarized following  
23 Table 5.69.

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**Table 5.68 Changes in Folsom Lake Storage under Alternative 3 as Compared to the Second Basis of Comparison**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 3</b>												
Wet	486	473	525	524	515	632	785	951	929	790	690	645
Above Normal	388	404	454	537	539	640	787	946	851	580	516	479
Below Normal	513	496	505	514	542	627	764	844	766	506	436	407
Dry	405	398	420	434	482	580	692	761	654	491	436	411
Critical Dry	331	314	322	325	370	436	474	485	431	343	291	257
<b>Second Basis of Comparison</b>												
Wet	483	470	522	524	515	632	785	951	937	793	688	646
Above Normal	390	412	467	537	538	640	787	946	857	591	522	485
Below Normal	506	489	502	514	541	626	761	847	739	475	408	387
Dry	405	399	423	437	486	585	698	769	664	486	432	408
Critical Dry	339	317	323	325	369	436	469	482	430	352	288	258
<b>Alternative 3 as Compared to Second Basis of Comparison</b>												
Wet	3	4	3	0	0	0	0	0	-8	-3	2	-1
Above Normal	-3	-9	-13	1	1	0	0	0	-6	-10	-7	-6
Below Normal	8	6	3	0	1	1	3	-3	27	31	28	21
Dry	-1	-1	-3	-3	-4	-4	-6	-7	-9	5	4	3
Critical Dry	-7	-3	-1	0	1	0	5	3	1	-9	4	-1
<b>Alternative 3 as Compared to Second Basis of Comparison (percent change)</b>												
Wet	0.7	0.8	0.6	0.0	0.0	0.0	0.0	0.0	-0.8	-0.4	0.3	-0.1
Above Normal	-0.7	-2.1	-2.8	0.1	0.2	0.0	0.0	0.0	-0.8	-1.8	-1.3	-1.2
Below Normal	1.5	1.3	0.6	0.1	0.2	0.1	0.3	-0.4	3.6	6.6	6.7	5.3
Dry	-0.1	-0.2	-0.8	-0.7	-0.8	-0.7	-0.9	-1.0	-1.4	1.1	0.8	0.8
Critical Dry	-2.2	-1.0	-0.3	0.0	0.2	0.0	1.0	0.6	0.2	-2.6	1.3	-0.4

1 **Table 5.69 Changes in Folsom Lake Elevation under Alternative 3 as Compared to**  
 2 **the Second Basis of Comparison**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 3</b>												
Wet	413	412	419	419	418	432	448	465	463	448	438	433
Above Normal	395	397	408	421	421	433	448	465	455	425	418	413
Below Normal	416	415	416	417	421	432	446	454	446	415	404	401
Dry	401	401	405	407	414	426	438	445	434	414	407	404
Critical Dry	388	386	390	390	396	406	411	411	403	389	379	372
<b>Second Basis of Comparison</b>												
Wet	412	412	419	419	418	432	448	465	464	449	438	433
Above Normal	397	400	410	421	421	433	448	465	456	427	419	414
Below Normal	415	414	416	417	421	432	446	455	443	410	401	398
Dry	401	401	405	407	414	427	439	446	435	413	406	403
Critical Dry	389	386	390	391	397	406	410	411	404	391	378	372
<b>Alternative 3 as Compared to Second Basis of Comparison</b>												
Wet	1	1	0	0	0	0	0	0	-1	0	0	0
Above Normal	-2	-3	-3	0	0	0	0	0	-1	-1	-1	-1
Below Normal	1	1	0	0	0	0	0	0	3	5	3	3
Dry	0	0	0	0	-1	-1	-1	-1	-1	1	0	0
Critical Dry	-1	0	0	0	0	0	0	0	0	-2	1	0
<b>Alternative 3 as Compared to Second Basis of Comparison (percent change)</b>												
Wet	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	-0.2	-0.1	0.0	0.0
Above Normal	-0.5	-0.8	-0.6	0.0	0.0	0.0	0.0	0.0	-0.1	-0.3	-0.2	-0.2
Below Normal	0.3	0.2	0.1	0.0	0.0	0.0	0.1	-0.1	0.7	1.2	0.9	0.6
Dry	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.2	-0.2	-0.3	0.2	0.1	0.1
Critical Dry	-0.2	-0.1	-0.1	0.0	0.0	-0.1	0.1	0.0	-0.1	-0.5	0.4	-0.1

3 Folsom Lake storage and surface water elevation would be similar under  
 4 Alternative 3 as compared to the Second Basis of Comparison in all months and  
 5 all water years.

6 The American River flows would be similar in all months over long-term  
 7 conditions, wet years, and dry years under Alternative 3 as compared to the  
 8 Second Basis of Comparison, as shown on Figures 5.65 through 5.67.

9 *Clear Creek*

10 Flows in Clear Creek downstream of Whiskeytown Dam would be identical under  
 11 Alternative 3 as compared to the Second Basis of Comparison, as summarized in  
 12 Table 5.70.

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**Table 5.70 Changes in Clear Creek Flows below Whiskeytown Dam under Alternative 3 as Compared to the Second Basis of Comparison**

Water Year	Average Monthly Flow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 3</b>												
Wet	200	200	200	309	356	272	200	200	200	85	85	150
Above Normal	181	182	188	192	196	196	196	200	200	85	85	150
Below Normal	195	195	195	195	195	195	195	195	191	85	85	150
Dry	178	184	188	190	190	190	190	190	183	85	85	150
Critical Dry	163	167	167	167	167	167	167	167	111	85	85	133
<b>Second Basis of Comparison</b>												
Wet	200	200	200	309	356	272	200	200	200	85	85	150
Above Normal	181	182	188	192	196	196	196	200	200	85	85	150
Below Normal	195	195	195	195	195	195	195	195	191	85	85	150
Dry	178	184	188	190	190	190	190	190	183	85	85	150
Critical Dry	163	167	167	167	167	167	167	167	111	85	85	133
<b>Alternative 3 as Compared to Second Basis of Comparison</b>												
Wet	0	0	0	0	0	0	0	0	0	0	0	0
Above Normal	0	0	0	0	0	0	0	0	0	0	0	0
Below Normal	0	0	0	0	0	0	0	0	0	0	0	0
Dry	0	0	0	0	0	0	0	0	0	0	0	0
Critical Dry	0	0	0	0	0	0	0	0	0	0	0	0
<b>Alternative 3 as Compared to Second Basis of Comparison (percent change)</b>												
Wet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Above Normal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Below Normal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Critical Dry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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1 *New Melones Reservoir and Stanislaus River*  
 2 Storage levels and surface water elevations in New Melones Reservoir under  
 3 Alternative 3 as compared to the Second Basis of Comparison are summarized in  
 4 Tables 5.71 and 5.72. Changes in flows in the Stanislaus River downstream of  
 5 Goodwin Dam are shown on Figures 5.68 through 5.70. The results are  
 6 summarized following Table 5.72.

7 **Table 5.71 Changes in New Melones Reservoir Storage under Alternative 3 as**  
 8 **Compared to the Second Basis of Comparison**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 3</b>												
Wet	1,562	1,567	1,618	1,720	1,792	1,871	1,906	2,049	2,146	2,057	1,934	1,855
Above Normal	1,269	1,295	1,356	1,442	1,530	1,620	1,634	1,713	1,720	1,627	1,529	1,481
Below Normal	1,530	1,536	1,550	1,570	1,620	1,650	1,614	1,617	1,599	1,501	1,403	1,357
Dry	1,327	1,320	1,326	1,342	1,378	1,409	1,380	1,360	1,319	1,224	1,137	1,091
Critical Dry	828	824	836	846	866	860	803	751	719	653	593	563
<b>Second Basis of Comparison</b>												
Wet	1,443	1,446	1,502	1,606	1,709	1,794	1,833	1,962	1,994	1,917	1,803	1,731
Above Normal	1,092	1,116	1,175	1,261	1,360	1,455	1,481	1,543	1,516	1,419	1,321	1,274
Below Normal	1,364	1,366	1,378	1,397	1,453	1,479	1,461	1,447	1,415	1,322	1,228	1,183
Dry	1,149	1,143	1,149	1,161	1,191	1,221	1,210	1,176	1,131	1,039	956	912
Critical Dry	667	663	674	680	696	690	646	585	557	498	449	426
<b>Alternative 3 as Compared to Second Basis of Comparison</b>												
Wet	119	121	116	114	83	77	73	88	153	141	131	124
Above Normal	177	179	181	181	170	165	153	170	204	208	207	208
Below Normal	167	170	172	173	167	170	153	170	184	179	175	174
Dry	177	177	177	181	187	188	170	183	188	185	181	179
Critical Dry	161	161	162	165	170	170	157	166	162	155	144	137
<b>Alternative 3 as Compared to Second Basis of Comparison (percent change)</b>												
Wet	8.2	8.4	7.7	7.1	4.8	4.3	4.0	4.5	7.7	7.3	7.3	7.2
Above Normal	16.3	16.0	15.4	14.4	12.5	11.3	10.3	11.0	13.4	14.7	15.7	16.3
Below Normal	12.2	12.5	12.5	12.4	11.5	11.5	10.5	11.8	13.0	13.6	14.3	14.7
Dry	15.4	15.5	15.4	15.6	15.7	15.4	14.0	15.6	16.6	17.8	19.0	19.6
Critical Dry	24.1	24.3	24.0	24.3	24.4	24.6	24.3	28.3	29.1	31.1	32.0	32.1

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**Table 5.72 Changes in New Melones Reservoir Elevation under Alternative 3 as Compared to the Second Basis of Comparison**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 3</b>												
Wet	1,003	1,004	1,010	1,022	1,030	1,038	1,042	1,055	1,064	1,056	1,045	1,037
Above Normal	964	967	974	987	999	1,009	1,012	1,021	1,022	1,013	1,002	924
Below Normal	998	998	1,000	1,002	1,011	1,014	1,011	1,012	1,010	1,000	989	983
Dry	974	973	974	977	981	985	983	982	978	966	954	948
Critical Dry	899	899	902	904	909	909	899	889	883	870	858	852
<b>Second Basis of Comparison</b>												
Wet	989	990	997	1,009	1,021	1,030	1,034	1,047	1,050	1,043	1,032	1,025
Above Normal	941	944	951	966	979	992	995	1,003	1,001	990	978	901
Below Normal	977	977	979	982	991	994	994	993	991	980	968	962
Dry	951	950	950	953	957	962	963	960	954	941	929	922
Critical Dry	866	866	870	872	878	879	871	856	850	835	823	817
<b>Alternative 3 as Compared to Second Basis of Comparison</b>												
Wet	14	14	13	12	9	8	7	8	14	13	13	12
Above Normal	23	23	23	21	19	18	16	18	21	23	24	23
Below Normal	20	21	21	21	20	20	17	19	20	20	21	21
Dry	24	24	24	24	25	23	20	23	24	24	25	26
Critical Dry	33	33	31	32	31	30	28	33	33	35	35	34
<b>Alternative 3 as Compared to Second Basis of Comparison (percent change)</b>												
Wet	1.4	1.4	1.3	1.2	0.9	0.8	0.7	0.8	1.3	1.3	1.2	1.2
Above Normal	2.4	2.4	2.4	2.2	2.0	1.8	1.6	1.7	2.1	2.3	2.4	2.5
Below Normal	2.1	2.1	2.1	2.1	2.0	2.0	1.7	1.9	2.0	2.1	2.1	2.2
Dry	2.5	2.5	2.5	2.5	2.6	2.4	2.1	2.3	2.5	2.6	2.7	2.8
Critical Dry	3.8	3.8	3.6	3.6	3.5	3.4	3.2	3.9	3.9	4.2	4.3	4.2



- 1 The following changes in New Melones Reservoir storage and surface water  
 2 elevations would occur under Alternative 3 as compared to the Second Basis of  
 3 Comparison.
- 4 • In wet years, storage would be similar in March through May and increased in  
 5 June through February (up to 8.4 percent).
  - 6 • In above normal years, storage would be increased in all months (up to  
 7 16.3 percent).
  - 8 • In below normal years, storage would be increased in all months (up to  
 9 14.7 percent).
  - 10 • In dry years, storage would be increased in all months (up to 19.6 percent).
  - 11 • In critical dry years, storage would be increased in all months (up to  
 12 32.1 percent).
  - 13 • In all months, in all water year types, surface water elevations would be  
 14 similar.

15 Flows in the Stanislaus River downstream of Goodwin Dam are shown on  
 16 Figures 5.68 to 5.70. Changes in flows in the river are summarized below.

- 17 • Over long-term conditions, similar flows would occur in October, December,  
 18 January, and March; reduced flows would occur in November, May, and June  
 19 (up to 52.3 percent); and increased flows in February, April, July, and August  
 20 through September (up to 26.8 percent).
- 21 • In wet years, similar flows would occur in October, November, January, and  
 22 April; reduced flows in May and June (up to 44.8 percent); and increased  
 23 flows in December, February, March, and July through September (up to  
 24 68.6 percent).
- 25 • In dry years, similar flows would occur in July through October; reduced  
 26 flows in November through March and May through June (up to  
 27 36.0 percent); and increased flows in April (40.2 percent).

28 *San Joaquin River at Vernalis*

29 Flows in the San Joaquin River at Vernalis under Alternative 3 as compared to the  
 30 Second Basis of Comparison are summarized below, as shown on Figures 5.71  
 31 through 5.73.

- 32 • Over long-term conditions, similar flows would occur in July through May  
 33 and reduced flows in June (11.8 percent).
- 34 • In wet years, similar flows would occur in September through January, March  
 35 through May, and July; reduced flows in June (8.3 percent); and increased  
 36 flows in August and February (6.2 percent).
- 37 • In dry years, similar flows would occur in July through March; reduced flows  
 38 in May and June (up to 12.3 percent); and increased flows in April  
 39 (6.6 percent).

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*San Luis Reservoir*

Storage levels and surface water elevations in San Luis Reservoir under Alternative 3 as compared to the Second Basis of Comparison are summarized in Tables 5.73 and 5.74. The results are summarized following Table 5.74.

**Table 5.73 Changes in San Luis Reservoir Storage under Alternative 3 as Compared to the Second Basis of Comparison**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 3</b>												
Wet	810	1,033	1,276	1,555	1,810	1,957	1,975	1,851	1,540	1,228	961	980
Above Normal	619	844	1,109	1,342	1,571	1,756	1,763	1,575	1,155	830	674	703
Below Normal	834	1,043	1,305	1,489	1,623	1,736	1,651	1,338	899	737	585	561
Dry	634	804	1,052	1,302	1,455	1,608	1,593	1,413	1,128	926	590	535
Critical Dry	548	632	804	1,076	1,216	1,256	1,227	1,069	838	572	380	351
<b>Second Basis of Comparison</b>												
Wet	790	1,017	1,365	1,748	1,965	2,033	2,031	1,852	1,487	1,167	889	925
Above Normal	658	883	1,213	1,671	1,913	2,001	1,995	1,717	1,263	861	612	631
Below Normal	854	1,064	1,334	1,742	1,908	1,980	1,908	1,628	1,251	964	635	591
Dry	617	764	998	1,427	1,728	1,925	1,870	1,665	1,341	1,007	660	596
Critical Dry	622	709	910	1,257	1,556	1,664	1,623	1,451	1,168	808	545	472
<b>Alternative 3 as Compared to Second Basis of Comparison</b>												
Wet	21	16	-88	-193	-155	-76	-56	-2	53	61	72	55
Above Normal	-38	-40	-104	-329	-342	-245	-233	-143	-108	-32	63	73
Below Normal	-20	-20	-29	-253	-285	-244	-257	-290	-352	-227	-50	-30
Dry	17	40	55	-125	-273	-317	-277	-252	-214	-81	-70	-61
Critical Dry	-74	-77	-106	-180	-340	-408	-396	-383	-330	-235	-164	-121
<b>Alternative 3 as Compared to Second Basis of Comparison (percent change)</b>												
Wet	-2.8	-2.9	-14.1	-15.7	-10.5	-4.9	-3.2	-3.9	-6.0	-1.8	3.6	1.4
Above Normal	-5.8	-3.9	-10.0	-21.7	-16.1	-11.8	-10.0	-10.4	-15.9	-8.3	6.4	12.1
Below Normal	-9.6	-8.0	-7.6	-21.7	-20.2	-15.1	-15.9	-25.0	-40.1	-28.4	-1.3	-4.4
Dry	7.5	12.7	13.2	-9.8	-19.2	-18.7	-16.5	-18.7	-18.6	-5.3	-11.2	-12.1
Critical Dry	-7.3	-8.0	-11.4	-15.2	-26.1	-27.7	-27.0	-28.5	-26.0	-20.6	-14.5	7.6

1 **Table 5.74 Changes in San Luis Reservoir Elevation under Alternative 3 as**  
 2 **Compared to the Second Basis of Comparison**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 3</b>												
Wet	427	452	477	503	525	537	539	529	502	473	447	449
Above Normal	406	431	459	482	504	520	521	505	467	433	417	420
Below Normal	431	454	480	497	509	519	512	484	440	423	405	401
Dry	410	430	456	480	494	508	506	490	464	444	405	397
Critical Dry	399	409	430	458	472	475	473	457	434	403	375	371
<b>Second Basis of Comparison</b>												
Wet	426	451	485	520	538	543	543	529	497	468	440	443
Above Normal	412	437	470	513	534	541	540	518	477	437	409	411
Below Normal	435	457	483	519	533	539	533	510	476	448	412	406
Dry	407	425	450	492	518	535	530	513	484	453	415	406
Critical Dry	409	419	441	475	502	512	509	494	468	432	400	389
<b>Alternative 3 as Compared to Second Basis of Comparison</b>												
Wet	1	1	-8	-17	-13	-6	-5	0	5	6	8	6
Above Normal	-7	-6	-11	-31	-30	-21	-20	-13	-11	-4	8	9
Below Normal	-4	-3	-3	-22	-24	-20	-22	-26	-36	-26	-7	-4
Dry	3	5	6	-11	-24	-27	-24	-23	-21	-9	-9	-9
Critical Dry	-10	-10	-12	-17	-30	-37	-36	-36	-34	-28	-25	-19
<b>Alternative 3 as Compared to Second Basis of Comparison (percent change)</b>												
Wet	0.3	0.2	-1.7	-3.3	-2.4	-1.1	-0.8	0.0	0.9	1.2	1.7	1.3
Above Normal	-1.6	-1.3	-2.3	-6.0	-5.6	-3.8	-3.6	-2.5	-2.2	-0.9	1.9	2.3
Below Normal	-0.9	-0.6	-0.6	-4.2	-4.5	-3.7	-4.1	-5.1	-7.5	-5.7	-1.7	-1.1
Dry	0.7	1.1	1.3	-2.2	-4.6	-5.0	-4.5	-4.4	-4.3	-2.0	-2.3	-2.2
Critical Dry	-2.5	-2.3	-2.6	-3.6	-6.1	-7.2	-7.1	-7.4	-7.2	-6.6	-6.4	-4.9

1 The following changes in San Luis Reservoir storage would occur under  
2 Alternative 3 as compared to the Second Basis of Comparison.

- 3 • In wet years, storage would be similar in July through November and March  
4 through May and reduced in December through February and June (up to  
5 15.7 percent). Surface water elevations would be similar in all months.
- 6 • In above-normal years, storage would be similar in November; increased in  
7 August and September (up to 12.1 percent); and reduced in October and  
8 December through July (up to 21.7 percent). Surface water elevations would  
9 be similar in March through December and reduced in January and February  
10 (up to 6.0 percent).
- 11 • In below-normal years, storage would be similar in August and September and  
12 reduced in October through July (up to 40.1 percent). Surface water  
13 elevations would be similar in all months.
- 14 • In dry years, storage would be reduced in January through September (up to  
15 19.2 percent) and increased in October through December (up to  
16 13.2 percent). Surface water elevations would be similar in all months.
- 17 • In critical dry years, storage would be reduced in October through August (up  
18 to 28.5 percent) and increased in September (7.6 percent). Surface water  
19 elevations would be similar September through January and reduced in  
20 February through August (up to 7.4 percent).

21 *Changes in Flows into the Yolo Bypass*

22 Flows from the Sacramento River into the Yolo Bypass at Fremont Weir under  
23 Alternative 3 as compared to the Second Basis of Comparison are summarized in  
24 Table 5.75. The results are summarized following Table 5.75.

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**Table 5.75 Changes in Flows into the Yolo Bypass at Fremont Weir under Alternative 3 as Compared to the Second Basis of Comparison**

Water Year	Average Monthly Flow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 3</b>												
Wet	139	973	9,693	25,241	30,361	18,837	5,617	289	113	0	0	100
Above Normal	100	100	2,686	6,188	14,531	8,490	1,768	100	100	0	0	100
Below Normal	100	100	262	1,250	4,001	1,153	293	100	100	0	0	100
Dry	100	100	342	923	2,007	1,406	410	100	100	0	0	100
Critical Dry	100	100	150	534	545	397	106	100	100	0	0	100
<b>Second Basis of Comparison</b>												
Wet	147	996	9,888	25,442	30,547	18,997	5,602	289	113	0	0	100
Above Normal	100	100	2,659	6,349	15,114	8,566	1,765	100	100	0	0	100
Below Normal	100	100	262	1,256	4,057	1,166	292	100	100	0	0	100
Dry	100	100	342	932	2,032	1,411	411	100	100	0	0	100
Critical Dry	100	100	149	542	533	408	106	100	100	0	0	100
<b>Alternative 3 as Compared to Second Basis of Comparison</b>												
Wet	-8	-23	-195	-201	-187	-160	15	0	0	0	0	0
Above Normal	0	0	28	-161	-583	-76	4	0	0	0	0	0
Below Normal	0	0	0	-6	-56	-13	0	0	0	0	0	0
Dry	0	0	-1	-9	-24	-4	-2	0	0	0	0	0
Critical Dry	0	0	0	-8	12	-11	0	0	0	0	0	0
<b>Alternative 3 as Compared to Second Basis of Comparison (percent change)</b>												
Wet	-5.6	-2.3	-2.0	-0.8	-0.6	-0.8	0.3	0.1	0.0	0.0	0.0	0.0
Above Normal	0.0	0.0	1.0	-2.5	-3.9	-0.9	0.2	0.0	0.0	0.0	0.0	0.0
Below Normal	0.0	0.0	0.2	-0.5	-1.4	-1.1	0.1	0.0	0.0	0.0	0.0	0.0
Dry	0.0	0.0	-0.2	-0.9	-1.2	-0.3	-0.4	0.0	0.0	0.0	0.0	0.0
Critical Dry	0.0	0.0	0.2	-1.5	2.2	-2.6	0.0	0.0	0.0	0.0	0.0	0.0

1 The following changes in flows from the Sacramento River into the Yolo Bypass  
2 at Fremont Weir would occur under Alternative 3 as compared to the Second  
3 Basis of Comparison.

- 4 • In wet years, flows into the Yolo Bypass would be similar in November  
5 through September and reduced in October (5.6 percent).
- 6 • In above-normal, below-normal, dry, and critical dry years, flows into the  
7 Yolo Bypass would be similar in all months.

8 *Changes in Delta Conditions*

9 Delta outflow under Alternative 3 as compared to the Second Basis of  
10 Comparison are summarized below and shown on Figures 5.74 through 5.76.

- 11 • In wet years, average monthly Delta outflow would increase in November  
12 through February and July through September (up to 2,546 cfs) and decrease  
13 in October and March through June (up to 1,127 cfs).
- 14 • In dry years, average monthly Delta outflow would increase in November  
15 through April, July and August (up to 3,391 cfs) and decrease in October,  
16 May, and June (up to 373 cfs).

17 The OMR conditions under Alternative 3 as compared to the Second Basis of  
18 Comparison are shown on Figures 5.77 through 5.79.

- 19 • Under Alternative 3, OMR flows are negative in all months of all water year  
20 types except in April in wet year (405 cfs). Under Second Basis of  
21 Comparison, OMR flows are negative in all months of all water year types.
- 22 • In wet years, flows would be more positive in September through February,  
23 April, and May (up to 5,528 cfs) and more negative in March and June  
24 through August (up to 1,453 cfs).
- 25 • In dry years, flows would be more positive in August through May (up to  
26 3,249 cfs); and more negative flows in June and July (up to 1,345 cfs).

27 *Changes in CVP and SWP Exports and Deliveries*

28 Delta exports under Alternative 3 as compared to the Second Basis of Comparison  
29 are summarized in Table 5.76.

1 **Table 5.76 Changes in Exports at Jones and Banks Pumping Plants under**  
 2 **Alternative 3 as Compared to the Second Basis of Comparison**

Water Year	Monthly Volume (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 3</b>												
Wet	544	615	601	559	594	589	494	490	519	648	667	654
Above Normal	430	533	574	414	469	566	441	413	397	586	680	647
Below Normal	524	587	607	394	373	448	312	266	330	683	650	588
Dry	440	471	523	389	314	337	270	242	292	492	318	426
Critical Dry	321	319	401	355	251	180	127	100	131	158	196	245
<b>Second Basis of Comparison</b>												
Wet	549	619	716	724	609	543	476	430	456	632	655	660
Above Normal	428	521	641	716	584	570	453	363	415	572	647	651
Below Normal	548	595	623	674	497	500	337	304	414	629	517	539
Dry	435	475	546	579	518	493	259	228	274	403	325	438
Critical Dry	340	345	455	433	406	266	134	121	132	139	203	249
<b>Alternative 3 as Compared to Second Basis of Comparison</b>												
Wet	-5	-5	-115	-165	-15	46	18	60	64	16	12	-5
Above Normal	2	12	-66	-303	-115	-4	-11	50	-19	13	33	-3
Below Normal	-24	-7	-16	-280	-124	-52	-25	-37	-83	54	133	49
Dry	5	-4	-23	-190	-203	-156	12	14	18	89	-7	-12
Critical Dry	-19	-26	-54	-78	-156	-86	-6	-21	0	19	-7	-4
<b>Alternative 3 as Compared to Second Basis of Comparison (percent change)</b>												
Wet	-0.8	-0.7	-16.0	-22.8	-2.4	8.6	3.7	14.0	14.0	2.5	1.8	-0.8
Above Normal	0.5	2.2	-10.3	-42.2	-19.7	-0.7	-2.5	13.8	-4.5	2.3	5.1	-0.5
Below Normal	-4.4	-1.3	-2.5	-41.5	-24.9	-10.4	-7.5	-12.3	-20.2	8.6	25.7	9.1
Dry	1.3	-0.8	-4.1	-32.8	-39.3	-31.6	4.5	6.1	6.5	22.1	-2.3	-2.7
Critical Dry	-5.7	-7.4	-11.8	-18.0	-38.3	-32.4	-4.8	-17.1	-0.2	14.0	-3.5	-1.7

1 The following changes would occur in CVP and SWP exports under Alternative 3  
 2 as compared to the Second Basis of Comparison.

- 3 • Long-term average annual exports would be 326 TAF (6 percent) less under  
 4 Alternative 3 as compared to the Second Basis of Comparison.
- 5 • In wet years, total exports would be similar in July through November,  
 6 February, and April; increased exports in March, May, and June (up to  
 7 14.0 percent); and reduced in December and January (up to 22.8 percent).
- 8 • In above-normal years, total exports would be similar in June through  
 9 November, March, and April; reduced exports in December through February  
 10 (up to 42.2 percent); and increased in May (up to 13.8 percent).
- 11 • In below-normal years, total exports would be similar in October through  
 12 December; reduced exports in January through June (up to 41.5 percent); and  
 13 increased in July through September (up to 25.7 percent).
- 14 • In dry years, total exports would be similar in August through December and  
 15 April; reduced exports in January through March (up to 39.3 percent); and  
 16 increased exports in May through July (up to 22.1 percent).
- 17 • In critical dry years, total exports would be similar in April, June, August, and  
 18 September; reduced exports in October through March and May (up to  
 19 38.3 percent); and increased exports in July (14.0 percent).

20 Deliveries to CVP and SWP water users would be similar under Alternative 3 as  
 21 compared to the Second Basis of Comparison, as summarized in Tables 5.77  
 22 and 5.78.

23 **Table 5.77 Changes CVP Water Deliveries under Alternative 3 as Compared to the**  
 24 **Second Basis of Comparison**

Annual Average Deliveries (TAF)					
		Alternative 3	Second Basis of Comparison	Alternative 3 as Compared to the Second Basis of Comparison	
				Difference	Percent Change
<b>North of Delta</b>					
CVP Agricultural Water Service Contractors	Long Term	209	219	-10	-5
	Dry	111	122	-11	-9
	Critical Dry	31	35	-4	-11



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Annual Average Deliveries (TAF)					
		Alternative 3	Second Basis of Comparison	Alternative 3 as Compared to the Second Basis of Comparison	
				Difference	Percent Change
CVP M&I (Including American River Contractors and Contra Costa Water District)	Long Term	392	392	0	0
	Dry	390	390	0	0
	Critical Dry	384	383	2	1
CVP M&I American River Contractors	Long Term	118	120	-2	-2
	Dry	104	105	-1	-1
	Critical Dry	78	79	-2	-3
CVP Sacramento River Settlement Contractors	Long Term	1,860	1,858	2	0
	Dry	1,906	1,905	1	0
	Critical Dry	1,742	1,732	10	1
CVP Refuge Level 2 Deliveries	Long Term	153	155	-1	-1
	Dry	149	151	-2	-1
	Critical Dry	103	105	-2	-2
Total CVP Agricultural, M&I, Sacramento River Settlement Contractors, and Refuge Level 2 Deliveries	Long Term	602	612	-10	0
	Dry	501	512	-12	0
	Critical Dry	415	418	5	0
<b>South of Delta (Does not include Eastside Contractors)</b>					
CVP Agricultural Water Service Contractors	Long Term	1,079	1,100	-20	-2
	Dry	596	650	-55	-8
	Critical Dry	168	195	-28	-14

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Annual Average Deliveries (TAF)					
		Alternative 3	Second Basis of Comparison	Alternative 3 as Compared to the Second Basis of Comparison	
				Difference	Percent Change
CVP M&I Users	Long Term	122	125	-2	-2
	Dry	108	109	-1	-1
	Critical Dry	83	85	-2	-2
San Joaquin River Exchange Contractors	Long Term	852	852	0	0
	Dry	875	875	0	0
	Critical Dry	741	741	0	0
CVP Refuge Level 2 Deliveries	Long Term	273	272	1	0
	Dry	281	280	1	0
	Critical Dry	234	232	3	1
Total CVP Agricultural, M&I, San Joaquin River Exchange Contractors, and Refuge Level 2 Deliveries	Long Term	1,202	1,225	-23	-1
	Dry	703	759	-54	-3
	Critical Dry	250	280	-27	-2
<b>Eastside Contractors Deliveries</b>					
Water Rights	Long Term	513	514	-1	0
	Dry	524	524	0	0
	Critical Dry	478	486	-8	-2
CVP Water Service Contracts	Long Term	123	118	5	4
	Dry	109	98	12	12
	Critical Dry	36	25	11	44
Total Water Rights and CVP Service Contracts Deliveries	Long Term	636	632	4	1
	Dry	633	621	11	2
	Critical Dry	514	511	3	1

1 The following changes in CVP water deliveries would occur under Alternative 3  
 2 as compared to the Second Basis of Comparison.

- 3 • Deliveries to CVP North of Delta agricultural water service contractors would  
 4 be reduced by 5 percent over the long-term conditions, 9 percent in dry years,  
 5 and 11 percent in critical dry years.
- 6 • Deliveries to CVP North of Delta M&I contractors (including American River  
 7 CVP contractors) would be similar in long-term conditions and dry and  
 8 critical dry years.
- 9 • Deliveries to CVP South of Delta agricultural water service contractors would  
 10 be similar over the long-term conditions and reduced by 8 percent in dry years  
 11 and 14 percent in critical dry years.
- 12 • Deliveries to CVP South of Delta M&I contractors would be similar in long-  
 13 term conditions and dry and critical dry years.
- 14 • Deliveries to the Eastside contractors would be similar under long-term  
 15 conditions, dry years, and in critical dry years.

16 **Table 5.78 Changes SWP Water Deliveries under Alternative 3 as Compared to the**  
 17 **Second Basis of Comparison**

Annual Average Deliveries (TAF)					
		Alternative 3	Second Basis of Comparison	Alternative 3 as Compared to the Second Basis of Comparison	
				Difference	Percent Change
<b>North of Delta</b>					
SWP Agricultural Uses	Long Term	0	0	0	0
	Dry	0	0	0	0
	Critical Dry	0	0	0	0
SWP M&I (without Article 21)	Long Term	80	83	-3	-4
	Dry	60	62	-2	-4
	Critical Dry	48	53	-5	-10
SWP M&I Article 21 Deliveries	Long Term	12	12	0	5
	Dry	13	13	0	1
	Critical Dry	12	12	0	3

Chapter 5: Surface Water Resources and Water Supplies

Annual Average Deliveries (TAF)					
		Alternative 3	Second Basis of Comparison	Alternative 3 as Compared to the Second Basis of Comparison	
				Difference	Percent Change
Total SWP Agricultural and M&I (without Article 21)	Long Term	80	83	-3	-4
	Dry	60	62	-2	-4
	Critical Dry	48	53	-5	-10
Total SWP Agricultural and M&I Article 21 Deliveries	Long Term	12	12	0	5
	Dry	13	13	0	1
	Critical Dry	12	12	0	3
<b>South of Delta</b>					
SWP Agricultural Users (without Article 21)	Long Term	716	750	-34	-4
	Dry	533	567	-34	-6
	Critical Dry	430	484	-54	-11
SWP Agricultural Article 21 Deliveries	Long Term	73	178	-105	-59
	Dry	36	143	-107	-75
	Critical Dry	27	100	-73	-72
SWP M&I Users (without Article 21)	Long Term	2,106	2,183	-77	-4
	Dry	1,649	1,732	-83	-5
	Critical Dry	1,340	1,494	-154	-10
SWP M&I Article 21 Deliveries	Long Term	33	104	-71	-68
	Dry	11	86	-75	-87
	Critical Dry	10	58	-48	-83

Annual Average Deliveries (TAF)					
		Alternative 3	Second Basis of Comparison	Alternative 3 as Compared to the Second Basis of Comparison	
				Difference	Percent Change
Total SWP Agricultural and M&I Users (without Article 21)	Long Term	2,822	2,933	-111	-4
	Dry	2,182	2,299	-117	-5
	Critical Dry	1,770	1,978	-208	-11
Total SWP Agricultural and M&I Article 21 Deliveries	Long Term	106	282	-176	-62
	Dry	47	229	-182	-80
	Critical Dry	38	158	-120	-76

1 The following changes in SWP water deliveries would occur under Alternative 3  
 2 as compared to the Second Basis of Comparison.

- 3 • Deliveries without Article 21 water to SWP North of Delta water contractors  
 4 would be similar over the long-term conditions and in dry years and reduced  
 5 by 10 percent in critical dry years.
- 6 • Deliveries without Article 21 water to SWP South of Delta water contractors  
 7 would be similar over the long-term conditions and in dry years and reduced  
 8 by 11 percent in critical dry years.
- 9 • Deliveries of Article 21 water to SWP North of Delta water contractors would  
 10 be similar over the long-term conditions and in dry and critical dry years.
- 11 • Deliveries of Article 21 water to SWP South of Delta water contractors would  
 12 be reduced by 62 percent over the long-term conditions; 80 percent in dry  
 13 years; and 76 percent in critical dry years.

14 *Effects Related to Cross Delta Water Transfers*

15 Potential effects to surface water resources could be similar to those identified in  
 16 a recent environmental analysis conducted by Reclamation for long-term water  
 17 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014i).  
 18 Potential effects were identified as reduced surface water storage in upstream  
 19 reservoirs and changes in flow patterns in river downstream of the reservoirs if  
 20 water was released from the reservoirs in patterns that were different than would  
 21 have been used by the water seller's. Because all water transfers would be  
 22 required to avoid adverse impacts to other water users and biological resources  
 23 (see Section 3.A.6.3, Transfers), including impacts associated with changes in

1 reservoir storage and river flow patterns, the analysis indicated that water  
2 transfers would not result in substantial changes in storage or river flows. For the  
3 purposes of this EIS, it is anticipated that similar conditions would occur due to  
4 cross Delta water transfers under Alternative 3 and the Second Basis of  
5 Comparison.

6 Under Alternative 3 and the Second Basis of Comparison, water could be  
7 transferred throughout the year. As indicated in Table 5.76, capacity would be  
8 available under Alternative 3 and the Second Basis of Comparison in a similar  
9 manner in all months of all water year types.

#### 10 *San Francisco Bay Area, Central Coast, and Southern California Regions*

##### 11 *Potential Changes in Surface Water Resources at Reservoirs that Store CVP* 12 *and SWP Water*

13 The San Francisco Bay Area, Central Coast, and Southern California regions  
14 include numerous reservoirs that store CVP and SWP water supplies, including  
15 CVP and SWP reservoirs, that primarily provide water supplies for M&I water  
16 users. Changes in the availability CVP and SWP water supplies for storage in  
17 these reservoirs under Alternative 3 as compared to the Second Basis of  
18 Comparison would be consistent with the following changes in water deliveries to  
19 M&I water users, as summarized in Tables 5.77 and 5.78.

- 20 • Deliveries to CVP South of Delta M&I contractors would be similar in long-  
21 term conditions and dry and critical dry years.
- 22 • Deliveries without Article 21 water to SWP South of Delta water contractors  
23 would be similar over the long-term conditions and in dry years and reduced  
24 by 11 percent in critical dry years.
- 25 • Deliveries of Article 21 water to SWP South of Delta water contractors would  
26 be reduced by 62 percent over the long-term conditions, 80 percent in dry  
27 years, and 76 percent in critical dry years.

##### 28 *Changes in CVP and SWP Exports and Deliveries*

29 Deliveries to CVP and SWP water users are described above in the Central Valley  
30 Region.

#### 31 **5.4.3.5 Alternative 4**

32 Surface water resources conditions under Alternative 4 would be identical to the  
33 surface water resources conditions under the Second Basis of Comparison;  
34 therefore, Alternative 4 is only compared to the No Action Alternative.

##### 35 **5.4.3.5.1 Alternative 4 Compared to the No Action Alternative**

36 Changes in surface water resources under Alternative 4 as compared to the No  
37 Action Alternative would be the same as the impacts described in Section  
38 5.4.3.2.1, Alternative 1 Compared to the No Action Alternative.

1    **5.4.3.6    Alternative 5**  
2    CVP and SWP operations under Alternative 5 are similar to the No Action  
3    Alternative with modified Old and Middle River flow criteria and New Melones  
4    Reservoir operations. Alternative 5 would include changed water demands for  
5    American River water supplies as compared to the No Action Alternative or  
6    Second Basis of Comparison. Alternative 5 would provide water supplies of up to  
7    17 TAF per year under a Warren Act Contract for El Dorado Irrigation District  
8    and 15 TAF per year under a CVP water service contract for El Dorado County  
9    Water Agency. These demands are not included in the analysis presented in this  
10   section of the EIS. A sensitivity analysis comparing the results of the analysis  
11   with and without these demands is presented in Appendix 5B of this EIS.

12   **5.4.3.6.1   Alternative 5 Compared to the No Action Alternative**

13    *Trinity River Region*

14      *Changes in CVP and SWP Reservoir Storage and Downstream River Flows*

15    Changes in Trinity Lake storage and surface water elevations under Alternative 5  
16    as compared to the No Action Alternative are summarized in Tables 5.79  
17    and 5.80. The results are summarized following Table 5.80.

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**Table 5.79 Changes in Trinity Lake Storage under Alternative 5 as Compared to the No Action Alternative**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 5</b>												
Wet	1,494	1,520	1,635	1,759	1,926	2,056	2,222	2,246	2,191	2,068	1,940	1,781
Above Normal	1,155	1,180	1,290	1,459	1,662	1,850	2,030	2,004	1,912	1,778	1,627	1,503
Below Normal	1,398	1,405	1,422	1,493	1,580	1,667	1,813	1,741	1,637	1,474	1,311	1,190
Dry	1,155	1,150	1,175	1,183	1,275	1,404	1,540	1,492	1,415	1,259	1,110	1,012
Critical Dry	744	726	741	743	784	866	913	878	856	755	622	539
<b>No Action Alternative</b>												
Wet	1,490	1,516	1,630	1,756	1,921	2,053	2,220	2,245	2,190	2,067	1,939	1,784
Above Normal	1,159	1,178	1,286	1,455	1,658	1,847	2,025	1,999	1,907	1,773	1,619	1,495
Below Normal	1,393	1,400	1,417	1,488	1,575	1,662	1,817	1,743	1,637	1,470	1,304	1,185
Dry	1,152	1,148	1,174	1,182	1,274	1,403	1,539	1,490	1,413	1,253	1,104	1,008
Critical Dry	747	731	746	750	790	872	923	888	862	745	612	536
<b>Alternative 5 as Compared to No Action Alternative</b>												
Wet	4	3	5	4	4	2	2	2	2	0	0	-2
Above Normal	-4	2	4	4	4	4	6	6	5	5	8	8
Below Normal	5	5	5	5	5	5	-5	-2	0	4	7	4
Dry	3	1	1	1	1	1	1	1	2	6	6	4
Critical Dry	-2	-5	-4	-7	-6	-6	-10	-10	-7	10	11	3
<b>Alternative 5 as Compared to No Action Alternative (percent change)</b>												
Wet	0.2	0.2	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.0	0.0	-0.1
Above Normal	-0.4	0.2	0.3	0.3	0.2	0.2	0.3	0.3	0.3	0.3	0.5	0.5
Below Normal	0.4	0.4	0.4	0.3	0.3	0.3	-0.3	-0.1	0.0	0.3	0.5	0.4
Dry	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.5	0.5	0.4
Critical Dry	-0.3	-0.6	-0.6	-0.9	-0.7	-0.7	-1.1	-1.1	-0.8	1.3	1.8	0.5



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**Table 5.80 Changes in Trinity Lake Elevation under Alternative 5 as Compared to the No Action Alternative**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 5</b>												
Wet	2,300	2,303	2,313	2,325	2,338	2,347	2,357	2,358	2,355	2,347	2,338	2,326
Above Normal	2,259	2,262	2,276	2,294	2,314	2,330	2,343	2,342	2,335	2,326	2,313	2,303
Below Normal	2,289	2,290	2,292	2,299	2,308	2,315	2,326	2,321	2,313	2,299	2,284	2,272
Dry	2,263	2,265	2,268	2,269	2,279	2,292	2,305	2,301	2,294	2,279	2,265	2,254
Critical Dry	2,209	2,206	2,209	2,212	2,220	2,234	2,241	2,237	2,235	2,221	2,199	2,183
<b>No Action Alternative</b>												
Wet	2,300	2,303	2,313	2,324	2,338	2,347	2,357	2,358	2,355	2,347	2,338	2,327
Above Normal	2,261	2,264	2,276	2,294	2,314	2,330	2,343	2,341	2,335	2,325	2,313	2,302
Below Normal	2,289	2,289	2,291	2,299	2,307	2,315	2,327	2,321	2,313	2,299	2,283	2,272
Dry	2,263	2,265	2,268	2,269	2,279	2,292	2,305	2,301	2,294	2,279	2,264	2,254
Critical Dry	2,210	2,207	2,210	2,213	2,220	2,235	2,242	2,238	2,235	2,220	2,196	2,182
<b>Alternative 5 as Compared to No Action Alternative</b>												
Wet	0	0	0	0	0	0	0	0	0	0	0	0
Above Normal	-2	-2	0	0	0	0	0	0	0	0	1	1
Below Normal	1	1	1	1	1	0	0	0	0	0	1	0
Dry	1	0	0	0	0	0	0	0	0	0	1	1
Critical Dry	0	-1	-1	-1	-1	-1	-1	-1	-1	2	3	1
<b>Alternative 5 as Compared to No Action Alternative (percent change)</b>												
Wet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Above Normal	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Below Normal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Critical Dry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1

1 Trinity Lake storage and surface water elevations would be similar in all months  
 2 and all water year types under Alternative 5 as compared to the No Action  
 3 Alternative.

4 Trinity River flows would be similar in all months under long-term conditions and  
 5 wet and dry years, as shown on Figures 5.53 through 5.55. Central Valley Region

6 *Changes in CVP and SWP Reservoir Storage and Downstream River Flows*  
 7 *Shasta Lake and Sacramento River*

8 Storage levels and surface water elevations in Shasta Lake under Alternative 5 as  
 9 compared to the No Action Alternative are summarized in Tables 5.81 and 5.82.  
 10 Changes in flows in the Sacramento River downstream of Keswick Dam and at  
 11 Freeport are shown on Figures 5.56 through 5.61. The results are summarized  
 12 following Table 5.82.

13 **Table 5.81 Changes in Shasta Lake Storage under Alternative 5 as Compared to the**  
 14 **No Action Alternative**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 5</b>												
Wet	2,704	2,716	3,078	3,385	3,590	3,836	4,299	4,461	4,243	3,736	3,410	2,989
Above Normal	2,369	2,388	2,598	3,164	3,454	4,019	4,401	4,430	4,042	3,409	3,071	2,842
Below Normal	2,603	2,565	2,704	3,077	3,450	3,820	4,039	3,970	3,602	3,012	2,663	2,620
Dry	2,344	2,287	2,433	2,627	3,039	3,509	3,745	3,699	3,315	2,787	2,497	2,459
Critical Dry	1,676	1,611	1,700	1,856	2,015	2,258	2,203	2,104	1,749	1,246	958	910
<b>No Action Alternative</b>												
Wet	2,700	2,719	3,077	3,384	3,589	3,836	4,298	4,460	4,242	3,735	3,410	2,985
Above Normal	2,369	2,385	2,600	3,167	3,453	4,021	4,404	4,429	4,039	3,407	3,069	2,834
Below Normal	2,587	2,548	2,686	3,062	3,442	3,814	4,026	3,957	3,588	3,002	2,643	2,608
Dry	2,345	2,283	2,428	2,621	3,034	3,505	3,737	3,668	3,284	2,767	2,496	2,462
Critical Dry	1,702	1,633	1,717	1,871	2,031	2,274	2,202	2,088	1,719	1,253	986	937
<b>Alternative 5 as Compared to No Action Alternative</b>												
Wet	4	-3	1	1	0	0	1	1	1	0	0	4
Above Normal	0	4	-2	-3	0	-1	-3	2	3	2	2	8
Below Normal	16	16	18	16	8	6	13	13	14	10	20	12
Dry	-1	4	5	6	5	4	8	31	31	20	1	-3
Critical Dry	-25	-22	-17	-15	-16	-16	1	16	31	-7	-28	-26
<b>Alternative 5 as Compared to No Action Alternative (percent change)</b>												
Wet	0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Above Normal	0.0	0.2	-0.1	-0.1	0.0	0.0	-0.1	0.0	0.1	0.1	0.1	0.3
Below Normal	0.6	0.6	0.7	0.5	0.2	0.2	0.3	0.3	0.4	0.3	0.8	0.5
Dry	0.0	0.2	0.2	0.2	0.2	0.1	0.2	0.8	0.9	0.7	0.0	-0.1
Critical Dry	-1.5	-1.3	-1.0	-0.8	-0.8	-0.7	0.0	0.8	1.8	-0.6	-2.8	-2.8

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**Table 5.82 Changes in Shasta Lake Elevation under Alternative 5 as Compared to the No Action Alternative**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 5</b>												
Wet	991	992	1,008	1,023	1,031	1,041	1,058	1,064	1,056	1,037	1,024	1,005
Above Normal	967	968	982	1,012	1,025	1,048	1,062	1,063	1,049	1,024	1,009	999
Below Normal	987	985	992	1,009	1,025	1,040	1,048	1,045	1,031	1,006	990	988
Dry	969	967	975	986	1,006	1,027	1,037	1,035	1,019	996	982	980
Critical Dry	925	921	928	938	950	967	965	959	937	899	874	869
<b>No Action Alternative</b>												
Wet	991	992	1,008	1,023	1,031	1,041	1,058	1,064	1,056	1,037	1,024	1,005
Above Normal	967	968	982	1,012	1,025	1,048	1,062	1,063	1,049	1,024	1,009	999
Below Normal	986	985	991	1,009	1,025	1,040	1,048	1,045	1,031	1,006	989	987
Dry	969	967	975	986	1,006	1,027	1,037	1,034	1,018	995	982	980
Critical Dry	927	923	929	939	951	968	965	958	935	899	876	872
<b>Alternative 5 as Compared to No Action Alternative</b>												
Wet	0	0	0	0	0	0	0	0	0	0	0	0
Above Normal	0	0	0	0	0	0	0	0	0	0	0	0
Below Normal	1	1	1	1	0	0	1	1	1	0	1	1
Dry	0	0	0	0	0	0	0	1	1	1	0	0
Critical Dry	-2	-2	-1	-1	-1	-1	0	1	3	-1	-2	-2
<b>Alternative 5 as Compared to No Action Alternative (percent change)</b>												
Wet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Above Normal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Below Normal	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.0	0.1	0.1
Dry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0
Critical Dry	-0.2	-0.2	-0.2	-0.1	-0.1	-0.1	0.0	0.1	0.3	-0.1	-0.3	-0.3

1 Shasta Lake storage and surface water elevations would be similar in all months  
2 and all water year types under Alternative 5 as compared to the No Action  
3 Alternative.

4 The following changes in Sacramento River flows would occur under  
5 Alternative 5 as compared to the No Action Alternative, as shown on Figures 5.56  
6 through 5.61.

- 7 • Sacramento River flows downstream of Keswick Dam (Figures 5.56 through  
8 5.58) would be similar over the long-term conditions and in wet and dry years.
- 9 • Sacramento River near Freeport (near the northern boundary of the Delta)  
10 (Figures 5.59 through 5.61) would be similar over the long-term conditions  
11 and in wet and dry years.

12 *Lake Oroville and Feather River*

13 Storage levels and surface water elevations in Lake Oroville under Alternative 5  
14 as compared to the No Action Alternative are summarized in Tables 5.83 and  
15 5.84. Changes in flows in the Feather River downstream of Thermalito Complex  
16 are shown on Figures 5.62 through 5.64. The results are summarized following  
17 Table 5.84.

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**Table 5.83 Changes in Lake Oroville Storage under Alternative 5 as Compared to the No Action Alternative**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 5</b>												
Wet	1,681	1,723	2,179	2,556	2,833	2,942	3,300	3,488	3,447	2,961	2,613	2,103
Above Normal	1,275	1,310	1,471	1,948	2,512	2,892	3,247	3,401	3,241	2,608	2,125	1,668
Below Normal	1,552	1,507	1,517	1,728	2,132	2,406	2,663	2,746	2,569	1,959	1,521	1,305
Dry	1,223	1,173	1,190	1,319	1,595	1,952	2,193	2,255	1,992	1,502	1,295	1,150
Critical Dry	1,102	1,037	1,025	1,114	1,229	1,383	1,415	1,411	1,266	1,045	929	873
<b>No Action Alternative</b>												
Wet	1,691	1,732	2,189	2,554	2,832	2,942	3,300	3,488	3,445	2,964	2,626	2,109
Above Normal	1,279	1,322	1,485	1,959	2,519	2,892	3,247	3,393	3,232	2,600	2,117	1,659
Below Normal	1,542	1,497	1,507	1,719	2,122	2,397	2,653	2,714	2,530	1,923	1,513	1,307
Dry	1,206	1,158	1,177	1,305	1,582	1,938	2,178	2,210	1,951	1,478	1,287	1,144
Critical Dry	1,092	1,029	1,019	1,108	1,223	1,381	1,408	1,392	1,243	1,018	917	865
<b>Alternative 5 as Compared to No Action Alternative</b>												
Wet	-10	-9	-10	1	1	0	0	0	2	-3	-13	-7
Above Normal	-3	-12	-14	-11	-7	0	0	8	9	8	8	9
Below Normal	10	10	10	9	10	10	10	32	39	36	8	-1
Dry	17	15	13	13	13	13	15	45	41	23	8	6
Critical Dry	10	9	6	6	6	3	7	19	22	27	12	8
<b>Alternative 5 as Compared to No Action Alternative (percent change)</b>												
Wet	-0.6	-0.5	-0.4	0.0	0.0	0.0	0.0	0.0	0.1	-0.1	-0.5	-0.3
Above Normal	-0.3	-0.9	-0.9	-0.6	-0.3	0.0	0.0	0.2	0.3	0.3	0.4	0.5
Below Normal	0.6	0.7	0.7	0.5	0.5	0.4	0.4	1.2	1.6	1.9	0.6	-0.1
Dry	1.4	1.3	1.1	1.0	0.8	0.7	0.7	2.0	2.1	1.6	0.6	0.5
Critical Dry	0.9	0.8	0.6	0.6	0.5	0.2	0.5	1.3	1.8	2.6	1.3	1.0

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**Table 5.84 Changes in Lake Oroville Elevation under Alternative 5 as Compared to the No Action Alternative**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 5</b>												
Wet	742	746	793	829	852	859	884	897	894	860	835	789
Above Normal	698	701	720	775	827	856	880	891	880	836	795	747
Below Normal	731	726	728	752	794	818	839	845	831	777	730	704
Dry	691	685	688	706	738	777	799	804	779	727	703	685
Critical Dry	676	668	665	679	694	712	716	715	696	667	650	642
<b>No Action Alternative</b>												
Wet	743	748	794	829	852	859	884	897	894	861	836	790
Above Normal	698	703	722	776	828	856	880	890	879	835	794	746
Below Normal	730	725	726	751	793	818	838	842	828	773	729	704
Dry	688	683	686	704	737	775	798	800	775	724	702	684
Critical Dry	674	667	664	678	693	712	715	712	693	663	648	640
<b>Alternative 5 as Compared to No Action Alternative</b>												
Wet	-1	-1	-1	0	0	0	0	0	0	0	-1	-1
Above Normal	0	-1	-2	-1	-1	0	0	1	1	1	1	1
Below Normal	1	1	2	1	1	1	1	2	3	4	1	0
Dry	3	2	2	2	1	1	1	4	4	3	1	1
Critical Dry	2	1	1	1	1	0	1	2	3	4	2	2
<b>Alternative 5 as Compared to No Action Alternative (percent change)</b>												
Wet	-0.2	-0.2	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1
Above Normal	0.0	-0.2	-0.2	-0.1	-0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1
Below Normal	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.3	0.4	0.5	0.1	0.0
Dry	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.5	0.5	0.4	0.2	0.2
Critical Dry	0.2	0.2	0.2	0.2	0.1	0.0	0.1	0.3	0.4	0.6	0.4	0.3

1 Lake Oroville storage and surface water elevations would be similar in all months  
2 and all water year types under Alternative 5 as compared to the No Action  
3 Alternative.

4 The following changes in Feather River flows would occur under Alternative 5 as  
5 compared to the No Action Alternative, as shown on Figures 5.62 through 5.64.

- 6 • Over long-term conditions, similar flows would occur in June through April  
7 and reduced flows in May (6.6 percent).
- 8 • In wet years, similar flows would occur in all months.
- 9 • In dry years, similar flows would occur in September through April and June;  
10 reduced flows in May (27.1 percent) and increased flows in July and August  
11 (up to 8.9 percent).

12 *Folsom Lake and American River*

13 Storage levels and surface water elevations in Folsom Lake under Alternative 5 as  
14 compared to the No Action Alternative are summarized in Tables 5.85 and 5.86.  
15 Changes in flows in the American River downstream of Nimbus Dam are shown  
16 on Figures 5.65 through 5.67. The results are summarized following Table 5.86.

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**Table 5.85 Changes in Folsom Lake Storage under Alternative 5 as Compared to the No Action Alternative**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 5</b>												
Wet	454	435	515	518	515	632	785	952	941	794	710	577
Above Normal	375	379	428	513	532	640	787	946	888	622	554	478
Below Normal	440	425	461	483	534	620	758	845	783	523	469	450
Dry	397	386	411	426	479	579	691	766	664	489	435	410
Critical Dry	325	304	314	320	367	433	483	499	411	324	257	231
<b>No Action Alternative</b>												
Wet	454	435	514	518	515	632	785	951	941	800	712	576
Above Normal	377	380	429	513	531	640	787	946	887	621	552	477
Below Normal	446	431	467	484	533	619	757	843	780	527	472	453
Dry	394	383	408	423	479	579	691	760	658	495	443	419
Critical Dry	324	305	315	320	366	432	475	486	415	327	267	231
<b>Alternative 5 as Compared to No Action Alternative</b>												
Wet	0	0	0	0	0	0	0	1	0	-6	-2	1
Above Normal	-2	-1	-1	1	1	0	0	0	1	1	2	1
Below Normal	-6	-7	-6	-2	0	0	0	2	3	-4	-3	-3
Dry	3	3	3	2	0	0	0	6	6	-5	-8	-9
Critical Dry	1	-1	0	0	0	0	8	13	-4	-3	-10	0
<b>Alternative 5 as Compared to No Action Alternative (percent change)</b>												
Wet	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	-0.8	-0.2	0.2
Above Normal	-0.7	-0.4	-0.2	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.4	0.3
Below Normal	-1.4	-1.5	-1.3	-0.3	0.0	0.1	0.1	0.3	0.4	-0.7	-0.6	-0.7
Dry	0.7	0.8	0.6	0.5	0.0	0.0	0.0	0.8	0.8	-1.1	-1.9	-2.1
Critical Dry	0.2	-0.2	-0.1	0.0	0.1	0.1	1.7	2.8	-0.9	-0.9	-3.9	0.2



1 **Table 5.86 Changes in Folsom Lake Elevation under Alternative 5 as Compared to**  
 2 **the No Action Alternative**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 5</b>												
Wet	409	407	418	418	418	432	448	465	464	449	440	425
Above Normal	394	395	405	418	420	433	449	464	458	431	423	413
Below Normal	406	405	410	413	420	431	445	454	447	417	411	408
Dry	400	400	404	406	413	426	438	446	435	413	406	403
Critical Dry	386	384	389	390	396	406	412	414	400	385	370	365
<b>No Action Alternative</b>												
Wet	409	407	418	418	418	432	448	464	464	449	440	425
Above Normal	394	395	405	418	420	433	449	464	458	430	422	413
Below Normal	408	406	411	414	420	431	445	454	447	418	411	409
Dry	400	399	403	405	413	426	438	445	434	414	408	405
Critical Dry	386	384	389	390	396	406	411	412	401	386	374	366
<b>Alternative 5 as Compared to No Action Alternative</b>												
Wet	0	0	0	0	0	0	0	0	0	-1	0	0
Above Normal	-1	0	0	0	0	0	0	0	0	0	0	0
Below Normal	-2	-2	-1	0	0	0	0	0	0	-1	0	0
Dry	0	0	0	0	0	0	0	1	1	-1	-2	-2
Critical Dry	0	0	0	0	0	0	1	2	-1	-2	-3	0
<b>Alternative 5 as Compared to No Action Alternative (percent change)</b>												
Wet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0
Above Normal	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Below Normal	-0.5	-0.4	-0.3	-0.1	0.0	0.0	0.0	0.0	0.1	-0.1	-0.1	-0.1
Dry	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.1	0.1	-0.3	-0.5	-0.5
Critical Dry	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	-0.2	-0.4	-0.9	-0.1

3 Folsom Lake storage and surface water elevations would be similar in all months  
 4 and all water year types under Alternative 5 as compared to the No Action  
 5 Alternative.

6 American River flows would be similar over long-term conditions and in wet and  
 7 dry years in all months under Alternative 5 as compared to the No Action  
 8 Alternative, as shown on Figures 5.65 through 5.67.

9 *Clear Creek*

10 Monthly Clear Creek flows under Alternative 5 are identical to flows under the  
 11 No Action Alternative, as summarized in Table 5.87.

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**Table 5.87 Changes in Clear Creek Flows below Whiskeytown Dam under Alternative 5 as Compared to the No Action Alternative**

Water Year	Average Monthly Flow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 5</b>												
Wet	200	200	200	309	356	272	200	277	200	85	85	150
Above Normal	181	182	188	192	196	196	196	277	200	85	85	150
Below Normal	195	195	195	195	195	195	195	274	191	85	85	150
Dry	175	184	188	190	190	190	190	267	183	85	85	150
Critical Dry	163	167	167	167	167	167	167	214	111	85	85	133
<b>No Action Alternative</b>												
Wet	200	200	200	309	356	272	200	277	200	85	85	150
Above Normal	181	182	188	192	196	196	196	277	200	85	85	150
Below Normal	195	195	195	195	195	195	195	274	191	85	85	150
Dry	177	184	188	190	190	190	190	267	183	85	85	150
Critical Dry	163	167	167	167	167	167	167	214	111	85	85	133
<b>Alternative 5 as Compared to No Action Alternative</b>												
Wet	0	0	0	0	0	0	0	0	0	0	0	0
Above Normal	0	0	0	0	0	0	0	0	0	0	0	0
Below Normal	0	0	0	0	0	0	0	0	0	0	0	0
Dry	2	0	0	0	0	0	0	0	0	0	0	0
Critical Dry	0	0	0	0	0	0	0	0	0	0	0	0
<b>Alternative 5 as Compared to No Action Alternative (percent change)</b>												
Wet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Above Normal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Below Normal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dry	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Critical Dry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0

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*New Melones Reservoir and Stanislaus River*

Storage levels and surface water elevations in New Melones Reservoir under Alternative 5 as compared to the No Action Alternative are summarized in Tables 5.88 and 5.89. Changes in flows in the Stanislaus River downstream of Goodwin Dam are shown on Figures 5.68 through 5.70. The results are summarized following Table 5.89.

1 **Table 5.88 Changes in New Melones Reservoir Storage under Alternative 5 as**  
 2 **Compared to the No Action Alternative**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 5</b>												
Wet	1,309	1,321	1,388	1,496	1,602	1,668	1,704	1,812	1,906	1,833	1,722	1,653
Above Normal	983	1,014	1,079	1,168	1,271	1,361	1,363	1,413	1,396	1,302	1,207	1,162
Below Normal	1,210	1,220	1,242	1,267	1,329	1,354	1,298	1,276	1,254	1,163	1,071	1,028
Dry	1,018	1,018	1,030	1,045	1,081	1,114	1,066	1,031	990	903	823	781
Critical Dry	558	559	570	578	597	591	506	449	433	391	355	336
<b>No Action Alternative</b>												
Wet	1,379	1,390	1,454	1,562	1,666	1,724	1,758	1,878	1,968	1,890	1,773	1,703
Above Normal	1,029	1,060	1,125	1,214	1,317	1,406	1,413	1,484	1,467	1,372	1,277	1,232
Below Normal	1,294	1,305	1,326	1,351	1,413	1,438	1,390	1,383	1,359	1,268	1,175	1,133
Dry	1,094	1,094	1,106	1,121	1,156	1,188	1,154	1,132	1,087	997	914	871
Critical Dry	624	623	638	645	661	656	602	554	526	476	431	408
<b>Alternative 5 as Compared to No Action Alternative</b>												
Wet	-70	-69	-65	-66	-64	-56	-54	-65	-62	-57	-51	-49
Above Normal	-46	-46	-46	-46	-46	-46	-51	-71	-71	-70	-70	-70
Below Normal	-84	-84	-84	-84	-84	-84	-93	-107	-106	-105	-105	-104
Dry	-77	-76	-76	-76	-75	-74	-88	-100	-97	-94	-91	-89
Critical Dry	-66	-64	-68	-66	-64	-65	-95	-105	-93	-84	-76	-73
<b>Alternative 5 as Compared to No Action Alternative (percent change)</b>												
Wet	-5.1	-5.0	-4.5	-4.2	-3.9	-3.2	-3.1	-3.5	-3.2	-3.0	-2.9	-2.9
Above Normal	-4.5	-4.4	-4.1	-3.8	-3.5	-3.3	-3.6	-4.8	-4.8	-5.1	-5.5	-5.7
Below Normal	-6.5	-6.5	-6.4	-6.2	-5.9	-5.8	-6.7	-7.7	-7.8	-8.3	-8.9	-9.2
Dry	-7.0	-7.0	-6.9	-6.8	-6.5	-6.2	-7.6	-8.9	-8.9	-9.4	-10.0	-10.2
Critical Dry	-10.5	-10.3	-10.6	-10.3	-9.8	-9.9	-15.8	-18.9	-17.6	-17.7	-17.7	-17.8

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**Table 5.89 Changes in New Melones Reservoir Elevation under Alternative 5 as Compared to the No Action Alternative**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 5</b>												
Wet	969	971	980	995	1,007	1,016	1,020	1,031	1,040	1,033	1,022	1,015
Above Normal	924	930	939	954	968	980	982	988	987	975	963	890
Below Normal	954	956	959	962	973	977	972	970	968	957	944	938
Dry	930	930	932	934	939	945	940	936	931	918	905	898
Critical Dry	837	838	842	845	853	855	834	818	815	804	796	791
<b>No Action Alternative</b>												
Wet	980	982	990	1,004	1,016	1,023	1,026	1,039	1,047	1,040	1,029	1,022
Above Normal	932	937	945	960	974	986	988	997	996	985	973	897
Below Normal	968	969	972	975	985	988	985	985	983	972	960	955
Dry	943	943	944	947	951	957	955	953	948	934	922	915
Critical Dry	856	856	862	864	870	871	860	848	840	828	818	812
<b>Alternative 5 as Compared to No Action Alternative</b>												
Wet	-11	-11	-10	-9	-8	-7	-7	-7	-7	-7	-6	-6
Above Normal	-8	-7	-6	-6	-6	-6	-6	-8	-8	-9	-10	-7
Below Normal	-13	-13	-13	-13	-12	-12	-13	-15	-15	-15	-16	-16
Dry	-13	-13	-12	-13	-12	-12	-15	-17	-17	-17	-17	-17
Critical Dry	-19	-18	-20	-19	-17	-16	-26	-30	-25	-24	-22	-21
<b>Alternative 5 as Compared to No Action Alternative (percent change)</b>												
Wet	-1.2	-1.2	-1.0	-0.9	-0.8	-0.7	-0.7	-0.7	-0.7	-0.6	-0.6	-0.6
Above Normal	-0.8	-0.7	-0.7	-0.6	-0.6	-0.6	-0.6	-0.8	-0.8	-0.9	-1.0	-0.7
Below Normal	-1.4	-1.4	-1.4	-1.3	-1.2	-1.2	-1.3	-1.5	-1.5	-1.6	-1.7	-1.7
Dry	-1.3	-1.3	-1.3	-1.3	-1.3	-1.2	-1.5	-1.8	-1.8	-1.8	-1.9	-1.9
Critical Dry	-2.2	-2.1	-2.3	-2.2	-2.0	-1.9	-3.0	-3.5	-3.0	-2.9	-2.7	-2.6

- 1 The following changes in New Melones Reservoir storage and elevation would  
2 occur under Alternative 5 as compared to the No Action Alternative.
- 3 • In wet years, storage would be similar in all months.
  - 4 • In above normal years, storage would be similar in October through June and  
5 reduced in July through September (up to 5.7 percent).
  - 6 • In below normal years, storage would be reduced in all months (up to  
7 9.2 percent).
  - 8 • In dry years, storage would be reduced in all months (up to 10.2 percent).
  - 9 • In critical dry years, storage would be reduced in all months (up to  
10 18.9 percent).
  - 11 • In all months, in all water year types, surface water elevations would be  
12 similar.

13 Flows in the Stanislaus River downstream of Goodwin Dam are shown on  
14 Figures 5.68 to 5.70. Changes in flows in these rivers are summarized below.

- 15 • Over long-term conditions, flows would be similar in September through  
16 February and June; reduced flows would occur in March, July, and August (up  
17 to 8.0 percent); and increased flows in April and May (up to 22.4 percent).
- 18 • In wet years, similar flows would occur in October, November, January,  
19 February, and April through June and reduced flows in December, March, and  
20 July through September (up to 18.0 percent).
- 21 • In dry years, similar flows would occur in June through March and increased  
22 flows in April and May (up to 47.3 percent).

23 *San Joaquin River at Vernalis*

24 Flows in the San Joaquin River at Vernalis under Alternative 5 as compared to the  
25 No Action Alternative are summarized below, as shown on Figures 5.71 through  
26 5.73.

- 27 • Over long-term conditions and wet years, similar flows would occur in all  
28 months.
- 29 • In dry years, similar flows would occur in June through March and increased  
30 flows in April and May (up to 15.7 percent).San Luis Reservoir.

31 Storage levels and surface water elevations in San Luis Reservoir under  
32 Alternative 5 as compared to the No Action Alternative are summarized in  
33 Tables 5.90 and 5.91. The results are summarized following Table 5.91.

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**Table 5.90 Changes in San Luis Reservoir Storage under Alternative 5 as Compared to the No Action Alternative**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 5</b>												
Wet	576	706	958	1,251	1,539	1,804	1,624	1,279	984	787	680	726
Above Normal	488	622	932	1,213	1,440	1,660	1,447	1,046	672	477	442	520
Below Normal	541	628	923	1,157	1,335	1,496	1,305	928	524	476	414	463
Dry	464	572	856	1,139	1,327	1,481	1,324	1,002	691	655	412	418
Critical Dry	429	505	698	994	1,166	1,216	1,103	875	600	428	284	270
<b>No Action Alternative</b>												
Wet	555	681	931	1,236	1,526	1,788	1,598	1,251	946	741	628	679
Above Normal	490	649	957	1,223	1,441	1,661	1,444	1,048	666	466	433	513
Below Normal	525	624	907	1,141	1,314	1,473	1,312	967	555	500	426	467
Dry	476	590	867	1,150	1,339	1,494	1,413	1,167	840	763	476	469
Critical Dry	478	556	752	1,040	1,204	1,252	1,192	1,028	739	544	343	323
<b>Alternative 5 as Compared to No Action Alternative</b>												
Wet	20	25	27	15	13	16	26	28	38	46	52	47
Above Normal	-2	-27	-24	-10	-2	-1	3	-2	6	10	8	7
Below Normal	16	4	16	17	21	23	-7	-39	-31	-24	-12	-4
Dry	-12	-18	-11	-11	-12	-13	-89	-165	-149	-107	-64	-51
Critical Dry	-50	-51	-53	-46	-38	-36	-89	-154	-140	-116	-59	-53
<b>Alternative 5 as Compared to No Action Alternative (percent change)</b>												
Wet	7.4	6.9	5.8	1.8	1.2	1.2	2.3	3.5	6.7	8.4	10.0	9.1
Above Normal	1.2	-3.0	-1.4	0.3	1.4	1.1	1.6	0.7	2.3	2.5	2.3	2.0
Below Normal	8.3	4.4	6.8	5.1	3.3	2.9	-0.6	-5.1	-9.2	-9.0	-3.1	-1.3
Dry	-0.4	-1.0	0.6	0.4	0.2	-0.1	-6.5	-14.6	-17.3	-12.7	-13.5	-12.3
Critical Dry	-12.6	-13.9	-10.4	-6.3	-4.3	-3.5	-7.1	-13.0	-15.6	-18.2	-17.6	-16.9

1 **Table 5.91 Changes in San Luis Reservoir Elevation under Alternative 5 as**  
 2 **Compared to the No Action Alternative**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 5</b>												
Wet	402	417	446	475	501	525	509	478	448	427	416	422
Above Normal	391	408	443	471	492	512	494	456	416	390	386	398
Below Normal	399	411	443	467	483	498	481	444	397	390	381	388
Dry	389	404	436	465	483	497	482	451	417	413	381	381
Critical Dry	383	393	417	450	467	471	460	437	405	383	359	357
<b>No Action Alternative</b>												
Wet	399	414	443	473	500	523	507	475	444	422	409	416
Above Normal	391	411	445	472	492	512	493	456	415	389	386	398
Below Normal	397	410	442	465	481	496	481	448	400	393	383	389
Dry	391	406	437	466	484	498	490	468	434	426	390	389
Critical Dry	390	400	423	454	470	475	469	453	422	399	369	366
<b>Alternative 5 as Compared to No Action Alternative</b>												
Wet	3	3	3	1	1	1	2	3	4	5	6	6
Above Normal	0	-3	-2	-1	0	0	0	0	1	1	1	1
Below Normal	2	1	2	2	2	2	-1	-4	-3	-3	-2	-1
Dry	-2	-2	-1	-1	-1	-1	-8	-16	-17	-13	-9	-7
Critical Dry	-7	-7	-6	-4	-3	-3	-9	-16	-18	-16	-10	-9
<b>Alternative 5 as Compared to No Action Alternative (percent change)</b>												
Wet	0.6	0.7	0.6	0.3	0.2	0.3	0.4	0.6	0.9	1.2	1.5	1.3
Above Normal	-0.1	-0.7	-0.5	-0.2	0.0	0.0	0.1	0.0	0.2	0.3	0.2	0.2
Below Normal	0.4	0.2	0.4	0.3	0.4	0.4	-0.1	-0.9	-0.9	-0.7	-0.4	-0.1
Dry	-0.4	-0.5	-0.3	-0.2	-0.2	-0.2	-1.6	-3.5	-3.9	-2.9	-2.3	-1.9
Critical Dry	-1.8	-1.6	-1.4	-0.9	-0.7	-0.7	-1.9	-3.6	-4.2	-4.1	-2.7	-2.4

- 1 The following changes in San Luis Reservoir storage would occur under  
2 Alternative 5 as compared to the No Action Alternative.
- 3 • In wet years, storage would be similar in January through May and increased  
4 in June through December (up to 10.0 percent).
  - 5 • In above-normal years, storage would be similar in all months.
  - 6 • In below-normal years, storage would be similar in November, February  
7 through April, August, and September; reduced in June and July (up to  
8 9.2 percent); and increased in October, December, January, and May (up to  
9 8.3 percent).
  - 10 • In dry years, storage would be similar in October through March and reduced  
11 in April through September (up to 17.3 percent).
  - 12 • In critical dry years, storage would be similar in February and March; and  
13 reduced in April through January (up to 18.2 percent).
  - 14 • Surface water elevations would be similar in all months, in all water years.

15 *Changes in Flows into the Yolo Bypass*

16 Flows from the Sacramento River into the Yolo Bypass at Fremont Weir under  
17 Alternative 5 as compared to the No Action Alternative are summarized in  
18 Table 5.92. The results are summarized following Table 5.92.



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**Table 5.92 Changes in Flows into the Yolo Bypass at Fremont Weir under Alternative 5 as Compared to the No Action Alternative**

Water Year	Average Monthly Flow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 5</b>												
Wet	170	933	8,400	24,048	29,507	18,512	5,627	289	113	0	0	100
Above Normal	100	100	2,786	6,000	12,885	7,895	1,688	100	100	0	0	100
Below Normal	100	100	242	1,004	3,115	886	293	100	100	0	0	100
Dry	100	100	317	896	2,015	1,398	407	100	100	0	0	100
Critical Dry	100	100	151	525	531	393	106	100	100	0	0	100
<b>No Action Alternative</b>												
Wet	183	910	8,420	24,291	29,547	18,493	5,627	289	113	0	0	100
Above Normal	100	100	2,765	5,997	13,013	7,928	1,688	100	100	0	0	100
Below Normal	100	100	242	1,004	3,031	883	293	100	100	0	0	100
Dry	100	100	322	902	2,024	1,393	407	100	100	0	0	100
Critical Dry	100	100	149	528	534	396	106	100	100	0	0	100
<b>Alternative 5 as Compared to No Action Alternative</b>												
Wet	-13	23	-20	-243	-40	18	0	0	0	0	0	0
Above Normal	0	0	22	4	-128	-34	0	0	0	0	0	0
Below Normal	0	0	-1	0	84	3	0	0	0	0	0	0
Dry	0	0	-5	-6	-10	4	0	0	0	0	0	0
Critical Dry	0	0	2	-3	-3	-3	0	0	0	0	0	0
<b>Alternative 5 as Compared to No Action Alternative (percent change)</b>												
Wet	-7.3	2.6	-0.2	-1.0	-0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Above Normal	0.0	0.0	0.8	0.1	-1.0	-0.4	0.0	0.0	0.0	0.0	0.0	0.0
Below Normal	0.0	0.0	-0.2	0.0	2.8	0.4	0.0	0.0	0.0	0.0	0.0	0.0
Dry	0.0	0.0	-1.6	-0.6	-0.5	0.3	0.1	0.0	0.0	0.0	0.0	0.0
Critical Dry	0.0	0.0	1.6	-0.5	-0.6	-0.7	0.0	0.0	0.0	0.0	0.0	0.0

1 Flows from the Sacramento River into Yolo Bypass at Fremont Weir would be  
2 similar under Alternative 5 and the No Action Alternative.

3 *Changes in Delta Conditions*

4 Delta outflow under Alternative 5 as compared to the No Action Alternative are  
5 summarized below and shown on Figures 5.74 through 5.76.

- 6 • In wet years, average monthly Delta outflow would be similar.  
7 • In dry years, average monthly Delta outflow would be similar in July through  
8 April and increased in May and June (up to 1,377 cfs).

9 The OMR conditions under Alternative 5 as compared to the No Action  
10 Alternative are shown on Figures 5.77 through 5.79.

- 11 • Under Alternative 5, OMR flows would be negative except in April and May  
12 of all water year types. Under the No Action Alternative, OMR flows would  
13 be negative except in April and May of wet and above normal years and April  
14 of below normal years.  
15 • In wet years, OMR flows would be more positive or no change in September,  
16 October, January, and April through June (up to 171 cfs) and more negative in  
17 November, December, March, and August (up to 124 cfs).  
18 • In dry years, OMR flows would be more positive or no change in October  
19 through March (up to 1,359 cfs) and more negative in June through September  
20 (up to 568 cfs).

21 *Changes in CVP and SWP Exports and Deliveries*

22 Delta exports under Alternative 5 as compared to the No Action Alternative are  
23 summarized in Table 5.93.

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**Table 5.93 Changes in Exports at Jones and Banks Pumping Plants under Alternative 5 as Compared to the No Action Alternative**

Water Year	Monthly Volume (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 5</b>												
Wet	408	505	564	514	532	592	202	202	444	667	718	627
Above Normal	376	423	561	407	405	496	127	92	315	590	705	625
Below Normal	381	456	588	387	359	397	103	55	208	663	632	561
Dry	370	394	513	392	315	318	80	41	205	577	333	433
Critical Dry	313	293	382	355	249	179	34	20	69	239	222	243
<b>No Action Alternative</b>												
Wet	410	497	564	513	537	594	204	207	445	669	717	638
Above Normal	376	450	562	406	401	496	130	105	315	587	709	628
Below Normal	386	456	590	387	354	394	134	100	209	657	622	542
Dry	374	398	510	392	315	318	153	126	194	541	296	426
Critical Dry	314	293	384	349	250	179	93	90	64	223	176	242
<b>Alternative 5 as Compared to No Action Alternative</b>												
Wet	-2	8	0	0	-5	-2	-2	-5	-1	-1	0	-11
Above Normal	1	-28	-1	1	4	0	-4	-14	0	2	-4	-3
Below Normal	-5	0	-2	0	5	4	-31	-45	-1	6	10	18
Dry	-4	-4	4	0	0	0	-73	-84	11	36	38	8
Critical Dry	-1	0	-2	6	-1	-1	-59	-70	4	17	46	1
<b>Alternative 5 as Compared to No Action Alternative (percent change)</b>												
Wet	-0.6	1.6	0.0	0.1	-0.9	-0.3	-1.0	-2.6	-0.2	-0.2	0.1	-1.8
Above Normal	0.2	-6.1	-0.1	0.3	0.9	0.0	-2.9	-13.0	-0.1	0.4	-0.5	-0.5
Below Normal	-1.3	0.0	-0.4	0.0	1.4	0.9	-23.4	-45.4	-0.3	0.8	1.6	3.4
Dry	-1.1	-1.0	0.7	-0.1	-0.1	0.0	-47.6	-67.0	5.7	6.7	12.8	1.8
Critical Dry	-0.2	0.1	-0.4	1.8	-0.4	-0.4	-63.8	-77.5	6.9	7.6	25.9	0.6

1 The following changes would occur in CVP and SWP exports under Alternative 5  
 2 as compared to the No Action Alternative.

- 3 • Long-term average annual exports would be 45 TAF (1 percent) less under  
 4 Alternative 5 as compared to the No Action Alternative.
- 5 • In wet years, total exports would be similar in all months.
- 6 • In above-normal years, total exports would be similar in June through April  
 7 and reduced in May (13.0 percent).
- 8 • In below-normal years, total exports would be similar in June through March  
 9 and reduced in April and May (up to 45.4 percent).
- 10 • In dry years, total exports would be similar in June, July, and September  
 11 through March; reduced in April and May (up to 67.0 percent); and increased  
 12 in August (12.8 percent).
- 13 • In critical dry years, total exports would be similar in June, July, and  
 14 September through March; reduced in April and May (up to 77.5 percent); and  
 15 increased August (25.9 percent).

16 Deliveries to CVP and SWP water users would be similar under Alternative 5 as  
 17 compared to the No Action Alternative, as summarized in Tables 5.94 and 5.95,  
 18 respectively.

19 **Table 5.94 Changes CVP Water Deliveries under Alternative 5 as Compared to the**  
 20 **No Action Alternative**

Annual Average Deliveries (TAF)					
		Alternative 5	No Action Alternative	Alternative 5 as compared to the No Action Alternative	
				Difference	Percent Change
<b>North of Delta</b>					
CVP Agricultural Water Service Contractors	Long Term	185	185	0	0
	Dry	85	86	0	0
	Critical Dry	24	24	0	0
CVP M&I (Including American River Contractors and Contra Costa Water District)	Long Term	386	386	0	0
	Dry	384	385	0	0
	Critical Dry	384	383	1	0

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Annual Average Deliveries (TAF)					
		Alternative 5	No Action Alternative	Alternative 5 as compared to the No Action Alternative	
				Difference	Percent Change
CVP M&I American River Contractors	Long Term	112	113	0	0
	Dry	96	97	0	0
	Critical Dry	74	75	-1	-1
CVP Sacramento River Settlement Contractors	Long Term	1,861	1,859	2	0
	Dry	1,906	1,906	0	0
	Critical Dry	1,747	1,737	10	1
CVP Refuge Level 2 Deliveries	Long Term	146	146	0	0
	Dry	145	146	0	0
	Critical Dry	103	102	1	1
Total CVP Agricultural, M&I, Sacramento River Settlement Contractors, and Refuge Level 2 Deliveries	Long Term	2,578	2,576	2	0
	Dry	2,520	2,523	-3	0
	Critical Dry	2,258	2,246	12	1
<b>South of Delta (Does not include Eastside Contractors)</b>					
CVP Agricultural Water Service Contractors	Long Term	834	847	-13	-2
	Dry	433	445	-12	-3
	Critical Dry	130	131	-1	-1
CVP M&I Users	Long Term	112	112	0	0
	Dry	100	99	1	1
	Critical Dry	80	80	0	0
San Joaquin River Exchange Contractors	Long Term	852	852	0	0
	Dry	875	875	0	0
	Critical Dry	741	741	0	0

Annual Average Deliveries (TAF)					
		Alternative 5	No Action Alternative	Alternative 5 as compared to the No Action Alternative	
				Difference	Percent Change
CVP Refuge Level 2 Deliveries	Long Term	273	273	0	0
	Dry	281	281	0	0
	Critical Dry	232	234	-2	-1
Total CVP Agricultural, M&I, San Joaquin River Exchange Contractors, and Refuge Level 2 Deliveries	Long Term	2,071	2,084	-13	-1
	Dry	1,689	1,700	-11	-1
	Critical Dry	1,183	1,186	-3	0
<b>Eastside Contractors Deliveries</b>					
Water Rights	Long Term	502	508	-6	-1
	Dry	524	524	0	0
	Critical Dry	406	445	-39	-9
CVP Water Service Contracts	Long Term	100	104	-4	-4
	Dry	69	84	-16	-19
	Critical Dry	8	4	4	100
Total Water Rights and CVP Service Contracts Deliveries	Long Term	602	612	-10	-2
	Dry	593	608	-15	-2
	Critical Dry	414	449	-35	-8

- 1 The following changes in CVP water deliveries would occur under Alternative 5  
2 as compared to the No Action Alternative.
- 3 • Deliveries to CVP North of Delta agricultural water service contractors would  
4 be similar over the long-term conditions and in dry and critical dry years.
  - 5 • Deliveries to CVP North of Delta M&I contractors would be similar over the  
6 long-term conditions and in dry and critical dry years in total and for the  
7 American River CVP contractors.
  - 8 • Deliveries to CVP South of Delta agricultural water service contractors would  
9 be similar over the long-term conditions and in dry and critical dry years.

- 1 • Deliveries to CVP South of Delta M&I contractors would be similar over the
- 2 long-term conditions and in dry and critical dry years.
- 3 • Deliveries to the Eastside contractors would be similar under long-term
- 4 conditions and dry years; and reduced by 8 percent in critical dry years.

5 **Table 5.95 Changes SWP Water Deliveries under the Alternative 5 as Compared to**  
 6 **the No Action Alternative**

Annual Average Deliveries (TAF)					
		Alternative 5	No Action Alternative	Alternative 5 as compared to the No Action Alternative	
				Difference	Percent Change
<b>North of Delta</b>					
SWP Agricultural Uses	Long Term	0	0	0	0
	Dry	0	0	0	0
	Critical Dry	0	0	0	0
SWP M&I (without Article 21)	Long Term	67	68	-1	-2
	Dry	51	51	0	-1
	Critical Dry	42	43	-1	-1
SWP M&I Article 21 Deliveries	Long Term	13	13	0	3
	Dry	14	14	1	4
	Critical Dry	13	13	1	5
Total SWP Agricultural and M&I (without Article 21)	Long Term	67	68	-1	-2
	Dry	51	51	0	-1
	Critical Dry	42	43	-1	-1
Total SWP Agricultural and M&I Article 21 Deliveries	Long Term	13	13	0	3
	Dry	14	14	1	4
	Critical Dry	13	13	1	5

Chapter 5: Surface Water Resources and Water Supplies

Annual Average Deliveries (TAF)					
		Alternative 5	No Action Alternative	Alternative 5 as compared to the No Action Alternative	
				Difference	Percent Change
<b>South of Delta</b>					
SWP Agricultural Users (without Article 21)	Long Term	598	610	-12	-2
	Dry	449	455	-7	-1
	Critical Dry	369	378	-9	-2
SWP Agricultural Article 21 Deliveries	Long Term	24	27	-2	-9
	Dry	6	5	1	20
	Critical Dry	4	7	-3	-43
SWP M&I Users (without Article 21)	Long Term	1,784	1,800	-15	-1
	Dry	1,397	1,406	-9	-1
	Critical Dry	1,157	1,173	-16	-1
SWP M&I Article 21 Deliveries	Long Term	19	20	-1	-7
	Dry	5	5	0	4
	Critical Dry	3	5	-2	-37
Total SWP Agricultural and M&I Users (without Article 21)	Long Term	2,383	2,410	-27	-1
	Dry	1,845	1,861	-15	-1
	Critical Dry	1,526	1,551	-25	-2
Total SWP Agricultural and M&I Article 21 Deliveries	Long Term	43	47	-4	-8
	Dry	11	10	1	12
	Critical Dry	7	12	-5	-41



1 The following changes in SWP water deliveries would occur under Alternative 5  
2 as compared to the No Action Alternative.

- 3 • Deliveries without Article 21 water to SWP North of Delta water contractors  
4 would be similar over the long-term conditions and in dry and critical dry  
5 years.
- 6 • Deliveries without Article 21 water to SWP South of Delta water contractors  
7 would be similar over the long-term conditions and in dry and critical dry  
8 years.
- 9 • Deliveries of Article 21 water to SWP North of Delta water contractors would  
10 be similar over the long-term conditions and in dry and critical dry years.
- 11 • Deliveries of Article 21 water to SWP South of Delta water contractors would  
12 be reduced by 8 percent over the long-term conditions and 41 percent in  
13 critical dry years; and increased by 12 percent in dry years.

14 *Effects Related to Cross Delta Water Transfers*

15 Potential effects to surface water resources could be similar to those identified in  
16 a recent environmental analysis conducted by Reclamation for long-term water  
17 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014i).

18 Potential effects were identified as reduced surface water storage in upstream  
19 reservoirs and changes in flow patterns in river downstream of the reservoirs if  
20 water was released from the reservoirs in patterns that were different than would  
21 have been used by the water seller's. Because all water transfers would be  
22 required to avoid adverse impacts to other water users and biological resources  
23 (see Section 3.A.6.3, Transfers), including impacts associated with changes in  
24 reservoir storage and river flow patterns, the analysis indicated that water  
25 transfers would not result in substantial changes in storage or river flows. For the  
26 purposes of this EIS, it is anticipated that similar conditions would occur due to  
27 cross Delta water transfers under Alternative 5 and the No Action Alternative.

28 Under Alternative 5 and the No Action Alternative, the timing of cross Delta  
29 water transfers would be limited to July through September, and the volume  
30 would be limited to 600,000 acre-feet per year in drier years and 360,000 acre-  
31 feet in all other years, in accordance with the 2008 USFWS BO and 2009 NMFS  
32 BO. As indicated in Table 5.93, capacity would be available under the No Action  
33 Alternative between July and September for water transfers in all water year  
34 types.

35 Overall, the potential for water transfer conveyance would be similar under  
36 Alternative 5 as compared to the No Action Alternative.

37 *San Francisco Bay Area, Central Coast, and Southern California Regions*

38 *Potential Changes in Surface Water Resources at Reservoirs that Store CVP*  
39 *and SWP Water*

40 The San Francisco Bay Area, Central Coast, and Southern California regions  
41 include numerous reservoirs that store CVP and SWP water supplies, including  
42 CVP and SWP reservoirs, that primarily provide water supplies for M&I water

1 users. Changes in the availability CVP and SWP water supplies for storage in  
2 these reservoirs under Alternative 5 as compared to the No Action  
3 Alternative would be consistent with the following changes in water deliveries to  
4 M&I water users, as summarized in Tables 5.94 and 5.95.

- 5 • Deliveries to CVP South of Delta M&I contractors would be similar over the  
6 long-term conditions and in dry and critical dry years.
- 7 • Deliveries without Article 21 water to SWP South of Delta water contractors  
8 would be similar over the long-term conditions and in dry and critical dry  
9 years.
- 10 • Deliveries of Article 21 water to SWP South of Delta water contractors would  
11 be reduced by 8 percent over the long-term conditions and 41 percent in  
12 critical dry years; and increased by 12 percent in dry years.

13 *Changes in CVP and SWP Exports and Deliveries*

14 Deliveries to CVP and SWP water users are described above in the Central Valley  
15 Region.

16 **5.4.3.6.2 Alternative 5 Compared to the Second Basis of Comparison**

17 *Trinity River Region*

18 *Changes in CVP and SWP Reservoir Storage and Downstream River Flows*

19 Changes in Trinity Lake storage and surface water elevations under Alternative 5  
20 as compared to the Second Basis of Comparison are summarized in Tables 5.96  
21 and 5.97. The results are summarized following Table 5.97.

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**Table 5.96 Changes in Trinity Lake Storage under Alternative 5 as Compared to the Second Basis of Comparison**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 5</b>												
Wet	1,494	1,520	1,635	1,759	1,926	2,056	2,222	2,246	2,191	2,068	1,940	1,781
Above Normal	1,155	1,180	1,290	1,459	1,662	1,850	2,030	2,004	1,912	1,778	1,627	1,503
Below Normal	1,398	1,405	1,422	1,493	1,580	1,667	1,813	1,741	1,637	1,474	1,311	1,190
Dry	1,155	1,150	1,175	1,183	1,275	1,404	1,540	1,492	1,415	1,259	1,110	1,012
Critical Dry	744	726	741	743	784	866	913	878	856	755	622	539
<b>Second Basis of Comparison</b>												
Wet	1,501	1,535	1,644	1,767	1,931	2,055	2,224	2,250	2,194	2,068	1,939	1,805
Above Normal	1,208	1,245	1,363	1,524	1,718	1,901	2,079	2,053	1,955	1,815	1,647	1,513
Below Normal	1,451	1,472	1,492	1,554	1,641	1,729	1,872	1,799	1,696	1,515	1,337	1,204
Dry	1,178	1,184	1,210	1,230	1,322	1,453	1,586	1,536	1,466	1,302	1,152	1,055
Critical Dry	819	803	813	825	868	949	999	962	929	811	667	598
<b>Alternative 5 as Compared to Second Basis of Comparison</b>												
Wet	-7	-16	-9	-8	-5	1	-2	-3	-3	0	1	-23
Above Normal	-53	-65	-73	-65	-56	-51	-49	-49	-43	-37	-20	-11
Below Normal	-54	-67	-69	-61	-62	-62	-59	-58	-60	-40	-26	-14
Dry	-23	-35	-35	-48	-47	-48	-46	-45	-51	-42	-42	-43
Critical Dry	-75	-77	-72	-82	-84	-84	-86	-84	-73	-56	-45	-59
<b>Alternative 5 as Compared to Second Basis of Comparison (percent change)</b>												
Wet	-0.5	-1.0	-0.5	-0.4	-0.3	0.0	-0.1	-0.2	-0.1	0.0	0.0	-1.3
Above Normal	-4.4	-5.2	-5.3	-4.3	-3.3	-2.7	-2.4	-2.4	-2.2	-2.0	-1.2	-0.7
Below Normal	-3.7	-4.6	-4.7	-3.9	-3.7	-3.6	-3.2	-3.2	-3.5	-2.7	-1.9	-1.2
Dry	-2.0	-3.0	-2.9	-3.9	-3.5	-3.3	-2.9	-2.9	-3.5	-3.3	-3.6	-4.1
Critical Dry	-9.1	-9.6	-8.8	-10.0	-9.6	-8.8	-8.6	-8.8	-7.9	-6.9	-6.7	-9.8

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**Table 5.97 Changes in Trinity Lake Elevation under Alternative 5 as Compared to the Second Basis of Comparison**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 5</b>												
Wet	2,300	2,303	2,313	2,325	2,338	2,347	2,357	2,358	2,355	2,347	2,338	2,326
Above Normal	2,259	2,262	2,276	2,294	2,314	2,330	2,343	2,342	2,335	2,326	2,313	2,303
Below Normal	2,289	2,290	2,292	2,299	2,308	2,315	2,326	2,321	2,313	2,299	2,284	2,272
Dry	2,263	2,265	2,268	2,269	2,279	2,292	2,305	2,301	2,294	2,279	2,265	2,254
Critical Dry	2,209	2,206	2,209	2,212	2,220	2,234	2,241	2,237	2,235	2,221	2,199	2,183
<b>Second Basis of Comparison</b>												
Wet	2,301	2,305	2,314	2,325	2,339	2,347	2,357	2,358	2,355	2,347	2,338	2,328
Above Normal	2,270	2,273	2,286	2,303	2,320	2,335	2,347	2,346	2,339	2,329	2,315	2,304
Below Normal	2,295	2,296	2,298	2,305	2,313	2,320	2,331	2,326	2,318	2,303	2,287	2,274
Dry	2,266	2,269	2,272	2,274	2,284	2,296	2,309	2,304	2,298	2,284	2,269	2,259
Critical Dry	2,218	2,216	2,217	2,222	2,229	2,243	2,250	2,246	2,243	2,227	2,204	2,191
<b>Alternative 5 as Compared to Second Basis of Comparison</b>												
Wet	-1	-2	-1	-1	0	0	0	0	0	0	0	-2
Above Normal	-10	-11	-11	-9	-7	-5	-4	-4	-4	-3	-2	-1
Below Normal	-5	-6	-6	-5	-5	-5	-5	-5	-5	-3	-3	-2
Dry	-2	-3	-3	-5	-4	-4	-4	-4	-4	-4	-5	-5
Critical Dry	-9	-9	-8	-9	-9	-9	-9	-9	-8	-6	-5	-8
<b>Alternative 5 as Compared to Second Basis of Comparison (percent change)</b>												
Wet	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
Above Normal	-0.5	-0.5	-0.5	-0.4	-0.3	-0.2	-0.2	-0.2	-0.2	-0.1	-0.1	0.0
Below Normal	-0.2	-0.3	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.1	-0.1
Dry	-0.1	-0.1	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Critical Dry	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.3	-0.2	-0.4

1 The following changes in Trinity Lake storage and surface water elevations would  
2 occur under Alternative 5 as compared to the Second Basis of Comparison.

- 3 • In wet, below normal, and dry years, storage would be similar.
- 4 • In above normal years, storage would be similar in January through October  
5 and reduced in November and December (up to 5.3 percent).
- 6 • In critical dry years, storage would be reduced in all months (up to  
7 10.0 percent).
- 8 • In all months, in all water year types, surface water elevations would be  
9 similar.

10 The following changes would occur on the Trinity River under Alternative 5 as  
11 compared to the Second Basis of Comparison, as summarized on Figures 5.53  
12 through 5.55.

- 13 • Over long-term conditions, flows would be similar in March through  
14 November and January and reduced in December and February (up to  
15 9.6 percent).
- 16 • In wet years, flows would be similar in January and April through November  
17 and reduced in December, February, and March (up to 13.9 percent).
- 18 • In dry years, flows would be similar in all months.

19 *Central Valley Region*

20 *Changes in CVP and SWP Reservoir Storage and Downstream River Flows*

21 *Shasta Lake and Sacramento River*

22 Storage levels and surface water elevations in Shasta Lake under Alternative 5 as  
23 compared to the Second Basis of Comparison are summarized in Tables 5.98 and  
24 5.99. Changes in flows in the Sacramento River downstream of Keswick Dam  
25 and at Freeport are shown on Figures 5.56 through 5.61. The results are  
26 summarized following Table 5.99.

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**Table 5.98 Changes in Shasta Lake Storage under Alternative 5 as Compared to the Second Basis of Comparison**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 5</b>												
Wet	2,704	2,716	3,078	3,385	3,590	3,836	4,299	4,461	4,243	3,736	3,410	2,989
Above Normal	2,369	2,388	2,598	3,164	3,454	4,019	4,401	4,430	4,042	3,409	3,071	2,842
Below Normal	2,603	2,565	2,704	3,077	3,450	3,820	4,039	3,970	3,602	3,012	2,663	2,620
Dry	2,344	2,287	2,433	2,627	3,039	3,509	3,745	3,699	3,315	2,787	2,497	2,459
Critical Dry	1,676	1,611	1,700	1,856	2,015	2,258	2,203	2,104	1,749	1,246	958	910
<b>Second Basis of Comparison</b>												
Wet	2,817	2,926	3,154	3,406	3,597	3,841	4,301	4,453	4,228	3,733	3,362	3,252
Above Normal	2,499	2,578	2,808	3,313	3,515	4,038	4,416	4,417	3,979	3,347	2,975	2,921
Below Normal	2,826	2,846	2,977	3,299	3,646	3,966	4,164	4,042	3,599	3,010	2,601	2,574
Dry	2,409	2,431	2,578	2,755	3,168	3,644	3,861	3,774	3,333	2,800	2,539	2,496
Critical Dry	1,873	1,826	1,911	2,050	2,222	2,460	2,386	2,270	1,861	1,409	1,151	1,086
<b>Alternative 5 as Compared to Second Basis of Comparison</b>												
Wet	-114	-211	-76	-21	-8	-5	-2	7	15	3	48	-263
Above Normal	-130	-190	-210	-149	-62	-19	-15	13	63	62	97	-79
Below Normal	-224	-281	-273	-221	-196	-146	-125	-72	3	1	62	45
Dry	-64	-144	-145	-129	-129	-135	-116	-75	-18	-13	-41	-38
Critical Dry	-197	-215	-211	-194	-207	-202	-183	-166	-111	-163	-193	-176
<b>Alternative 5 as Compared to Second Basis of Comparison (percent change)</b>												
Wet	-4.0	-7.2	-2.4	-0.6	-0.2	-0.1	0.0	0.2	0.4	0.1	1.4	-8.1
Above Normal	-5.2	-7.4	-7.5	-4.5	-1.8	-0.5	-0.3	0.3	1.6	1.8	3.3	-2.7
Below Normal	-7.9	-9.9	-9.2	-6.7	-5.4	-3.7	-3.0	-1.8	0.1	0.0	2.4	1.8
Dry	-2.7	-5.9	-5.6	-4.7	-4.1	-3.7	-3.0	-2.0	-0.5	-0.5	-1.6	-1.5
Critical Dry	-10.5	-11.8	-11.0	-9.5	-9.3	-8.2	-7.7	-7.3	-6.0	-11.5	-16.8	-16.2

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**Table 5.99 Changes in Shasta Lake Elevation under Alternative 5 as Compared to the Second Basis of Comparison**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 5</b>												
Wet	991	992	1,008	1,023	1,031	1,041	1,058	1,064	1,056	1,037	1,024	1,005
Above Normal	967	968	982	1,012	1,025	1,048	1,062	1,063	1,049	1,024	1,009	999
Below Normal	987	985	992	1,009	1,025	1,040	1,048	1,045	1,031	1,006	990	988
Dry	969	967	975	986	1,006	1,027	1,037	1,035	1,019	996	982	980
Critical Dry	925	921	928	938	950	967	965	959	937	899	874	869
<b>Second Basis of Comparison</b>												
Wet	997	1,002	1,012	1,024	1,032	1,041	1,058	1,063	1,055	1,037	1,022	1,017
Above Normal	974	978	992	1,019	1,028	1,048	1,062	1,062	1,046	1,021	1,005	1,003
Below Normal	997	998	1,004	1,019	1,034	1,046	1,053	1,049	1,031	1,006	987	986
Dry	972	974	982	992	1,012	1,032	1,041	1,038	1,020	997	984	982
Critical Dry	938	935	941	950	961	977	974	967	943	910	889	884
<b>Alternative 5 as Compared to Second Basis of Comparison</b>												
Wet	-6	-10	-4	-1	0	0	0	0	1	0	2	-12
Above Normal	-7	-10	-10	-7	-3	-1	-1	0	2	3	4	-4
Below Normal	-10	-13	-12	-10	-8	-6	-5	-3	0	0	3	2
Dry	-3	-7	-7	-6	-6	-5	-4	-3	-1	-1	-3	-2
Critical Dry	-13	-14	-14	-12	-11	-10	-9	-8	-5	-11	-15	-14
<b>Alternative 5 as Compared to Second Basis of Comparison (percent change)</b>												
Wet	-0.6	-1.0	-0.4	-0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.2	-1.2
Above Normal	-0.7	-1.0	-1.0	-0.7	-0.3	-0.1	-0.1	0.0	0.2	0.3	0.4	-0.4
Below Normal	-1.0	-1.3	-1.2	-0.9	-0.8	-0.6	-0.4	-0.3	0.0	0.0	0.3	0.2
Dry	-0.3	-0.7	-0.7	-0.6	-0.6	-0.5	-0.4	-0.3	-0.1	-0.1	-0.3	-0.2
Critical Dry	-1.4	-1.5	-1.4	-1.3	-1.1	-1.0	-0.9	-0.9	-0.5	-1.2	-1.7	-1.6

- 1 The following changes in Shasta Lake storage and surface water elevation would  
2 occur under Alternative 5 as compared to the Second Basis of Comparison.
- 3 • In wet years, storage would be similar in October and December through  
4 August and reduced in November and September (up to 8.1 percent).
  - 5 • In above normal years, storage would be similar in February through  
6 September and reduced in October through December (up to 7.5 percent).
  - 7 • In below normal years, storage would be similar in March through September  
8 and reduced in October through February (up to 9.9 percent).
  - 9 • In dry years, storage would be similar in January through October and reduced  
10 in November through December (up to 5.9 percent).
  - 11 • In critical dry years, storage would be reduced in all months (up to  
12 16.8 percent).
  - 13 • In all months, in all water year types, surface water elevations are similar.
- 14 The following changes in Sacramento River flows would occur under  
15 Alternative 5 as compared to the Second Basis of Comparison, as shown on  
16 Figures 5.56 through 5.61.
- 17 • Sacramento River downstream of Keswick Dam (Figures 5.56 through 5.58).
    - 18 – Over long-term conditions, flows would be similar in July, August,  
19 October, and February through April; reduced in December, January, May  
20 and June (up to 8.2 percent); and increased in September and November  
21 (up to 38.5 percent).
    - 22 – In wet years, flows would be similar in January through July; reduced in  
23 December and August (up to 15.0 percent); and increased in September  
24 through November (up to 77.3 percent).
    - 25 – In dry years, similar flows would occur in July through October and  
26 December through March; reduced in April through June (up to  
27 10.1 percent); and increased flows in November (32.1 percent).
  - 28 • Sacramento River near Freeport (near the northern boundary of the Delta)  
29 (Figures 5.59 through 5.61).
    - 30 – Over long-term conditions, flows would be similar in October and  
31 December through April; reduced in May and June (up to 11.5 percent);  
32 and increased in July through September and November (43.4 percent).
    - 33 – In wet years, flows would be similar in October and January through June;  
34 reduced in December (6.2 percent); and increased in July through  
35 September and November (up to 89.0 percent).
    - 36 – In dry years, similar flows would occur in August through October and  
37 December through April; reduced in May and June (up to 13.6 percent);  
38 and increased flows in July and November (up to 19.3 percent).



*Lake Oroville and Feather River*

Storage levels and surface water elevations in Lake Oroville under Alternative 5 as compared to the Second Basis of Comparison are summarized in Tables 5.100 and 5.101. Changes in flows in the Feather River downstream of Thermalito Complex are shown on Figures 5.62 through 5.64. The results are summarized following Table 5.101.

**Table 5.100 Changes in Lake Oroville Storage under Alternative 5 as Compared to the Second Basis of Comparison**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 5</b>												
Wet	1,681	1,723	2,179	2,556	2,833	2,942	3,300	3,488	3,447	2,961	2,613	2,103
Above Normal	1,275	1,310	1,471	1,948	2,512	2,892	3,247	3,401	3,241	2,608	2,125	1,668
Below Normal	1,552	1,507	1,517	1,728	2,132	2,406	2,663	2,746	2,569	1,959	1,521	1,305
Dry	1,223	1,173	1,190	1,319	1,595	1,952	2,193	2,255	1,992	1,502	1,295	1,150
Critical Dry	1,102	1,037	1,025	1,114	1,229	1,383	1,415	1,411	1,266	1,045	929	873
<b>Second Basis of Comparison</b>												
Wet	1,936	1,984	2,354	2,636	2,871	2,942	3,300	3,477	3,402	2,976	2,728	2,569
Above Normal	1,465	1,523	1,702	2,173	2,648	2,937	3,271	3,357	3,081	2,493	2,087	1,827
Below Normal	1,823	1,783	1,831	2,037	2,361	2,627	2,875	2,836	2,461	1,930	1,637	1,424
Dry	1,371	1,324	1,344	1,473	1,764	2,120	2,363	2,357	2,031	1,688	1,427	1,261
Critical Dry	1,117	1,044	1,041	1,125	1,235	1,406	1,423	1,407	1,219	1,027	911	839
<b>Alternative 5 as Compared to Second Basis of Comparison</b>												
Wet	-255	-261	-175	-81	-38	0	0	10	45	-15	-115	-466
Above Normal	-190	-213	-231	-225	-136	-44	-24	44	159	115	37	-159
Below Normal	-271	-275	-314	-309	-228	-220	-212	-90	109	28	-116	-118
Dry	-148	-151	-153	-155	-169	-168	-170	-102	-39	-186	-132	-111
Critical Dry	-15	-7	-17	-11	-7	-23	-8	4	47	19	18	34
<b>Alternative 5 as Compared to Second Basis of Comparison (percent change)</b>												
Wet	-13.1	-13.1	-7.4	-3.1	-1.3	0.0	0.0	0.3	1.3	-0.5	-4.2	-18.1
Above Normal	-13.0	-14.0	-13.6	-10.4	-5.1	-1.5	-0.7	1.3	5.2	4.6	1.8	-8.7
Below Normal	-14.9	-15.4	-17.1	-15.1	-9.7	-8.4	-7.4	-3.2	4.4	1.5	-7.1	-8.3
Dry	-10.8	-11.4	-11.4	-10.5	-9.6	-7.9	-7.2	-4.3	-1.9	-11.0	-9.2	-8.8
Critical Dry	-1.4	-0.6	-1.6	-0.9	-0.5	-1.6	-0.6	0.3	3.8	1.8	2.0	4.1

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**Table 5.101 Changes in Lake Oroville Elevation under Alternative 5 as Compared to the Second Basis of Comparison**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 5</b>												
Wet	742	746	793	829	852	859	884	897	894	860	835	789
Above Normal	698	701	720	775	827	856	880	891	880	836	795	747
Below Normal	731	726	728	752	794	818	839	845	831	777	730	704
Dry	691	685	688	706	738	777	799	804	779	727	703	685
Critical Dry	676	668	665	679	694	712	716	715	696	667	650	642
<b>Second Basis of Comparison</b>												
Wet	768	773	810	837	854	859	884	896	891	861	844	831
Above Normal	717	723	745	796	838	859	882	888	869	826	790	763
Below Normal	757	752	757	779	812	834	854	852	823	775	743	719
Dry	706	701	705	721	755	791	814	813	784	748	718	698
Critical Dry	677	668	668	680	694	715	716	714	691	664	647	636
<b>Alternative 5 as Compared to Second Basis of Comparison</b>												
Wet	-26	-26	-16	-7	-3	0	0	1	3	-1	-9	-42
Above Normal	-19	-22	-25	-21	-11	-3	-2	3	11	10	5	-17
Below Normal	-26	-26	-29	-27	-19	-16	-15	-7	8	2	-13	-14
Dry	-15	-16	-16	-16	-17	-15	-14	-9	-5	-22	-15	-13
Critical Dry	-1	0	-2	-1	-1	-3	-1	1	5	4	3	6
<b>Alternative 5 as Compared to Second Basis of Comparison (percent change)</b>												
Wet	-3.3	-3.4	-2.0	-0.9	-0.3	0.0	0.0	0.1	0.3	-0.1	-1.0	-5.1
Above Normal	-2.7	-3.1	-3.4	-2.7	-1.3	-0.4	-0.2	0.3	1.3	1.2	0.6	-2.2
Below Normal	-3.4	-3.4	-3.8	-3.4	-2.3	-1.9	-1.8	-0.8	1.0	0.3	-1.8	-2.0
Dry	-2.1	-2.2	-2.3	-2.2	-2.2	-1.9	-1.7	-1.2	-0.7	-2.9	-2.2	-1.9
Critical Dry	-0.2	0.0	-0.3	-0.2	-0.1	-0.4	-0.1	0.1	0.8	0.6	0.5	0.9

1 The following changes in Lake Oroville storage and surface water elevation  
2 would occur under Alternative 5 as compared to the Second Basis of Comparison.

- 3 • In wet years, storage would be similar in January through August and reduced  
4 in September through December (up to 18.1 percent).
- 5 • In above-normal years, storage would be similar in March through August and  
6 reduced in September through February (up to 14.0 percent).
- 7 • In below-normal years, storage would be similar in May through July and  
8 reduced in August through April (up to 17.1 percent).
- 9 • In dry years, storage would be similar in May and June and reduced in July  
10 through April (up to 11.4 percent).
- 11 • In critical dry years, storage would be similar in all months.
- 12 • Surface water elevations would be similar in all months, in all years.

13 The following changes in Feather River flows would occur under Alternative 5 as  
14 compared to the No Action Alternative, as shown on Figures 5.62 through 5.64.

- 15 • Over long-term conditions, similar flows would occur in November and April;  
16 reduced flows in October, December through March, May, and June (up to  
17 27.7 percent); and increased flows in July through September (up to  
18 76.2 percent).
- 19 • In wet years, similar flows would occur in October, November, March  
20 through May; reduced flows in December through February and June (up to  
21 25.6 percent); and increased flows in July through September (up to  
22 181.9 percent).
- 23 • In dry years, similar flows would occur in November through April; reduced  
24 flows in October, May, June, August, and September (up to 45.4 percent); and  
25 increased flows in July (60.4 percent).

26 *Folsom Lake and American River*

27 Storage levels and surface water elevations in Folsom Lake under Alternative 5 as  
28 compared to the Second Basis of Comparison are summarized in Tables 5.102  
29 and 5.103. Changes in flows in the American River downstream of Nimbus Dam  
30 are shown on Figures 5.65 through 5.67. The results are summarized below  
31 following 5.103.

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**Table 5.102 Changes in Folsom Lake Storage under Alternative 5 as Compared to the Second Basis of Comparison**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 5</b>												
Wet	454	435	515	518	515	632	785	952	941	794	710	577
Above Normal	375	379	428	513	532	640	787	946	888	622	554	478
Below Normal	440	425	461	483	534	620	758	845	783	523	469	450
Dry	397	386	411	426	479	579	691	766	664	489	435	410
Critical Dry	325	304	314	320	367	433	483	499	411	324	257	231
<b>Second Basis of Comparison</b>												
Wet	483	470	522	524	515	632	785	951	937	793	688	646
Above Normal	390	412	467	537	538	640	787	946	857	591	522	485
Below Normal	506	489	502	514	541	626	761	847	739	475	408	387
Dry	405	399	423	437	486	585	698	769	664	486	432	408
Critical Dry	339	317	323	325	369	436	469	482	430	352	288	258
<b>Alternative 5 as Compared to Second Basis of Comparison</b>												
Wet	-29	-35	-8	-6	0	0	0	0	4	1	23	-69
Above Normal	-16	-34	-39	-24	-6	0	0	1	30	32	32	-7
Below Normal	-66	-65	-41	-31	-7	-7	-3	-2	44	49	60	63
Dry	-9	-13	-12	-12	-7	-5	-7	-3	0	4	3	2
Critical Dry	-14	-12	-9	-5	-2	-3	14	17	-19	-28	-31	-27
<b>Alternative 5 as Compared to Second Basis of Comparison (percent change)</b>												
Wet	-6.0	-7.4	-1.5	-1.2	0.0	0.0	0.0	0.0	0.5	0.1	-6.0	-7.4
Above Normal	-4.0	-8.2	-8.3	-4.4	-1.2	0.0	0.0	0.1	3.5	5.4	-4.0	-8.2
Below Normal	-13.0	-13.2	-8.2	-6.1	-1.4	-1.1	-0.4	-0.2	5.9	10.2	-13.0	-13.2
Dry	-2.2	-3.2	-2.9	-2.7	-1.4	-0.9	-1.0	-0.4	0.0	0.8	-2.2	-3.2
Critical Dry	-4.1	-3.8	-2.8	-1.5	-0.6	-0.7	3.0	3.5	-4.5	-8.0	-4.1	-3.8

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**Table 5.103 Changes in Folsom Lake Elevation under Alternative 5 as Compared to the Second Basis of Comparison**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 5</b>												
Wet	409	407	418	418	418	432	448	465	464	449	440	425
Above Normal	394	395	405	418	420	433	449	464	458	431	423	413
Below Normal	406	405	410	413	420	431	445	454	447	417	411	408
Dry	400	400	404	406	413	426	438	446	435	413	406	403
Critical Dry	386	384	389	390	396	406	412	414	400	385	370	365
<b>Second Basis of Comparison</b>												
Wet	412	412	419	419	418	432	448	465	464	449	438	433
Above Normal	397	400	410	421	421	433	448	465	456	427	419	414
Below Normal	415	414	416	417	421	432	446	455	443	410	401	398
Dry	401	401	405	407	414	427	439	446	435	413	406	403
Critical Dry	389	386	390	391	397	406	410	411	404	391	378	372
<b>Alternative 5 as Compared to Second Basis of Comparison</b>												
Wet	-4	-5	-1	-1	0	0	0	-1	0	0	3	-8
Above Normal	-3	-6	-5	-3	-1	0	0	-1	3	4	4	-1
Below Normal	-9	-9	-6	-4	-1	-1	0	-1	5	7	10	10
Dry	-1	-1	-1	-2	-1	-1	-1	-1	0	0	0	0
Critical Dry	-3	-3	-2	-1	0	0	2	2	-3	-6	-8	-7
<b>Alternative 5 as Compared to Second Basis of Comparison (percent change)</b>												
Wet	-0.8	-1.1	-0.2	-0.2	0.0	0.0	0.0	-0.2	-0.1	0.0	0.6	-1.9
Above Normal	-0.7	-1.4	-1.3	-0.7	-0.2	0.0	0.0	-0.1	0.6	0.9	0.9	-0.2
Below Normal	-2.3	-2.2	-1.4	-1.0	-0.2	-0.2	-0.1	-0.2	1.0	1.8	2.4	2.5
Dry	-0.2	-0.4	-0.4	-0.4	-0.2	-0.2	-0.2	-0.1	-0.1	0.0	-0.1	-0.1
Critical Dry	-0.7	-0.7	-0.4	-0.2	0.0	-0.1	0.4	0.5	-0.8	-1.6	-2.0	-1.8

1 The following changes in Folsom Lake storage and surface water elevation would  
2 occur under Alternative 5 as compared to the Second Basis of Comparison.

- 3 • In wet years, storage would be similar in December through July and reduced  
4 in August through November (up to 7.4 percent).
- 5 • In above normal years, storage would be similar in January through June,  
6 August, and October; reduced in September, November, and December (up to  
7 8.3 percent); and increased in July (5.4 percent).
- 8 • In below normal years, storage would be similar in February through May;  
9 reduced in August through January (up to 13.2 percent); and increased in June  
10 and July (up to 10.2 percent).
- 11 • In dry years, storage would be similar in all months.
- 12 • In critical dry years, storage would be similar in August and June and reduced  
13 in July (8.0 percent).
- 14 • Surface water elevations would be similar in all months, in all years.

15 The following changes in American River flows would occur under Alternative 5  
16 as compared to the Second Basis of Comparison, as shown on Figures 5.62  
17 through 5.64.

- 18 • Over long-term conditions, similar flows would occur in November through  
19 July; reduced flows in August (5.8 percent) and increased in September and  
20 October (42.4 percent).
- 21 • In wet years, similar flows would occur in October, November, and January  
22 through July; reduced flows in December and August (up to 13.7 percent);  
23 and increased flows in September (88.2 percent).
- 24 • In dry years, similar flows would occur in November through September and  
25 increased flows in October (16.7 percent).

#### 26 *Clear Creek*

27 Changes in flows in Clear Creek downstream of Whiskeytown Dam are  
28 summarized in Table 5.104.

29 Monthly Clear Creek flows under Alternative 5 as compared to the Second Basis  
30 of Comparison are identical except in May. In May, under Alternative 5, flows  
31 are up to 40.7 percent higher than under the Second Basis of Comparison.

1 **Table 5.104 Changes in Clear Creek Flows below Whiskeytown Dam under**  
 2 **Alternative 5 as Compared to the Second Basis of Comparison**

Water Year	Average Monthly Flow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 5</b>												
Wet	200	200	200	309	356	272	200	277	200	85	85	150
Above Normal	181	182	188	192	196	196	196	277	200	85	85	150
Below Normal	195	195	195	195	195	195	195	274	191	85	85	150
Dry	177	184	188	190	190	190	190	267	183	85	85	150
Critical Dry	163	167	167	167	167	167	167	214	111	85	85	133
<b>Second Basis of Comparison</b>												
Wet	200	200	200	309	356	272	200	200	200	85	85	150
Above Normal	181	182	188	192	196	196	196	200	200	85	85	150
Below Normal	195	195	195	195	195	195	195	195	191	85	85	150
Dry	178	184	188	190	190	190	190	190	183	85	85	150
Critical Dry	163	167	167	167	167	167	167	167	111	85	85	133
<b>Alternative 5 as Compared to Second Basis of Comparison</b>												
Wet	0	0	0	0	0	0	0	77	0	0	0	0
Above Normal	0	0	0	0	0	0	0	77	0	0	0	0
Below Normal	0	0	0	0	0	0	0	78	0	0	0	0
Dry	-1	0	0	0	0	0	0	77	0	0	0	0
Critical Dry	0	0	0	0	0	0	0	47	0	0	0	0
<b>Alternative 5 as Compared to Second Basis of Comparison (percent change)</b>												
Wet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.7	0.0	0.0	0.0	0.0
Above Normal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.7	0.0	0.0	0.0	0.0
Below Normal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40.1	0.0	0.0	0.0	0.0
Dry	-0.3	0.0	0.0	0.0	0.0	0.0	0.0	40.7	0.0	0.0	0.0	0.0
Critical Dry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.3	0.0	0.0	0.1	0.0

3 *New Melones Reservoir and Stanislaus River*  
 4 Storage levels and surface water elevations in New Melones Reservoir under  
 5 Alternative 5 as compared to the Second Basis of Comparison are summarized in  
 6 Tables 5.105 and 5.106. Changes in flows in the Stanislaus River downstream of  
 7 Goodwin Dam are shown on Figures 5.68 through 5.70. The results are  
 8 summarized following Table 5.106.

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**Table 5.105 Changes in New Melones Reservoir Storage under Alternative 5 as Compared to the Second Basis of Comparison**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 5</b>												
Wet	1,309	1,321	1,388	1,496	1,602	1,668	1,704	1,812	1,906	1,833	1,722	1,653
Above Normal	983	1,014	1,079	1,168	1,271	1,361	1,363	1,413	1,396	1,302	1,207	1,162
Below Normal	1,210	1,220	1,242	1,267	1,329	1,354	1,298	1,276	1,254	1,163	1,071	1,028
Dry	1,018	1,018	1,030	1,045	1,081	1,114	1,066	1,031	990	903	823	781
Critical Dry	558	559	570	578	597	591	506	449	433	391	355	336
<b>Second Basis of Comparison</b>												
Wet	1,443	1,446	1,502	1,606	1,709	1,794	1,833	1,962	1,994	1,917	1,803	1,731
Above Normal	1,092	1,116	1,175	1,261	1,360	1,455	1,481	1,543	1,516	1,419	1,321	1,274
Below Normal	1,364	1,366	1,378	1,397	1,453	1,479	1,461	1,447	1,415	1,322	1,228	1,183
Dry	1,149	1,143	1,149	1,161	1,191	1,221	1,210	1,176	1,131	1,039	956	912
Critical Dry	667	663	674	680	696	690	646	585	557	498	449	426
<b>Alternative 5 as Compared to Second Basis of Comparison</b>												
Wet	-134	-125	-114	-110	-108	-126	-129	-149	-88	-84	-81	-77
Above Normal	-108	-102	-96	-92	-89	-94	-118	-130	-120	-117	-114	-112
Below Normal	-154	-145	-137	-130	-124	-125	-164	-170	-161	-159	-157	-155
Dry	-132	-125	-119	-116	-110	-107	-144	-145	-141	-136	-133	-131
Critical Dry	-109	-104	-104	-102	-99	-99	-140	-136	-123	-107	-95	-90
<b>Alternative 5 as Compared to Second Basis of Comparison (percent change)</b>												
Wet	-9.3	-8.6	-7.6	-6.8	-6.3	-7.0	-7.0	-7.6	-4.4	-4.4	-4.5	-4.5
Above Normal	-9.9	-9.1	-8.1	-7.3	-6.5	-6.5	-8.0	-8.4	-7.9	-8.2	-8.7	-8.8
Below Normal	-11.3	-10.6	-9.9	-9.3	-8.5	-8.5	-11.2	-11.8	-11.4	-12.0	-12.8	-13.1
Dry	-11.5	-11.0	-10.4	-10.0	-9.3	-8.7	-11.9	-12.3	-12.5	-13.1	-13.9	-14.3
Critical Dry	-16.4	-15.7	-15.5	-15.0	-14.2	-14.4	-21.7	-23.2	-22.2	-21.5	-21.1	-21.2



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**Table 5.106 Changes in New Melones Reservoir Elevation under Alternative 5 as Compared to the Second Basis of Comparison**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 5</b>												
Wet	969	971	980	995	1,007	1,016	1,020	1,031	1,040	1,033	1,022	1,015
Above Normal	924	930	939	954	968	980	982	988	987	975	963	890
Below Normal	954	956	959	962	973	977	972	970	968	957	944	938
Dry	930	930	932	934	939	945	940	936	931	918	905	898
Critical Dry	837	838	842	845	853	855	834	818	815	804	796	791
<b>Second Basis of Comparison</b>												
Wet	989	990	997	1,009	1,021	1,030	1,034	1,047	1,050	1,043	1,032	1,025
Above Normal	941	944	951	966	979	992	995	1,003	1,001	990	978	901
Below Normal	977	977	979	982	991	994	994	993	991	980	968	962
Dry	951	950	950	953	957	962	963	960	954	941	929	922
Critical Dry	866	866	870	872	878	879	871	856	850	835	823	817
<b>Alternative 5 as Compared to Second Basis of Comparison</b>												
Wet	-20	-19	-17	-15	-14	-15	-15	-16	-10	-10	-10	-9
Above Normal	-17	-14	-12	-12	-12	-11	-14	-15	-14	-15	-15	-11
Below Normal	-23	-22	-20	-20	-18	-18	-22	-23	-22	-23	-24	-24
Dry	-21	-20	-19	-19	-18	-17	-23	-24	-23	-24	-24	-25
Critical Dry	-29	-28	-29	-27	-25	-24	-37	-38	-35	-31	-27	-27
<b>Alternative 5 as Compared to Second Basis of Comparison (percent change)</b>												
Wet	-2.1	-1.9	-1.7	-1.4	-1.4	-1.4	-1.4	-1.5	-0.9	-0.9	-0.9	-0.9
Above Normal	-1.8	-1.5	-1.3	-1.3	-1.2	-1.2	-1.4	-1.5	-1.4	-1.5	-1.5	-1.2
Below Normal	-2.3	-2.2	-2.1	-2.0	-1.8	-1.8	-2.2	-2.3	-2.3	-2.4	-2.5	-2.5
Dry	-2.2	-2.1	-2.0	-2.0	-1.8	-1.8	-2.4	-2.5	-2.5	-2.5	-2.6	-2.7
Critical Dry	-3.4	-3.2	-3.3	-3.1	-2.9	-2.7	-4.2	-4.5	-4.1	-3.7	-3.3	-3.3

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The following changes in New Melones Reservoir storage would occur under Alternative 5 as compared to the Second Basis of Comparison.

- In wet years, storage would be reduced in all months (up to 9.3 percent).
- In above-normal years, storage would be reduced in all months (up to 9.9 percent).
- In below-normal years, storage would be reduced in all months (up to 13.1 percent).
- In dry years, storage would be reduced in all months (up to 14.3 percent).

- 1 • In critical dry years, storage would be reduced in all months (up to  
2 23.2 percent).
- 3 • Surface water elevations would be similar in all months, in all water year  
4 types.
- 5 Flows in the Stanislaus River downstream of Goodwin Dam are shown on  
6 Figures 5.68 to 5.70. Changes in flows in the river are summarized below.
- 7 • Over long-term conditions, similar flows would occur in August; reduced  
8 flows would occur in November through February, June, July, August, and  
9 September (up to 35.8 percent) and increased flows in October and March  
10 through May (up to 144.8 percent).
- 11 • In wet years, similar flows would occur in February and April; reduced flows  
12 in November through January and June through September (up to  
13 52.8 percent) and increased flows in October and March (up to 113.1 percent).
- 14 • In dry years, similar flows would occur in July through September; reduced  
15 flows in November through March and June (up to 35.7 percent); and  
16 increased flows in October, April, and May (150.1 percent).

17 *San Joaquin River at Vernalis*

18 Flows in the San Joaquin River at Vernalis under Alternative 5 as compared to the  
19 Second Basis of Comparison are summarized below, as shown on Figures 5.71  
20 through 5.73.

- 21 • Over long-term conditions, similar flows would occur in November through  
22 March, May, and July through September; reduced flows in June  
23 (8.2 percent); and increased flows in October and April (18.7 percent).
- 24 • In wet years, similar flows would occur in November through May and July  
25 through September; reduced flows in June (9.8 percent); and increased flows  
26 in October (16.2 percent).
- 27 • In dry years, similar flows would occur in November through March and June  
28 through September and increased flows in October, April, and May (up to  
29 24.5 percent).

30 *San Luis Reservoir*

31 Storage levels and surface water elevations in San Luis Reservoir under  
32 Alternative 5 as compared to the Second Basis of Comparison are summarized in  
33 Tables 5.107 and 5.108. The results are summarized following Table 5.108.

1 **Table 5.107 Changes in San Luis Reservoir Storage under Alternative 5 as**  
 2 **Compared to the Second Basis of Comparison**

Water Year	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 5</b>												
Wet	576	706	958	1,251	1,539	1,804	1,624	1,279	984	787	680	726
Above Normal	488	622	932	1,213	1,440	1,660	1,447	1,046	672	477	442	520
Below Normal	541	628	923	1,157	1,335	1,496	1,305	928	524	476	414	463
Dry	464	572	856	1,139	1,327	1,481	1,324	1,002	691	655	412	418
Critical Dry	429	505	698	994	1,166	1,216	1,103	875	600	428	284	270
<b>Second Basis of Comparison</b>												
Wet	790	1,017	1,365	1,748	1,965	2,033	2,031	1,852	1,487	1,167	889	925
Above Normal	658	883	1,213	1,671	1,913	2,001	1,995	1,717	1,263	861	612	631
Below Normal	854	1,064	1,334	1,742	1,908	1,980	1,908	1,628	1,251	964	635	591
Dry	617	764	998	1,427	1,728	1,925	1,870	1,665	1,341	1,007	660	596
Critical Dry	622	709	910	1,257	1,556	1,664	1,623	1,451	1,168	808	545	472
<b>Alternative 5 as Compared to Second Basis of Comparison</b>												
Wet	-214	-311	-407	-498	-426	-229	-408	-573	-503	-380	-210	-199
Above Normal	-170	-261	-281	-458	-473	-342	-548	-671	-591	-385	-170	-111
Below Normal	-313	-435	-411	-584	-572	-483	-603	-699	-727	-489	-221	-128
Dry	-153	-192	-141	-289	-402	-444	-546	-663	-650	-352	-249	-178
Critical Dry	-193	-204	-212	-263	-390	-448	-520	-577	-569	-379	-261	-202
<b>Alternative 5 as Compared to Second Basis of Comparison (percent change)</b>												
Wet	-32.8	-41.2	-42.7	-38.1	-27.8	-14.4	-24.5	-40.8	-48.9	-42.3	-28.2	-22.9
Above Normal	-27.2	-40.4	-32.7	-35.5	-29.5	-19.7	-30.2	-47.2	-59.3	-51.4	-33.4	-15.2
Below Normal	-43.5	-53.6	-42.3	-43.4	-37.9	-29.3	-36.5	-51.0	-70.0	-61.5	-40.1	-27.4
Dry	-23.0	-26.7	-12.8	-23.4	-27.7	-26.2	-31.9	-44.1	-51.4	-30.7	-35.2	-26.2
Critical Dry	-37.0	-38.2	-28.3	-24.7	-30.5	-30.8	-33.8	-39.5	-46.3	-41.0	-43.7	-30.8

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**Table 5.108 Changes in San Luis Elevation Storage under Alternative 5 as Compared to the Second Basis of Comparison**

Water Year	End of Month Elevation (Feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 5</b>												
Wet	402	417	446	475	501	525	509	478	448	427	416	422
Above Normal	391	408	443	471	492	512	494	456	416	390	386	398
Below Normal	399	411	443	467	483	498	481	444	397	390	381	388
Dry	389	404	436	465	483	497	482	451	417	413	381	381
Critical Dry	383	393	417	450	467	471	460	437	405	383	359	357
<b>Second Basis of Comparison</b>												
Wet	426	451	485	520	538	543	543	529	497	468	440	443
Above Normal	412	437	470	513	534	541	540	518	477	437	409	411
Below Normal	435	457	483	519	533	539	533	510	476	448	412	406
Dry	407	425	450	492	518	535	530	513	484	453	415	406
Critical Dry	409	419	441	475	502	512	509	494	468	432	400	389
<b>Alternative 5 as Compared to Second Basis of Comparison</b>												
Wet	-24	-34	-40	-45	-36	-19	-34	-51	-49	-41	-24	-22
Above Normal	-21	-29	-28	-42	-41	-29	-47	-62	-61	-47	-23	-13
Below Normal	-36	-46	-40	-53	-50	-41	-53	-66	-80	-58	-31	-17
Dry	-18	-21	-14	-26	-35	-38	-48	-62	-68	-39	-34	-25
Critical Dry	-26	-26	-24	-26	-36	-41	-49	-57	-63	-48	-42	-33
<b>Alternative 5 as Compared to Second Basis of Comparison (percent change)</b>												
Wet	-5.6	-7.6	-8.2	-8.6	-6.8	-3.5	-6.3	-9.6	-9.9	-8.7	-5.5	-4.9
Above Normal	-5.2	-6.6	-5.9	-8.2	-7.7	-5.3	-8.6	-11.9	-12.9	-10.7	-5.5	-3.1
Below Normal	-8.2	-10.1	-8.3	-10.1	-9.4	-7.6	-9.9	-12.9	-16.7	-13.0	-7.6	-4.3
Dry	-4.5	-4.9	-3.0	-5.3	-6.8	-7.1	-9.0	-12.0	-13.9	-8.7	-8.1	-6.2
Critical Dry	-6.4	-6.2	-5.4	-5.4	-7.1	-8.0	-9.5	-11.6	-13.5	-11.2	-10.4	-8.5

1 The following changes in San Luis Reservoir storage and surface water elevations  
2 would occur under Alternative 5 as compared to the Second Basis of Comparison.

- 3 • In wet years, storage would be reduced in all months (up to 48.9 percent).  
4 Surface water elevations would be similar in September and March and  
5 reduced in October through February and April through August (up to  
6 9.9 percent).
- 7 • In above-normal years, storage would be reduced in all months (up to  
8 59.3 percent). Surface water elevations would be similar in September and  
9 reduced in October through August (up to 12.9 percent).
- 10 • In below-normal years, storage would be reduced in all months (up to  
11 70.0 percent). Surface water elevations would be similar in September and  
12 reduced in October through August (up to 16.7 percent).
- 13 • In dry years, storage would be reduced in all months (up to 51.4 percent).  
14 Surface water elevations would be similar in October through December and  
15 reduced in January through September (up to 13.9 percent).
- 16 • In critical dry years, storage would be reduced in all months (46.3 percent).  
17 Surface water elevations would be reduced in all months (up to 13.5 percent).

18 *Changes in Flows into the Yolo Bypass*

19 Flows from the Sacramento River into the Yolo Bypass at Fremont Weir under  
20 Alternative 5 as compared to the Second Basis of Comparison are summarized in  
21 Table 5.109. The results are summarized following Table 5.109.

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**Table 5.109 Changes in Flows into the Yolo Bypass at Fremont Weir under Alternative 5 as Compared to the Second Basis of Comparison**

Water Year	Average Monthly Flow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 5</b>												
Wet	170	933	8,400	24,048	29,507	18,512	5,627	289	113	0	0	100
Above Normal	100	100	2,786	6,000	12,885	7,895	1,688	100	100	0	0	100
Below Normal	100	100	242	1,004	3,115	886	293	100	100	0	0	100
Dry	100	100	317	896	2,015	1,398	407	100	100	0	0	100
Critical Dry	100	100	151	525	531	393	106	100	100	0	0	100
<b>Second Basis of Comparison</b>												
Wet	147	996	9,888	25,442	30,547	18,997	5,602	289	113	0	0	100
Above Normal	100	100	2,659	6,349	15,114	8,566	1,765	100	100	0	0	100
Below Normal	100	100	262	1,256	4,057	1,166	292	100	100	0	0	100
Dry	100	100	342	932	2,032	1,411	411	100	100	0	0	100
Critical Dry	100	100	149	542	533	408	106	100	100	0	0	100
<b>Alternative 5 as Compared to Second Basis of Comparison</b>												
Wet	23	-63	-1,488	-1,394	-1,040	-486	25	0	0	0	0	0
Above Normal	0	0	128	-349	-2,230	-671	-77	0	0	0	0	0
Below Normal	0	0	-20	-252	-942	-280	1	0	0	0	0	0
Dry	0	0	-25	-36	-17	-13	-4	0	0	0	0	0
Critical Dry	0	0	2	-17	-2	-15	0	0	0	0	0	0
<b>Alternative 5 as Compared to Second Basis of Comparison (percent change)</b>												
Wet	15.8	-6.3	-15.0	-5.5	-3.4	-2.6	0.4	-0.1	-0.1	0.0	0.0	0.0
Above Normal	0.0	0.0	4.8	-5.5	-14.8	-7.8	-4.4	0.0	0.0	0.0	0.0	0.0
Below Normal	0.0	0.0	-7.7	-20.1	-23.2	-24.0	0.3	0.0	0.0	0.0	0.0	0.0
Dry	0.0	0.0	-7.4	-3.9	-0.8	-0.9	-0.9	0.0	0.0	0.0	0.0	0.0
Critical Dry	0.0	0.0	1.0	-3.2	-0.4	-3.6	0.0	0.0	0.0	0.0	0.0	0.0

1 The following changes in flows from the Sacramento River into the Yolo Bypass  
2 at Fremont Weir would occur under Alternative 5 as compared to the Second  
3 Basis of Comparison.

- 4 • In wet years, flows would be similar in February through September; reduced  
5 flows in November through January (up to 15.0 percent); and increased in  
6 October (15.8 percent).
- 7 • In above-normal years, flows would be similar in April through December and  
8 reduced flows in January through March (up to 14.8 percent).
- 9 • In below-normal years, flows would be similar in April through November  
10 and reduced flows in December through March (up to 24.0 percent).
- 11 • In dry years, flows would be similar in January through November and  
12 reduced flows in December (up to 7.4 percent).
- 13 • In critical dry years, flows would be similar in all months.

14 *Changes in Delta Conditions*

15 Delta outflow under Alternative 5 as compared to the Second Basis of  
16 Comparison are summarized below and shown on Figures 5.74 through 5.76.

- 17 • In wet years, average monthly Delta outflow would be increased in July  
18 through November, January, and April and May (up to 13,666 cfs) and  
19 reduced in December, February, March, and June (up to 1,713 cfs).
- 20 • In dry years, average monthly Delta outflow would be increased in July  
21 through May (up to 3,384 cfs) and reduced in June (526 cfs).

22 *Changes in OMR Flows*

23 The OMR conditions under Alternative 5 as compared to the Second Basis of  
24 Comparison are shown on Figures 5.77 through 5.79.

- 25 • Under Alternative 5, OMR flows would be negative except in April and May  
26 of all water year types. Under the Second Basis of Comparison, OMR flows  
27 would be negative in all months.
- 28 • In wet years, OMR flows would be more positive in September through  
29 February, April and May (up to 10,017 cfs) and more negative in March and  
30 June through August (up to 964 cfs).
- 31 • In dry years, OMR flows would be more positive in September through June  
32 (up to 4,724 cfs) and more negative in July and August (up to 2,620 cfs).

33 *Changes in CVP and SWP Exports and Deliveries*

34 Delta exports under Alternative 5 as compared to the Second Basis of Comparison  
35 are summarized in Table 5.110.

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**Table 5.110 Changes in Exports at Jones and Banks Pumping Plants under Alternative 5 as Compared to the Second Basis of Comparison**

Water Year	Monthly Volume (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Alternative 5</b>												
Wet	408	505	564	514	532	592	202	202	444	667	718	627
Above Normal	376	423	561	407	405	496	127	92	315	590	705	625
Below Normal	381	456	588	387	359	397	103	55	208	663	632	561
Dry	370	394	513	392	315	318	80	41	205	577	333	433
Critical Dry	313	293	382	355	249	179	34	20	69	239	222	243
<b>Second Basis of Comparison</b>												
Wet	549	619	716	724	609	543	476	430	456	632	655	660
Above Normal	428	521	641	716	584	570	453	363	415	572	647	651
Below Normal	548	595	623	674	497	500	337	304	414	629	517	539
Dry	435	475	546	579	518	493	259	228	274	403	325	438
Critical Dry	340	345	455	433	406	266	134	121	132	139	203	249
<b>Alternative 5 as Compared to Second Basis of Comparison</b>												
Wet	-141	-115	-152	-210	-77	49	-274	-228	-11	35	63	-33
Above Normal	-51	-99	-79	-310	-179	-74	-326	-271	-100	17	58	-26
Below Normal	-167	-139	-35	-288	-138	-102	-234	-249	-205	34	115	22
Dry	-65	-81	-33	-187	-203	-175	-178	-186	-69	174	8	-5
Critical Dry	-27	-52	-73	-77	-157	-88	-100	-100	-63	101	19	-6
<b>Alternative 5 as Compared to Second Basis of Comparison (percent change)</b>												
Wet	-25.7	-18.5	-21.2	-29.1	-12.6	9.0	-57.6	-53.1	-2.5	5.6	9.6	-5.0
Above Normal	-12.0	-18.9	-12.3	-43.2	-30.7	-12.9	-72.0	-74.7	-24.2	3.0	8.9	-4.0
Below Normal	-30.5	-23.4	-5.6	-42.6	-27.7	-20.5	-69.5	-82.0	-49.7	5.4	22.3	4.0
Dry	-14.9	-17.1	-6.0	-32.3	-39.2	-35.5	-68.9	-81.8	-25.3	43.2	2.4	-1.0
Critical Dry	-7.9	-15.1	-16.0	-17.9	-38.6	-32.9	-74.9	-83.2	-47.7	72.3	9.6	-2.5



- 1 The following changes would occur in CVP and SWP exports under Alternative 5  
2 as compared to the Second Basis of Comparison.
- 3 • Long-term average annual exports would be 1,096 TAF (19 percent) less  
4 under Alternative 5 as compared to the Second Basis of Comparison.
  - 5 • In wet years, total exports would be similar in June and September; increased  
6 exports in March, July, and August (up to 9.6 percent); and reduced in  
7 October through February, April, and May (up to 57.6 percent).
  - 8 • In above-normal years, total exports would be similar in July and September;  
9 increased exports in August (8.9 percent); and reduced in October through  
10 June (up to 74.7 percent).
  - 11 • In below-normal years, total exports would be similar in September; increased  
12 exports in July and August (up to 22.3 percent); and reduced in October  
13 through June (up to 82.0 percent).
  - 14 • In dry years, total exports would be similar in August and September;  
15 increased in July (43.2 percent); and reduced exports in October through June  
16 (up to 81.8 percent).
  - 17 • In critical dry years, total exports would be similar in September; increased in  
18 July and August (up to 72.3 percent); and reduced exports in October through  
19 June (up to 83.2 percent).
- 20 Deliveries to CVP and SWP water users would decline under Alternative 5 as  
21 compared to the Second Basis of Comparison, as summarized in Tables 5.111 and  
22 5.112, respectively, due to reduced water supply availability and export  
23 limitations.

1 **Table 5.111 Changes CVP Water Deliveries under Alternative 5 as Compared to the**  
 2 **Second Basis of Comparison**

Annual Average Deliveries (TAF)					
		Alternative 5	Second Basis of Comparison	Alternative 5 as compared to the Second Basis of Comparison	
				Difference	Percent Change
<b>North of Delta</b>					
CVP Agricultural Water Service Contractors	Long Term	185	219	-34	-16
	Dry	85	122	-37	-30
	Critical Dry	24	35	-11	-31
CVP M&I (Including American River Contractors and Contra Costa Water District)	Long Term	386	392	-6	-2
	Dry	384	390	-6	-2
	Critical Dry	384	383	1	0
CVP M&I American River Contractors	Long Term	112	120	-7	-6
	Dry	96	105	-9	-9
	Critical Dry	74	79	-6	-8
CVP Sacramento River Settlement Contractors	Long Term	1,861	1,858	3	0
	Dry	1,906	1,905	1	0
	Critical Dry	1,747	1,732	15	1
CVP Refuge Level 2 Deliveries	Long Term	146	155	-8	-5
	Dry	145	151	-6	-4
	Critical Dry	103	105	-2	-2
Total CVP Agricultural, M&I, Sacramento River Settlement Contractors, and Refuge Level 2 Deliveries	Long Term	2,578	2,624	-46	-2
	Dry	2,520	2,568	-48	-2
	Critical Dry	2,258	2,255	3	0

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Annual Average Deliveries (TAF)					
		Alternative 5	Second Basis of Comparison	Alternative 5 as compared to the Second Basis of Comparison	
				Difference	Percent Change
<b>South of Delta (Does not include Eastside Contractors)</b>					
CVP Agricultural Users Water Service Contractors	Long Term	834	1,100	-266	-24
	Dry	433	650	-217	-33
	Critical Dry	130	195	-65	-33
CVP M&I Users	Long Term	112	125	-13	-10
	Dry	100	109	-9	-8
	Critical Dry	80	85	-5	-6
San Joaquin River Exchange Contractors	Long Term	852	852	0	0
	Dry	875	875	0	0
	Critical Dry	741	741	0	0
CVP Refuge Level 2 Deliveries	Long Term	273	272	0	0
	Dry	281	280	1	0
	Critical Dry	232	232	0	0
Total CVP Agricultural, M&I, San Joaquin River Exchange Contractors, and Refuge Level 2 Deliveries	Long Term	2,071	2,349	-278	-12
	Dry	1,689	1,914	-225	-12
	Critical Dry	1,183	1,253	-70	-6
<b>Eastside Contractors Deliveries</b>					
Water Rights	Long Term	502	514	-12	-2
	Dry	524	524	0	0
	Critical Dry	406	486	-80	-16
CVP Water Service Contracts	Long Term	100	118	-19	-16
	Dry	69	98	-29	-30
	Critical Dry	8	25	-17	-68

Annual Average Deliveries (TAF)					
		Alternative 5	Second Basis of Comparison	Alternative 5 as compared to the Second Basis of Comparison	
				Difference	Percent Change
Total Water Rights and CVP Service Contracts Deliveries	Long Term	602	632	-30	-5
	Dry	593	622	-29	-5
	Critical Dry	414	511	-97	-19

- 1 The following changes in CVP water deliveries would occur under Alternative 5  
 2 as compared to the Second Basis of Comparison.
- 3 • Deliveries to CVP North of Delta agricultural water service contractors would  
 4 be reduced by 16 percent over the long-term conditions, 30 percent in dry  
 5 years, and 31 percent in critical dry years.
  - 6 • Deliveries to CVP North of Delta M&I contractors would be similar in long-  
 7 term conditions and dry and critical dry years; however, American River  
 8 Contractors would be reduced by 6 percent over the long-term conditions,  
 9 9 percent in dry years, and 8 percent in critical dry years.
  - 10 • Deliveries to CVP South of Delta agricultural water service contractors would  
 11 be reduced by 24 percent over the long-term conditions, 33 percent in dry  
 12 years, and 33 percent in critical dry years.
  - 13 • Deliveries to CVP South of Delta M&I contractors would be reduced by  
 14 10 percent in long-term conditions, 8 percent in dry years, and 6 percent in  
 15 critical dry years.
  - 16 • Deliveries to the Eastside contractors would be reduced by 5 percent under  
 17 long-term conditions and dry years and 19 percent in critical dry years.

1 **Table 5.112 Changes SWP Water Deliveries under Alternative 5 as Compared to the**  
 2 **Second Basis of Comparison**

Annual Average Deliveries (TAF)					
		Alternative 5	Second Basis of Comparison	Alternative 5 as compared to the Second Basis of Comparison	
				Difference	Percent Change
<b>North of Delta</b>					
SWP Agricultural Uses	Long Term	0	0	0	0
	Dry	0	0	0	0
	Critical Dry	0	0	0	0
SWP M&I (without Article 21)	Long Term	67	83	-16	-19
	Dry	51	62	-11	-18
	Critical Dry	42	53	-11	-21
SWP M&I Article 21 Deliveries	Long Term	13	12	1	13
	Dry	14	13	1	11
	Critical Dry	13	12	1	15
Total SWP Agricultural and M&I (without Article 21)	Long Term	67	83	-16	-19
	Dry	51	62	-11	-18
	Critical Dry	42	53	-11	-21
Total SWP Agricultural and M&I Article 21 Deliveries	Long Term	13	12	1	13
	Dry	14	13	1	11
	Critical Dry	13	12	1	15
<b>South of Delta</b>					
SWP Agricultural Users (without Article 21)	Long Term	598	750	-152	-20
	Dry	449	567	-118	-21
	Critical Dry	369	484	-115	-24

Annual Average Deliveries (TAF)					
		Alternative 5	Second Basis of Comparison	Alternative 5 as compared to the Second Basis of Comparison	
				Difference	Percent Change
SWP Agricultural Article 21 Deliveries	Long Term	24	178	-154	-86
	Dry	6	143	-137	-96
	Critical Dry	4	100	-96	-96
SWP M&I Users (without Article 21)	Long Term	1,784	2,183	-399	-18
	Dry	1,397	1,732	-335	-19
	Critical Dry	1,157	1,494	-337	-23
SWP M&I Article 21 Deliveries	Long Term	19	104	-83	-82
	Dry	5	86	-82	-95
	Critical Dry	3	58	-55	-95
Total SWP Agricultural and M&I Users (without Article 21)	Long Term	2,383	2,933	-550	-19
	Dry	1,845	2,299	-454	-20
	Critical Dry	1,526	1,978	-452	-23
Total SWP Agricultural and M&I Article 21 Deliveries	Long Term	43	282	-239	-85
	Dry	11	229	-218	-95
	Critical Dry	7	158	-151	-95

- 1 The following changes in SWP water deliveries would occur under Alternative 5  
2 as compared to the Second Basis of Comparison.
- 3 • Deliveries without Article 21 water to SWP North of Delta water contractors  
4 would be reduced by 19 percent over the long-term conditions, 18 percent in  
5 dry years, and 21 percent in critical dry years.
  - 6 • Deliveries without Article 21 water to SWP South of Delta water contractors  
7 would be reduced by 19 percent over the long-term conditions, 20 percent in  
8 dry years, and 23 percent in critical dry years.

- 1 • Deliveries of Article 21 water to SWP North of Delta water contractors would  
2 be increased by 13 percent over the long-term conditions, 11 percent in dry  
3 years, and 15 percent in critical dry years.
- 4 • Deliveries of Article 21 water to SWP South of Delta water contractors would  
5 be reduced by 85 percent over the long-term conditions, 95 percent in dry  
6 years, and 95 percent in critical dry years.

7 *Effects Related to Cross Delta Water Transfers*

8 Potential effects to surface water resources could be similar to those identified in  
9 a recent environmental analysis conducted by Reclamation for long-term water  
10 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014i).  
11 Potential effects were identified as reduced surface water storage in upstream  
12 reservoirs and changes in flow patterns in river downstream of the reservoirs if  
13 water was released from the reservoirs in patterns that were different than would  
14 have been used by the water seller's. Because all water transfers would be  
15 required to avoid adverse impacts to other water users and biological resources  
16 (see Section 3.A.6.3, Transfers), including impacts associated with changes in  
17 reservoir storage and river flow patterns, the analysis indicated that water  
18 transfers would not result in substantial changes in storage or river flows. For the  
19 purposes of this EIS, it is anticipated that similar conditions would occur due to  
20 cross Delta water transfers under Alternative 5 and the Second Basis of  
21 Comparison.

22 Under Alternative 5, the timing of cross Delta water transfers would be limited to  
23 July through September in accordance with the 2008 USFWS BO and 2009  
24 NMFS BO. The maximum amount of water to be transferred would be  
25 600,000 acre-feet per year in critical dry years or in dry years following a dry or  
26 critical dry year. In all other water year types, the maximum amount of water  
27 would be 360,000 acre-feet per year. The maximum amount of water that can be  
28 exported in the CVP and SWP facilities is approximately 770,000 acre-feet per  
29 month. As indicated in Table 5.110, capacity would be available under  
30 Alternative 5 between July and September for water transfers in all water year  
31 types.

32 Under the Second Basis of Comparison, water could be transferred throughout the  
33 year. As indicated in Table 5.110, capacity would be available under the Second  
34 Basis of Comparison in all months of all water year types without a maximum  
35 volume of transferred water.

36 Overall, the potential for water transfer conveyance would be less under  
37 Alternative 5 than under the Second Basis of Comparison.

38 *San Francisco Bay Area, Central Coast, and Southern California Regions*

39 *Potential Changes in Surface Water Resources at Reservoirs that Store CVP*  
40 *and SWP Water*

41 The San Francisco Bay Area, Central Coast, and Southern California regions  
42 include numerous reservoirs that store CVP and SWP water supplies, including  
43 CVP and SWP reservoirs, that primarily provide water supplies for M&I water

1 users. Changes in the availability CVP and SWP water supplies for storage in  
 2 these reservoirs under Alternative 5 as compared to the Second Basis of  
 3 Comparison would be consistent with the following changes in water deliveries to  
 4 M&I water users, as summarized in Tables 5.111 and 5.112.

- 5 • Deliveries to CVP South of Delta M&I contractors would be reduced by  
 6 10 percent in long-term conditions, 9 percent in dry years, and 8 percent in  
 7 critical dry years.
- 8 • Deliveries without Article 21 water to SWP South of Delta water contractors  
 9 would be reduced by 19 percent over the long-term conditions, 20 percent in  
 10 dry years, and 23 percent in critical dry years.
- 11 • Deliveries of Article 21 water to SWP South of Delta water contractors would  
 12 be reduced by 85 percent over the long-term conditions, 95 percent in dry  
 13 years, and 95 percent in critical dry years.

14 *Changes in CVP and SWP Exports and Deliveries*

15 Deliveries to CVP and SWP water users are described above in the Central Valley  
 16 Region.

17 **5.4.3.7 Summary of Impact Analysis**

18 The results of the impact analysis on surface water conditions and water supplies  
 19 due to implementation of Alternatives 1 through 5 as compared to the No Action  
 20 Alternative and the Second Basis of Comparison are presented in Tables 5.113  
 21 through 5.116.

22 **Table 5.113 Comparison of Surface Water Conditions under Alternatives 1**  
 23 **through 5 to the No Action Alternative**

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	<p><b>Trinity Lake</b>                      In wet years and dry years, storage would be similar in all months.                      In above-normal years, storage would be similar in January through October and increased in November and December (up to 6 percent).                      In below-normal years, storage would be similar in January through October and increased in November and December (up to 5 percent).                      In critical dry years, storage would be increased in all months (up to 12 percent).                      In all months, in all water year types, surface water elevations would be similar.</p> <p><b>Trinity River downstream of Lewiston Dam</b>                      Over long-term conditions, flows would be similar in March through November; and increased in December through February (up to 11 percent).                      In wet years, flows would be similar in April through November and increased in December through March (up to 13 percent).                      In dry years, flows would be similar all months.</p> <p><b>Shasta Lake</b>                      In wet years, storage would be similar in December through August and October and increased in September and November (up to 9 percent).</p>	<p>Environmental effects associated with changes in the following physical conditions are related to impacts on biological resources (as described in Chapter 9, Fish and Aquatic Resources, and Chapter 10, Terrestrial Biological Resources), and recreation resources (as described in Chapter 15, Recreation Resources).                      Mitigation measures, if needed, related to environmental changes caused by changes in surface water conditions are presented in Chapters 9, 10, and 15.</p>



Alternative	Potential Change	Consideration for Mitigation Measures
	<p>In above-normal years, storage would be similar in January through September and increased in October through December (up to 8 percent).</p> <p>In below-normal years, storage would be similar in March through September and increased in October through February (up to 12 percent).</p> <p>In dry years, storage would be similar in February through October and increased in November through January (up to 7 percent).</p> <p>In critical dry years, storage would be increased under all months (up to 17 percent).</p> <p>In all months, in all water year types, surface water elevations would be similar.</p> <p><b>Sacramento River at Keswick</b></p> <p>Over long-term conditions, similar flows would occur in October, February through May, July, and August; reduced flows in September and November (up to 27 percent); and increased flows in December, January, and June (up to 8 percent).</p> <p>In wet years, similar flows would occur in January through July; reduced flows in September through November (up to 44 percent); and increased flows in December and August (up to 17 percent).</p> <p>In dry years, similar flows would occur in July through October, December through March, and May; reduced flows in November (25 percent); and increased flows in April and June (up to 8 percent).</p> <p><b>Sacramento River at Freeport</b></p> <p>Over long-term conditions, similar flows would occur in October, December through May, and August; reduced flows in September, November, and July (up to 30 percent); and increased flows in June (13 percent).</p> <p>In wet years, similar flows would occur in January through June and October; reduced flows in July through September and November (up to 47 percent); and increased flows in December (7 percent).</p> <p>In dry years, similar flows would occur in August through October and December through April; reduced flows in November and July (up to 14 percent); and increased flows in May and June (up to 14 percent).</p> <p><b>Lake Oroville</b></p> <p>In wet years, storage would be similar in January through August and reduced in September through December (up to 22 percent).</p> <p>In above-normal years, storage would be similar in February through August and reduced in September through January (up to 15 percent).</p> <p>In below-normal years, storage would be similar in May through July and reduced in August through April (up to 22 percent).</p> <p>In dry years, storage would be similar in June and reduced in all other months (up to 14 percent).</p> <p>In critical dry years, storage would be similar under all months.</p> <p>In all months, in all water year types, surface water elevations would be similar.</p> <p><b>Feather River downstream of Thermalito Complex</b></p> <p>Over long-term conditions, similar flows would occur in November and April; reduced flows in July through September (up to 43 percent); and increased flows in October, December through March, May, and June (up to 37 percent).</p>	

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Alternative	Potential Change	Consideration for Mitigation Measures
	<p>In wet years, similar flows would occur in October, November, and March through May; reduced flows in July through September (up to 65 percent); and increased flows in December through February and June (up to 35 percent).</p> <p>In dry years, similar flows would occur in December through April; reduced flows in July (34 percent); and increased flows in August through October, May, and June (up to 38 percent).</p> <p><b>Folsom Lake</b></p> <p>In wet years, storage would be similar in December through August; and increased in September through December (up to 12 percent).</p> <p>In above-normal years, storage would be similar in January through July and September through October; increased in November and December (up to 9 percent); and reduced in August (5 percent).</p> <p>In below-normal years, storage would be similar in February through May; reduced in June through September (up to 15 percent); and increased in October through January (up to 14 percent).</p> <p>In dry years, storage would be similar in all months.</p> <p>In critical dry years, storage would be similar in October through June and increased in July through September (up to 12 percent).</p> <p>In all months, in all water year types, surface water elevations would be similar.</p> <p><b>American River downstream of Nimbus Dam</b></p> <p>Over long-term conditions, similar flows would occur in November through May and July; reduced flows in September and October (up to 31 percent); and increased flows in June (5 percent).</p> <p>In wet years, similar flows would occur in October, November, and January through July; reduced flows in September (48 percent); and increased flows in August (12 percent).</p> <p>In dry years, similar flows would occur in November through January, March through June, August, and September; reduced flows in October (14 percent); and increased flows in February and July (up to 8 percent).</p> <p><b>Clear Creek downstream of Whiskeytown Dam</b></p> <p>Flows identical June through April and reduced in May (41 percent).</p> <p><b>New Melones Reservoir</b></p> <p>In wet years, storage would be similar in all months.</p> <p>In above normal years, storage would be similar in December through September and increased in October and November (up to 6 percent).</p> <p>In below normal years, storage would be similar in November through September and increased in October (5 percent).</p> <p>In dry years, storage would be similar in all months.</p> <p>In critical dry years, storage would be similar in July through September and increased in October through June (up to 8 percent).</p> <p>In all months, in all water year types, surface water elevations would be similar.</p> <p><b>Stanislaus River downstream of Goodwin Dam</b></p> <p>Over long-term conditions, similar flows would occur in July through September; reduced flows in October, March, and April (up to 60 percent); and increased flows in November through February and June (up to 51 percent).</p>	

Alternative	Potential Change	Consideration for Mitigation Measures
	<p>In wet years, similar flows would occur in February and April; reduced flows in October, March, May, July, and August (up to 54 percent); and increased flows in September, November through January, and June (up to 103 percent).</p> <p>In dry years, similar flows would occur in July through September; reduced flows in October and April (up to 61 percent); and increased flows in November through March, May, and June (up to 56 percent).</p> <p><b>San Joaquin River at Vernalis</b></p> <p>Over long-term conditions, similar flows would occur in July through September and November through May; reduced flows in October (16 percent); and increased flows in June (8 percent).</p> <p>In wet years, similar flows would occur in July through September and November through May; reduced flows in October (14 percent); and increased flows in June (10 percent).</p> <p>In dry years, similar flows would occur in November through March and May through September and reduced flows in October and April (up to 15 percent).</p> <p><b>San Luis Reservoir</b></p> <p>In wet years, storage would be increased in all months (up to 109 percent). Water storage elevations would be increased in all months (up to 12 percent).</p> <p>In above-normal years, storage would be increased in all months (up to 151 percent). Water storage elevations would be increased in all months (up to 15 percent).</p> <p>In below-normal years, storage would be increased in all months (up to 203 percent). Water storage elevations would be increased in all months (up to 19 percent).</p> <p>In dry years, storage would be increased in all months (up to 70 percent). Water storage elevations would be increased in all months (up to 12 percent).</p> <p>In critical dry years, storage would be increased in all months (up to 57 percent). Water storage elevations would be increased in all months (up to 11 percent).</p> <p><b>Yolo Bypass</b></p> <p>In wet years, flows into Yolo Bypass would be similar in January through September; reduced in October (20 percent); and increased in November and December (up to 17 percent).</p> <p>In above-normal years, flows into Yolo Bypass would be similar in April through December and increased in January through March (up to 16 percent).</p> <p>In below-normal years, flows into Yolo Bypass would be similar in April through November and increased in December through March (up to 34 percent).</p> <p>In dry years, flows into Yolo Bypass would be similar in January through November and increased in December (6 percent).</p> <p>In critical dry years, flows into Yolo Bypass would be similar in all months.</p> <p><b>Delta Outflow</b></p> <p>In wet years, average monthly Delta outflow would increase in December, February, March, and June (up to 1,492 cfs) and decrease in July through November, January, April, and May (up to 13,683 cfs).</p> <p>In dry years, average monthly Delta outflow would be similar in September; decrease in July, August, and October through May (up to 3,114 cfs); and increase in June (385 cfs).</p>	

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Alternative	Potential Change	Consideration for Mitigation Measures
	<p><b>Reverse Flows in Old and Middle Rivers</b></p> <p>In wet years, average monthly OMR flows, would be more positive in June through August and March (up to 923 cfs) and more negative in April through June and September through February (up to 10,005 cfs).</p> <p>In dry years, average monthly OMR flows would be positive in July (up to 2,073 cfs) and more negative in August through June (up to 3,489 cfs).</p>	
Alternative 2	Surface water conditions identical under Alternative 2 as under No Action Alternative.	None needed.
Alternative 3	<p><b>Trinity Lake</b></p> <p>In wet, above-normal years, below normal, and dry years, storage would be similar in all months.</p> <p>In critical dry years, storage would be increased in all months (up to 12 percent).</p> <p>In all months, in all water year types, surface water elevations would be similar.</p> <p><b>Trinity River downstream of Lewiston Dam</b></p> <p>Over long-term conditions, flows would be similar in March through November; and increased in December through February (up to 12 percent).</p> <p>In wet years, flows would be similar in April through October; reduced in November (7 percent); and increased in December through March (up to 15 percent).</p> <p>In dry years, flows would be similar in all months.</p> <p><b>Shasta Lake</b></p> <p>In wet years, storage would be similar in December through August and increased in September and November (up to 9 percent).</p> <p>In above-normal years, storage would be similar in January through October and increased in November and December (up to 7 percent).</p> <p>In below-normal years, storage would be similar in March through September; and increased in October through February (up to 12 percent).</p> <p>In dry years, storage would be similar in March through October and increased in November through January (up to 7 percent).</p> <p>In critical dry years, storage would increase in all months (up to 12 percent).</p> <p>In all months, in all water year types, surface water elevations would be similar.</p> <p><b>Sacramento River at Keswick</b></p> <p>Over long-term conditions, similar flows would occur in October, February through May, July, and August; reduced flows in September and November (up to 20 percent); and increased flows in December, January, and June (up to 9 percent).</p> <p>In wet years, similar flows would occur in February through August; reduced flows in September through November (up to 42 percent); and increased flows in December and January (up to 17 percent).</p> <p>In dry years, similar flows would occur in July through September and December through May; reduced flows in November (25 percent) and increased flows in January and June (up to 7 percent).</p> <p><b>Sacramento River at Freeport</b></p> <p>Over long-term conditions, similar flows would occur in October, December through May, July, and August; reduced flows in September and November (up to 30 percent); and increased flows in June (12 percent).</p>	<p>Environmental effects associated with changes in the following physical conditions are related to impacts on biological resources (as described in Chapter 9, Fish and Aquatic Resources, and Chapter 10, Terrestrial Biological Resources), and recreation resources (as described in Chapter 15, Recreation Resources).</p> <p>Mitigation measures, if needed, related to environmental changes caused by changes in surface water conditions are presented in Chapters 9, 10, and 15.</p>

Alternative	Potential Change	Consideration for Mitigation Measures
	<p>In wet years, similar flows would occur in January through May, July, and October; reduced flows in August, September, and November (up to 48.1 percent); and increased flows in December and June (up to 7 percent).</p> <p>In dry years, similar flows would occur in July through October and December through April; reduced flows in November (14 percent); and increased flows in May and June (up to 16 percent).</p> <p><b>Lake Oroville</b></p> <p>In wet years, storage would be similar in January through August and increased in September through December (up to 19 percent).</p> <p>In above-normal years, storage would be similar in February through August; and increased in September through January (up to 19 percent).</p> <p>In below-normal years, storage would be similar in June through September; and increased in October through May (up to 23 percent).</p> <p>In dry years, storage would be similar in May through September and increased in October through April (up to 12 percent).</p> <p>In critical dry years, storage would be similar under all months.</p> <p>In all months, in all water year types, surface water elevations would be similar.</p> <p><b>Feather River downstream of Thermalito Complex</b></p> <p>Over long-term conditions, similar flows would occur in October, November, March, April, and July; reduced flows in August and September (up to 49 percent); and increased flows in December through February, May, and June (up to 34 percent).</p> <p>In wet years, similar flows would occur in October, November, February through May, and July; reduced flows in August and September (up to 70 percent) and increased flows in December, January, and June (up to 28 percent).</p> <p>In dry years, similar flows would occur in September and January through April; reduced flows in October through December and July (up to 14 percent); and increased flows in May, June, and August (37 percent).</p> <p><b>Folsom Lake</b></p> <p>In wet years, storage would be similar in December through August and increased in September through December (up to 12 percent).</p> <p>In above-normal years, storage would be similar in January through June, September, and October; increased in November and December (up to 6 percent); and reduced in July and August (up to 7 percent).</p> <p>In below-normal years, storage would be similar in February through July; reduced in August and September (up to 10 percent); and increased in October through January (up to 15 percent).</p> <p>In dry years, storage would be similar in all months.</p> <p>In critical dry years, storage would be similar in October through July and increased in August and September (up to 12 percent).</p> <p>In all months, in all water year types, surface water elevations would be similar.</p> <p><b>American River downstream of Nimbus Dam</b></p> <p>Over long-term conditions, similar flows would occur in November, January through May, July, and August; reduced flows in September and October (up to 29 percent); and increased flows in June (6 percent).</p>	

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Alternative	Potential Change	Consideration for Mitigation Measures
	<p>In wet years, similar flows would occur in October, November, and January through July; reduced flows in September (46 percent); and increased flows in August and December (up to 9 percent).</p> <p>In dry years, similar flows would occur in November through January and March through September; reduced flows in October (11 percent); and increased flows in February (6 percent).</p> <p><b>Clear Creek downstream of Whiskeytown Dam</b> Flows would be identical June through April and reduced in May (29 percent).</p> <p><b>New Melones Reservoir</b> In wet years, storage would be increased in all months (up to 13 percent). In above-normal years, storage would be increased in all months (up to 23 percent). In below-normal years, storage would be increased in all months (up to 20 percent). In dry years, storage would be increased in all months (up to 25 percent). In critical dry years, storage would be increased in all months (up to 38 percent). In all months, in all water year types, surface water elevations would be similar.</p> <p><b>Stanislaus River downstream of Goodwin Dam</b> Over long-term conditions, reduced flows would occur in October and March through June (up to 58 percent) and increased flows in November through February and July through September (up to 37 percent). In wet years, similar flows would occur in April; reduced flows in October, March, and May (up to 53 percent) and increased flows in June through September and November through February (up to 68 percent). In dry years, similar flows would occur in March and July through September; reduced flows in October and April through June (up to 60 percent); and increased flows in November through February (up to 37 percent).</p> <p><b>San Joaquin River at Vernalis</b> Over long-term conditions, similar flows would occur in November through September and reduced flows in October (16 percent). In wet years, similar flows would occur in November through August; reduced flows in October (14 percent); and increased flows in September (6 percent). In dry years, similar flows would occur in November through March and July through September and reduced flows in October and April through June (up to 15 percent).</p> <p><b>San Luis Reservoir</b> In wet years, storage would be increased in all months (up to 96 percent). Water storage elevations would be increased in all months (up to 13 percent). In above-normal years, storage would be increased in all months (up to 111 percent). Water storage elevations would be similar in October through March and increased in April through September (up to 11 percent). In below-normal years, storage would be increased in all months (up to 107 percent). Water storage elevations would be similar in September and increased in October through August (up to 11 percent).</p>	

Alternative	Potential Change	Consideration for Mitigation Measures
	<p>In dry years, storage would be similar in September; and increased in October through August (up to 52 percent). Water storage elevations would be similar December through May and July through October and increased in November and June (up to 7 percent).</p> <p>In critical dry years, storage would be similar in February through May and increased in June through January (up to 29 percent). Water storage elevations would be similar in all months.</p> <p><b>Yolo Bypass</b></p> <p>In wet years, flows into Yolo Bypass would be similar in January through September; reduced in October (25 percent); and increased in November and December (up to 15 percent).</p> <p>In above-normal years, storage would be similar in April through January and increased in February and March (up to 17 percent).</p> <p>In below-normal years, flows into Yolo Bypass would be similar in April through November and increased in December through March (up to 32 percent).</p> <p>In dry years, flows into Yolo Bypass would be similar in January through November and increased in December (6 percent).</p> <p>In critical dry years, flows into Yolo Bypass would be similar in all months.</p> <p><b>Delta Outflow</b></p> <p>In wet years, average monthly Delta outflow would increase in December through March (up to 3,307 cfs) and decrease in April through November (up to 13,678 cfs).</p> <p>In dry years, average monthly Delta outflow would increase in January, February, June, and July (up to 277 cfs) and decrease in August through December and March through May (up to 2,902 cfs).</p> <p><b>Reverse Flows in Old and Middle Rivers</b></p> <p>In wet years, average monthly OMR flows would be more positive in July and August (up to 800 cfs) and more negative in September through June (up to 4,477 cfs).</p> <p>In dry years, average monthly OMR flows would be more positive in July and January (up to 728 cfs) and more negative in August through December and February through June (up to 1,847 cfs).</p>	
Alternative 4	<p><b>Trinity Lake</b></p> <p>In wet years and dry years, storage would be similar in all months.</p> <p>In above-normal years, storage would be similar in January through October and increased in November and December (up to 6 percent).</p> <p>In below-normal years, storage would be similar in January through October and increased in November and December (up to 5 percent).</p> <p>In critical dry years, storage would be increased in all months (up to 12 percent).</p> <p>In all months, in all water year types, surface water elevations would be similar.</p> <p><b>Trinity River downstream of Lewiston Dam</b></p> <p>Over long-term conditions, flows would be similar in March through November; and increased in December through February (up to 11 percent).</p> <p>In wet years, flows would be similar in April through November and increased in December through March (up to 13 percent).</p> <p>In dry years, flows would be similar all months.</p>	<p>Environmental effects associated with changes in the following physical conditions are related to impacts on biological resources (as described in Chapter 9, Fish and Aquatic Resources, and Chapter 10, Terrestrial Biological Resources), and recreation resources (as described in Chapter 15, Recreation Resources).</p> <p>Mitigation measures, if needed, related to environmental changes caused by changes in surface water conditions are presented in Chapters 9, 10, and 15.</p>

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Alternative	Potential Change	Consideration for Mitigation Measures
	<p><b>Shasta Lake</b></p> <p>In wet years, storage would be similar in December through August and October and increased in September and November (up to 9 percent).</p> <p>In above-normal years, storage would be similar in January through September and increased in October through December (up to 8 percent).</p> <p>In below-normal years, storage would be similar in March through September and increased in October through February (up to 12 percent).</p> <p>In dry years, storage would be similar in February through October and increased in November through January (up to 7 percent).</p> <p>In critical dry years, storage would be increased under all months (up to 17 percent).</p> <p>In all months, in all water year types, surface water elevations would be similar.</p> <p><b>Sacramento River at Keswick</b></p> <p>Over long-term conditions, similar flows would occur in October, February through May, July, and August; reduced flows in September and November (up to 27 percent); and increased flows in December, January, and June (up to 8 percent).</p> <p>In wet years, similar flows would occur in January through July; reduced flows in September through November (up to 44 percent); and increased flows in December and August (up to 17 percent).</p> <p>In dry years, similar flows would occur in July through October, December through March, and May; reduced flows in November (25 percent); and increased flows in April and June (up to 8 percent).</p> <p><b>Sacramento River at Freeport</b></p> <p>Over long-term conditions, similar flows would occur in October, December through May, and August; reduced flows in September, November, and July (up to 30 percent); and increased flows in June (13 percent).</p> <p>In wet years, similar flows would occur in January through June and October; reduced flows in July through September and November (up to 47 percent); and increased flows in December (7 percent).</p> <p>In dry years, similar flows would occur in August through October and December through April; reduced flows in November and July (up to 14 percent); and increased flows in May and June (up to 14 percent).</p> <p><b>Lake Oroville</b></p> <p>In wet years, storage would be similar in January through August and reduced in September through December (up to 22 percent).</p> <p>In above-normal years, storage would be similar in February through August and reduced in September through January (up to 15 percent).</p> <p>In below-normal years, storage would be similar in May through July and reduced in August through April (up to 22 percent).</p> <p>In dry years, storage would be similar in June and reduced in all other months (up to 14 percent).</p> <p>In critical dry years, storage would be similar under all months.</p> <p>In all months, in all water year types, surface water elevations would be similar.</p>	



Alternative	Potential Change	Consideration for Mitigation Measures
	<p><b>Feather River downstream of Thermalito Complex</b>                      Over long-term conditions, similar flows would occur in November and April; reduced flows in July through September (up to 43 percent); and increased flows in October, December through March, May, and June (up to 37 percent).                      In wet years, similar flows would occur in October, November, and March through May; reduced flows in July through September (up to 65 percent); and increased flows in December through February and June (up to 35 percent).                      In dry years, similar flows would occur in December through April; reduced flows in July (34 percent); and increased flows in August through October, May, and June (up to 38 percent).</p> <p><b>Folsom Lake</b>                      In wet years, storage would be similar in December through August; and increased in September through December (up to 12 percent).                      In above-normal years, storage would be similar in January through July and September through October; increased in November and December (up to 9 percent); and reduced in August (5 percent).                      In below-normal years, storage would be similar in February through May; reduced in June through September (up to 15 percent); and increased in October through January (up to 14 percent).                      In dry years, storage would be similar in all months.                      In critical dry years, storage would be similar in October through June and increased in July through September (up to 12 percent).                      In all months, in all water year types, surface water elevations would be similar.</p> <p><b>American River downstream of Nimbus Dam</b>                      Over long-term conditions, similar flows would occur in November through May and July; reduced flows in September and October (up to 31 percent); and increased flows in June (5 percent).                      In wet years, similar flows would occur in October, November, and January through July; reduced flows in September (48 percent); and increased flows in August (12 percent).                      In dry years, similar flows would occur in November through January, March through June, August, and September; reduced flows in October (14 percent); and increased flows in February and July (up to 8 percent).</p> <p><b>Clear Creek downstream of Whiskeytown Dam</b>                      Flows identical June through April and reduced in May (41 percent).</p> <p><b>New Melones Reservoir</b>                      In wet years, storage would be similar in all months.                      In above normal years, storage would be similar in December through September and increased in October and November (up to 6 percent).                      In below normal years, storage would be similar in November through September and increased in October (5 percent).                      In dry years, storage would be similar in all months.                      In critical dry years, storage would be similar in July through September and increased in October through June (up to 8 percent).</p>	

Alternative	Potential Change	Consideration for Mitigation Measures
	<p>In all months, in all water year types, surface water elevations would be similar.</p> <p><b>Stanislaus River downstream of Goodwin Dam</b>                      Over long-term conditions, similar flows would occur in July through September; reduced flows in October, March, and April (up to 60 percent); and increased flows in November through February and June (up to 51 percent).                      In wet years, similar flows would occur in February and April; reduced flows in October, March, May, July, and August (up to 54 percent); and increased flows in September, November through January, and June (up to 103 percent).                      In dry years, similar flows would occur in July through September; reduced flows in October and April (up to 61 percent); and increased flows in November through March, May, and June (up to 56 percent).</p> <p><b>San Joaquin River at Vernalis</b>                      Over long-term conditions, similar flows would occur in July through September and November through May; reduced flows in October (16 percent); and increased flows in June (8 percent).                      In wet years, similar flows would occur in July through September and November through May; reduced flows in October (14 percent); and increased flows in June (10 percent).                      In dry years, similar flows would occur in November through March and May through September and reduced flows in October and April (up to 15 percent).</p> <p><b>San Luis Reservoir</b>                      In wet years, storage would be increased in all months (up to 109 percent). Water storage elevations would be increased in all months (up to 12 percent).                      In above-normal years, storage would be increased in all months (up to 151 percent). Water storage elevations would be increased in all months (up to 15 percent).                      In below-normal years, storage would be increased in all months (up to 203 percent). Water storage elevations would be increased in all months (up to 19 percent).                      In dry years, storage would be increased in all months (up to 70 percent). Water storage elevations would be increased in all months (up to 12 percent).                      In critical dry years, storage would be increased in all months (up to 57 percent). Water storage elevations would be increased in all months (up to 11 percent).</p> <p><b>Yolo Bypass</b>                      In wet years, flows into Yolo Bypass would be similar in January through September; reduced in October (20 percent); and increased in November and December (up to 17 percent).                      In above-normal years, flows into Yolo Bypass would be similar in April through December and increased in January through March (up to 16 percent).                      In below-normal years, flows into Yolo Bypass would be similar in April through November and increased in December through March (up to 34 percent).                      In dry years, flows into Yolo Bypass would be similar in January through November and increased in December (6 percent).                      In critical dry years, flows into Yolo Bypass would be similar in all months.</p>	

Alternative	Potential Change	Consideration for Mitigation Measures
	<p><b>Delta Outflow</b>                      In wet years, average monthly Delta outflow would increase in December, February, March, and June (up to 1,492 cfs) and decrease in July through November, January, April, and May (up to 13,683 cfs).                      In dry years, average monthly Delta outflow would be similar in September; decrease in July, August, and October through May (up to 3,114 cfs); and increase in June (385 cfs).</p> <p><b>Reverse Flows in Old and Middle Rivers</b>                      In wet years, average monthly OMR flows, would be more positive in June through August and March (up to 923 cfs) and more negative in April through June and September through February (up to 10,005 cfs).                      In dry years, average monthly OMR flows would be positive in July (up to 2,073 cfs) and more negative in August through June (up to 3,489 cfs).</p>	
Alternative 5	<p><b>Trinity Lake</b>                      Similar storage and surface water elevations in all months and all water year types.</p> <p><b>Trinity River downstream of Lewiston Dam</b>                      Similar flows in all months for long-term conditions and wet and dry years.</p> <p><b>Shasta Lake</b>                      Similar storage and surface water elevations in all months and all water year types.</p> <p><b>Sacramento River at Keswick</b>                      Similar flows in all months for long-term conditions and wet and dry years.</p> <p><b>Sacramento River at Freeport</b>                      Similar flows in all months for long-term conditions and wet and dry years.</p> <p><b>Lake Oroville</b>                      Similar storage and surface water elevations in all months and all water year types.</p> <p><b>Feather River downstream of Thermalito Complex</b>                      Over long-term conditions, similar flows would occur in June through April and reduced flows in May (7 percent).                      In wet years, similar flows would occur in all months.                      In dry years, similar flows would occur in September through April and June; reduced flows in May (27 percent); and increased flows in July and August (up to 9 percent).</p> <p><b>Folsom Lake</b>                      Similar storage and surface water elevations in all months and all water year types.</p> <p><b>American River downstream of Nimbus Dam</b>                      Similar flows in all months for long-term conditions and wet and dry years.</p> <p><b>Clear Creek downstream of Whiskeytown Dam</b>                      Flows would be identical in all months.</p> <p><b>New Melones Reservoir</b>                      In wet years, storage would be similar in all months.                      In above normal years, storage would be similar in October through June and reduced in July through September (up to 6 percent).                      In below normal years, storage would be reduced in all months (up to 9 percent).                      In dry years, storage would be reduced in all months (up to 10 percent).</p>	<p>Environmental effects associated with changes in stream flows and reservoir storage related to fish and aquatic resources, terrestrial resources, and recreation are related to impacts on biological resources (as described in Chapter 9, Fish and Aquatic Resources, and Chapter 10, Terrestrial Biological Resources), and recreation resources (as described in Chapter 15, Recreation Resources).</p> <p>Mitigation measures, if needed, related to environmental changes caused by changes in surface water conditions are presented in Chapters 9, 10, and 15.</p>

Alternative	Potential Change	Consideration for Mitigation Measures
	<p>In critical dry years, storage would be reduced in all months (up to 19 percent).                      In all months, in all water year types, surface water elevations would be similar.</p> <p><b>Stanislaus River downstream of Goodwin Dam</b>                      Over long-term conditions, flows would be similar in September through February and June; reduced flows would occur in March, July, and August (up to 8 percent); and increased flows in April and May (up to 22 percent).                      In wet years, similar flows would occur in October, November, January, February, and April through June and reduced flows in December, March, and July through September (up to 18 percent).                      In dry years, similar flows would occur in June through March and increased flows in April and May (up to 47 percent).</p> <p><b>San Joaquin River at Vernalis</b>                      Over long-term conditions and wet years, similar flows would occur in all months.                      In dry years, similar flows would occur in June through March and increased flows in April and May (up to 16 percent).</p> <p><b>San Luis Reservoir</b>                      In wet years, storage would be similar in January through May and increased in June through December (up to 10 percent).                      In above-normal years, storage would be similar in all months.                      In below-normal years, storage would be similar in November, February through April, August, and September; reduced in June and July (up to 9 percent); and increased in October, December, January, and May (up to 8 percent).                      In dry years, storage would be similar in October through March; and reduced in April through September (up to 17 percent).                      In critical dry years, storage would be similar in February and March and reduced in April through January (up to 18 percent).                      Surface water elevations would be similar in all months, in all water years.</p> <p><b>Yolo Bypass</b>                      Similar flows into the Yolo Bypass in all months and all water year types.</p> <p><b>Delta Outflow</b>                      In wet years, average monthly Delta outflow would be similar.                      In dry years, average monthly Delta outflow would be similar in July through April and increased in May and June (up to 1,377 cfs).</p> <p><b>Reverse Flows in Old and Middle Rivers</b>                      In wet years, OMR flows would be more positive or no change in September, October, January, and April through June (up to 171 cfs) and more negative in November, December, March, and August (up to 124 cfs).                      In dry years, OMR flows would be more positive or no change in October through March (up to 1,359 cfs) and more negative in June through September (up to 568 cfs).</p>	

1 **Table 5.114 Comparison of CVP and SWP Water Supply Deliveries under**  
 2 **Alternatives 1 through 5 to the No Action Alternative**

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	<p>Long-term average annual exports would be 1,051 TAF (22 percent) more under Alternative 1 as compared to the No Action Alternative.</p> <p>Deliveries to CVP North of Delta agricultural water service contractors would be increased by 18 percent over the long-term conditions, 43 percent in dry years, and 50 percent in critical dry years.</p> <p>Deliveries to CVP North of Delta M&amp;I contractors would be similar in total; however, deliveries to the American River CVP contractors would be increased by 6 percent over the long-term conditions, 8 percent in dry years, and 7 percent in critical dry years.</p> <p>Deliveries to CVP South of Delta agricultural water service contractors would be increased by 30 percent over the long-term conditions, 46 percent in dry years, and 49 percent in critical dry years.</p> <p>Deliveries to CVP South of Delta M&amp;I contractors would be increased by 12 percent over the long-term conditions, 10 percent in dry years, and 5 percent in critical dry years.</p> <p>Deliveries to the Eastside contractors would be similar under long-term conditions and in dry years, but increased by 14 percent in critical dry years.</p> <p>Deliveries under Table A contracts without Article 21 water to SWP North of Delta water contractors would be increased by 22 percent over the long-term conditions, 22 percent in dry years, and 25 percent in critical dry years.</p> <p>Deliveries under Table A contracts without Article 21 water to SWP South of Delta water contractors would be increased by 22 percent over the long-term conditions, 24 percent in dry years, and 28 percent in critical dry years.</p>	None needed.
Alternative 2	Water supply conditions identical under Alternative 2 as under No Action Alternative.	None needed.
Alternative 3	<p>Long-term average annual exports would be 726 TAF (15 percent) more under Alternative 3 as compared to the No Action Alternative.</p> <p>Deliveries to CVP North of Delta agricultural water service contractors would be increased by 13 percent over the long-term conditions and 29 percent in dry and critical dry years.</p> <p>Deliveries to CVP North of Delta M&amp;I contractors would be similar in total; however, deliveries to the American River CVP contractors would increase by 5 percent over the long-term conditions and 7 percent in dry years, but remain similar in critical dry years.</p> <p>Deliveries to CVP South of Delta agricultural water service contractors would be increased by 28 percent over the long-term conditions, 34 percent in dry years, and 27 percent in critical dry years.</p> <p>Deliveries to CVP South of Delta M&amp;I contractors would be similar in critical dry years and increased by 10 percent over the long-term conditions and 8 percent in dry years.</p> <p>Deliveries to the Eastside contractors would be similar under long-term conditions and dry years and increased by 14 percent in critical dry years.</p>	None needed.

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Alternative	Potential Change	Consideration for Mitigation Measures
	<p>Deliveries under Table A contracts without Article 21 water to SWP North of Delta water contractors would be increased by 17 percent over the long-term conditions and in dry years and 13 percent in critical dry years.</p> <p>Deliveries under Table A contracts without Article 21 water to SWP South of Delta water contractors would be increased by 17 percent over the long-term conditions and in dry years and 14 percent in critical dry years.</p>	
Alternative 4	Same water supply conditions as described for Alternative 1 compared to the No Action Alternative.	None needed.
Alternative 5	<p>Long-term average annual exports would be 45 TAF (1 percent) less under Alternative 5 as compared to the No Action Alternative.</p> <p>Deliveries to CVP North of Delta agricultural water service contractors would be similar over the long-term conditions and in dry and critical dry years.</p> <p>Deliveries to CVP North of Delta M&amp;I contractors would be similar over the long-term conditions and in dry and critical dry years in total and for the American River CVP contractors.</p> <p>Deliveries to CVP South of Delta agricultural water service contractors would be similar over the long-term conditions and in dry and critical dry years.</p> <p>Deliveries to CVP South of Delta M&amp;I contractors would be similar over the long-term conditions and in dry and critical dry years.</p> <p>Deliveries to the Eastside contractors would be similar under long-term conditions and dry years; and reduced by 8 percent in critical dry years.</p> <p>Deliveries under Table A contracts without Article 21 water to SWP North of Delta water contractors would be similar over the long-term conditions and in dry and critical dry years.</p> <p>Deliveries under Table A contracts without Article 21 water to SWP South of Delta water contractors would be similar over the long-term conditions and in dry and critical dry years.</p>	To mitigate reductions of up to 7 percent in critical dry years to the Eastside Contractors, Reclamation would support water transfers from other basin water rights holders to the Eastside Contractors.

Note: Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools, incremental differences of 5 percent or less between alternatives and the No Action Alternative are considered to be “similar.”

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**Table 5.115 Comparison of Surface Water Conditions under the No Action Alternative and Alternatives 1 through 5 to the Second Basis of Comparison**

Alternative	Potential Change	Consideration for Mitigation Measures
No Action Alternative	<p><b>Trinity Lake</b>                      In wet years, below normal, and dry years, storage would be similar in all months.                      In above-normal years, storage would be similar in January through October; and less in November and December (up to 6 percent).                      In critical dry years, storage would be less in all months (up to 10 percent).                      In all months, in all water year types, surface water elevations would be similar.</p> <p><b>Trinity River downstream of Lewiston Dam</b>                      Over long-term conditions (over the 82-year analysis period), flows would be similar in March through November and reduced in December through February (up to 10 percent).                      In wet years, flows would be similar in April through November and reduced in December through March (up to 11 percent).                      In dry years, flows would be similar all months.</p> <p><b>Shasta Lake</b>                      In wet years, storage would be similar in October and December through August and reduced in September and November (up to 8 percent).                      In above-normal years, storage would be similar in January through September and reduced in October through December (up to 8 percent).                      In below-normal years, storage would be similar in March through September and reduced in October through February (up to 11 percent).                      In dry years, storage would be similar in January through October and reduced in November and December (up to 6 percent).                      In critical dry years, storage would be reduced under all months (up to 14 percent).                      In all months, in all water year types, surface water elevations would be similar.</p> <p><b>Sacramento River at Keswick</b>                      Over long-term conditions, similar flows would occur in October, February through May, July, and August; increased flows in September and November (up to 38 percent); and reduced flows in December, January, and June (up to 8 percent).                      In wet years, similar flows would occur in January through July; increased flows in September through November (up to 78 percent); and reduced flows in December and August (up to 15 percent).                      In dry years, similar flows would occur in July through October, December through March, and May; increased flows in November (33 percent); and reduced flows in April and June (up to 7 percent).</p> <p><b>Sacramento River at Freeport</b>                      Over long-term conditions, similar flows would occur in October, December through May, and August; increased flows in September, November, and July (up to 43 percent); and reduced flows in June (11 percent).                      In wet years, similar flows would occur in January through June and October; increased flows in July through September and November (up to 90 percent); and reduced flows in December (11 percent).</p>	Not considered for this comparison.

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Alternative	Potential Change	Consideration for Mitigation Measures
	<p>In dry years, similar flows would occur in August through October and December through April; increased flows in November and July (up to 16 percent); and reduced flows in May and June (up to 12 percent).</p> <p><b>Lake Oroville</b></p> <p>In wet years, storage would be similar in January through August; and reduced in September through December (up to 18 percent).</p> <p>In above normal years, storage would be similar in February through August and reduced in September through January (up to 13 percent).</p> <p>In below normal years, storage would be similar in May through July and reduced in August through April (up to 18 percent).</p> <p>In dry years, storage would be similar in June and reduced in all other months (up to 13 percent).</p> <p>In critical dry years, storage would be similar under all months.</p> <p>In all months, in all water year types, surface water elevations would be similar.</p> <p><b>Feather River downstream of Thermalito Complex</b></p> <p>Over long-term conditions, similar flows would occur in November and April; increased flows in July through September (up to 76 percent); and reduced flows in October, December through March, May, and June (up to 27 percent).</p> <p>In wet years, similar flows would occur in October through November and March through May; increased flows in July through September (up to 184 percent); and reduced flows in December through February (up to 26 percent).</p> <p>In dry years, similar flows would occur in November through March; increased flows in April and July (up to 52 percent); and reduced flows in August through October and May and June (up to 28 percent).</p> <p><b>Folsom Lake</b></p> <p>In wet years, storage would be similar in December through August and reduced in September through November (up to 11 percent).</p> <p>In above-normal years, storage would be similar in January through June, September, and October; reduced in November and December (up to 8 percent); and increased in July and August (up to 6 percent).</p> <p>In below-normal years, storage would be similar in February through May; reduced in October through January (up to 12 percent); and increased in July through September (up to 17 percent).</p> <p>In dry years, storage would be similar in all months.</p> <p>In critical dry years, storage would be similar in October through June and reduced in July through September (up to 11 percent).</p> <p>In all months, in all water year types, surface water elevations would be similar.</p> <p><b>American River downstream of Nimbus Dam</b></p> <p>Over long-term conditions, similar flows would occur in November through May and July; increased flows in September and October (up to 45 percent); and reduced flows in June and August (up to 6 percent).</p> <p>In wet years, similar flows would occur in October through November and January through July; increased flows in September (91 percent); and reduced flows in December and August (up to 11 percent).</p>	



Alternative	Potential Change	Consideration for Mitigation Measures
	<p>In dry years, similar flows would occur in all months except October, February and July; increased flows in October (17 percent); and reduced flows in February and July (up to 7 percent).</p> <p><b>Clear Creek downstream of Whiskeytown Dam</b> Flows identical June through April and increased in May (41 percent).</p> <p><b>New Melones Reservoir</b> In wet, below-normal, and dry years, storage would be similar in all months. In above-normal years, storage would be similar in all months except October when storage would be reduced by 6 percent. In critical dry years, storage would be similar in February, March, and July through September and reduced in October through January and April through June (up to 7 percent). In all months, in all water year types, surface water elevations would be similar.</p> <p><b>Stanislaus River downstream of Goodwin Dam</b> Over long-term conditions, similar flows would occur in May and July through September; increased flows in October, March, and April (up to 149 percent); and reduced flows in November through February and June (up to 34 percent). In wet years, similar flows would occur in February and April; increased flows in October, March, May, July, and August (up to 117 percent); and reduced flows in September, November through January, and June (up to 51 percent). In dry years, similar flows would occur in July through September; increased flows in October and April (up to 154 percent); and reduced flows in November through March, May, and June (up to 36 percent).</p> <p><b>San Joaquin River at Vernalis</b> Over long-term conditions, similar flows would occur in July through September and November through May; increased flows in October (19 percent); and reduced flows in June (8 percent). In wet years, similar flows would occur in July through September and November through May; increased flows in October (17 percent); and reduced flows in June (9 percent). In dry years, similar flows would occur in November through March and May through September and increased flows in October and April (up to 18 percent).</p> <p><b>San Luis Reservoir</b> In wet years, storage would be similar in June and September; increased in March, July, and August (up to 10 percent); and reduced in October through February, April, and May (up to 57 percent). Surface water elevations would be less in all months (up to 11 percent). In above-normal years, storage would be similar in July and September; increased in August (10 percent); and reduced in October through June (up to 71 percent). Surface water elevations would be less in all months (up to 13 percent). In below-normal years, storage would be similar in July and September; increased in August (20 percent); and reduced in October through June (up to 67 percent). Surface water elevations would be less in all months (up to 16 percent).</p>	

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Alternative	Potential Change	Consideration for Mitigation Measures
	<p>In dry years, storage would be similar in September; increased in July (34 percent); and reduced in October through June and August (up to 44 percent). Surface water elevations would be similar in September through January and less in February through August (up to 10 percent).</p> <p>In critical dry years, storage would be similar in September; increased in July (60 percent); and reduced in August and October through June (up to 51 percent). Surface water elevations would be similar in October through January and reduced in February through September (up to 10 percent).</p> <p><b>Yolo Bypass</b></p> <p>In wet years, flows into Yolo Bypass would be similar in January through September; increased in October (25 percent); and reduced in November and December (up to 15 percent).</p> <p>In above-normal years, flows into Yolo Bypass would be similar in April through December and reduced in January through March (up to 14 percent).</p> <p>In below-normal years, flows into Yolo Bypass would be similar in April through November and reduced in December through March (up to 25 percent).</p> <p>In dry years, flows into Yolo Bypass would be similar in January through November and reduced in December (6 percent).</p> <p>In critical dry years, flows into Yolo Bypass would be similar in all months.</p> <p><b>Delta Outflow</b></p> <p>In wet years, average monthly Delta outflow in July through November, January, April, and May (up to 13,683 cfs) and decrease in December, February, March, and June (up to 1,590 cfs).</p> <p>In dry years, average monthly Delta outflow would be similar or increase in all months (up to 3,114 cfs).</p> <p><b>Reverse Flows in Old and Middle Rivers</b></p> <p>In wet years, average monthly OMR flows would be more positive in September through February, April, and May (up to 10,005 cfs) and more negative in March and June through August (up to 923 cfs).</p> <p>In dry years, average monthly OMR flows would be more positive in August through June (up to 3,489 cfs) and more negative in June (2,073 cfs).</p>	
Alternative 1	Surface water conditions identical under Alternative 1 as under Second Basis of Comparison.	None needed.
Alternative 2	Same surface water conditions as described for No Action Alternative as compared to the Second Basis of Comparison.	Not considered for this comparison.
Alternative 3	<p><b>Trinity Lake</b></p> <p>Similar storage and surface water elevations in all months and all water year types.</p> <p><b>Trinity River downstream of Lewiston Dam</b></p> <p>Similar flows in all months for long-term conditions and wet and dry years.</p> <p><b>Shasta Lake</b></p> <p>Similar storage and surface water elevations in all months and all water year types.</p> <p><b>Sacramento River at Keswick</b></p> <p>Similar flows in all months for long-term conditions and wet and dry years.</p>	Not considered for this comparison.

Alternative	Potential Change	Consideration for Mitigation Measures
	<p><b>Sacramento River at Freeport</b>                      Similar flows in all months for long-term conditions and wet years.                      In dry years, similar flows would occur in July through May and increased flows in June (11 percent).</p> <p><b>Lake Oroville</b>                      Similar storage and surface water elevations in all months and all water year types.</p> <p><b>Feather River downstream of Thermalito Complex</b>                      Over long-term conditions, similar flows would occur in November and January through June; reduced flows in October, December, and September (up to 13 percent); and increased flows in July and August (up to 17 percent).                      In wet years, similar flows would occur in November and January through May; reduced flows in October, December, and September (up to 15 percent); and increased flows in June through August (up to 11 percent).                      In dry years, similar flows would occur in November and January through June; reduced flows in August through October (up to 21 percent); and increased flows in July (37 percent).</p> <p><b>Folsom Lake</b>                      Similar storage and surface water elevations in all months and all water year types.</p> <p><b>American River downstream of Nimbus Dam</b>                      Similar flows in all months for long-term conditions and wet and dry years.</p> <p><b>Clear Creek downstream of Whiskeytown Dam</b>                      Flows would be identical in all months.</p> <p><b>New Melones Reservoir</b>                      In wet years, storage would be similar in March through May and increased in June through February (up to 8 percent).                      In above-normal years, storage would be increased in all months (up to 16 percent).                      In below-normal years, storage would be increased in all months (up to 15 percent).                      In dry years, storage would be increased in all months (up to 20 percent).                      In critical dry years, storage would be increased in all months (up to 32 percent).                      In all months, in all water year types, surface water elevations would be similar.</p> <p><b>Stanislaus River downstream of Goodwin Dam</b>                      Over long-term conditions, similar flows would occur in October, December, January, and March; reduced flows would occur in November, May, and June (up to 52 percent); and increased flows in February, April, July, and August through September (up to 27 percent).                      In wet years, similar flows would occur in October, November, January, and April; reduced flows in May and June (up to 45 percent); and increased flows in December, February, March, and July through September (up to 69 percent).                      In dry years, similar flows would occur in July through October; reduced flows in November through March and May through June (up to 36 percent); and increased flows in April (40 percent).</p>	

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Alternative	Potential Change	Consideration for Mitigation Measures
	<p><b>San Joaquin River at Vernalis</b>                      Over long-term conditions, similar flows would occur in July through May and reduced flows in June (12 percent). In wet years, similar flows would occur in September through January, March through May, and July; reduced flows in June (8 percent); and increased flows in August and February (6 percent).                      In dry years, similar flows would occur in July through March; reduced flows in May and June (up to 12 percent); and increased flows in April (7 percent).</p> <p><b>San Luis Reservoir</b>                      In wet years, storage would be similar in July through November and March through May and reduced in December through February and June (up to 16 percent). Surface water elevations would be similar in all months.                      In above-normal years, storage would be similar in November; increased in August and September (up to 12 percent); and reduced in October and December through July (up to 22 percent). Surface water elevations would be similar in March through December and reduced in January and February (up to 6 percent).                      In below-normal years, storage would be similar in August and September and reduced in October through July (up to 40 percent). Surface water elevations would be similar in all months.                      In dry years, storage would be reduced in January through September (up to 19 percent) and increased in October through December (up to 13 percent). Surface water elevations would be similar in all months.                      In critical dry years, storage would be reduced in October through August (up to 29 percent) and increased in September (8 percent). Surface water elevations would be similar September through January and reduced in February through August (up to 7 percent).</p> <p><b>Yolo Bypass</b>                      In wet years, flows into the Yolo Bypass would be similar in November through September and reduced in October (6 percent).                      In above-normal, below-normal, dry, and critical dry years, flows into the Yolo Bypass would be similar in all months.</p> <p><b>Delta Outflow</b>                      In wet years, average monthly Delta outflow would increase in November through February and July through September (up to 2,546 cfs) and decrease in October and March through June (up to 1,127 cfs).                      In dry years, average monthly Delta outflow would increase in November through April, July and August (up to 3,391 cfs) and decrease October, May, and June (up to 373 cfs).</p> <p><b>Reverse Flows in Old and Middle Rivers</b>                      In wet years, flows would be more positive in September through February, April, and May (up to 5,528 cfs) and more negative in March and June through August (up to 1,453 cfs).                      In dry years, flows would be more positive in August through May (up to 3,249 cfs) and more negative flows in June and July (up to 1,345 cfs).</p>	
Alternative 4	Surface water conditions identical under Alternative 4 as under Second Basis of Comparison.	None needed.

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 5	<p><b>Trinity Lake</b>                      In wet, below-normal, and dry years, storage would be similar.                      In above-normal years, storage would be similar in January through October and reduced in November and December (up to 5 percent).                      In critical dry years, storage would be reduced in all months (up to 10 percent).                      In all months, in all water year types, surface water elevations would be similar.</p> <p><b>Trinity River downstream of Lewiston Dam</b>                      Over long-term conditions, flows would be similar in March through November and January and reduced in December and February (up to 10 percent).                      In wet years, flows would be similar in January and April through November and reduced in December, February, and March (up to 14 percent).                      In dry years, flows would be similar in all months.</p> <p><b>Shasta Lake</b>                      In wet years, storage would be similar in October and December through August and reduced in November and September (up to 8 percent).                      In above-normal years, storage would be similar in February through September and reduced in October through December (up to 8 percent).                      In below-normal years, storage would be similar in March through September and reduced in October through February (up to 10 percent).                      In dry years, storage would be similar in January through October and reduced in November through December (up to 6 percent).                      In critical dry years, storage would be reduced in all months (up to 17 percent).                      In all months, in all water year types, surface water elevations are similar.</p> <p><b>Sacramento River at Keswick</b>                      Over long-term conditions, flows would be similar in July, August, October, and February through April; reduced in December, January, May and June (up to 8 percent); and increased in September and November (up to 39 percent).                      In wet years, flows would be similar in January through July; reduced in December and August (up to 15 percent); and increased in September through November (up to 77 percent).                      In dry years, similar flows would occur in July through October and December through March; reduced in April through June (up to 10 percent); and increased flows in November (32 percent).</p> <p><b>Sacramento River at Freeport</b>                      Over long-term conditions, flows would be similar in October and December through April; reduced in May and June (up to 12 percent); and increased in July through September and November (43 percent).                      In wet years, flows would be similar in October and January through June; reduced in December (6 percent); and increased in July through September and November (up to 89 percent).                      In dry years, similar flows would occur in August through October and December through April; reduced in May and June (up to 14 percent); and increased flows in July and November (up to 19 percent).</p>	<p>Not considered for this comparison.</p>

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Alternative	Potential Change	Consideration for Mitigation Measures
	<p><b>Lake Oroville</b>                      In wet years, storage would be similar in January through August; and reduced in September through December (up to 18 percent).                      In above-normal years, storage would be similar in March through August and reduced in September through February (up to 14 percent).                      In below-normal years, storage would be similar in May through July and reduced in August through April (up to 17 percent).                      In dry years, storage would be similar in May and June and reduced in July through April (up to 11 percent).                      In critical dry years, storage would be similar in all months.                      Surface water elevations would be similar in all months, in all years.</p> <p><b>Feather River downstream of Thermalito Complex</b>                      Over long-term conditions, similar flows would occur in November and April; reduced flows in October, December through March, May, and June (up to 28 percent); and increased flows in July through September (up to 76 percent).                      In wet years, similar flows would occur in October, November, March through May; reduced flows in December through February and June (up to 26 percent); and increased flows in July through September (up to 182 percent).                      In dry years, similar flows would occur in November through April; reduced flows in October, May, June, August, and September (up to 45 percent); and increased flows in July (60 percent).</p> <p><b>Folsom Lake</b>                      In wet years, storage would be similar in December through July and reduced in August through November (up to 7 percent).                      In above-normal years, storage would be similar in January through June, August, and October; reduced in September, November, and December (up to 8 percent); and increased in July (5 percent).                      In below-normal years, storage would be similar in February through May; reduced in August through January (up to 13 percent); and increased in June and July (up to 10 percent).                      In dry years, storage would be similar in all months.                      In critical dry years, storage would be similar in August and June and reduced in July (8 percent).                      Surface water elevations would be similar in all months, in all years.</p> <p><b>American River downstream of Nimbus Dam</b>                      Over long-term conditions, similar flows would occur in November through July; reduced flows in August (6 percent); and increased in September and October (42 percent).                      In wet years, similar flows would occur in October, November, and January through July; reduced flows in December and August (up to 14 percent); and increased flows in September (88 percent).                      In dry years, similar flows would occur in November through September; and increased flows in October (17 percent).</p>	

Alternative	Potential Change	Consideration for Mitigation Measures
	<p><b>Clear Creek downstream of Whiskeytown Dam</b>                      Flows identical June through April and increased in May (41 percent).</p> <p><b>New Melones Reservoir</b>                      In wet years, storage would be reduced in all months (up to 9 percent).                      In above-normal years, storage would be reduced in all months (up to 10 percent).                      In below-normal years, storage would be reduced in all months (up to 13 percent).                      In dry years, storage would be reduced in all months (up to 14 percent).                      In critical dry years, storage would be reduced in all months (up to 23 percent).                      Surface water elevations would be similar in all months, in all water year types.</p> <p><b>Stanislaus River downstream of Goodwin Dam</b>                      Over long-term conditions, similar flows would occur in August; reduced flows would occur in November through February, June, July, August, and September (up to 36 percent); and increased flows in October and March through May (up to 149 percent).                      In wet years, similar flows would occur in February and April; reduced flows in November through January and June through September (up to 53 percent); and increased flows in October and March (up to 113 percent).                      In dry years, similar flows would occur in July through September; reduced flows in November through March and June (up to 36 percent); and increased flows in October, April, and May (150 percent).</p> <p><b>San Joaquin River at Vernalis</b>                      Over long-term conditions, similar flows would occur in November through March, May, and July through September; reduced flows in June (8 percent); increased flows in October and April (19 percent).                      In wet years, similar flows would occur in November through May and July through September; reduced flows in June (10 percent); and increased flows in October (16 percent).                      In dry years, similar flows would occur in November through March and June through September; and increased flows in October, April, and May (up to 25 percent).</p> <p><b>San Luis Reservoir</b>                      In wet years, storage would be reduced in all months (up to 49 percent). Surface water elevations would be similar in September and March; and reduced in October through February and April through August (up to 10 percent).                      In above-normal years, storage would be reduced in all months (up to 59 percent). Surface water elevations would be similar in September; and reduced in October through August (up to 13 percent).                      In below-normal years, storage would be reduced in all months (up to 70 percent). Surface water elevations would be similar in September; and reduced in October through August (up to 17 percent).                      In dry years, storage would be reduced in all months (up to 51 percent). Surface water elevations would be similar in October through December; and reduced in January through September (up to 14 percent).</p>	

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Alternative	Potential Change	Consideration for Mitigation Measures
	<p>In critical dry years, storage would be reduced in all months (46 percent). Surface water elevations would be reduced in all months (up to 14 percent).</p> <p><b>Yolo Bypass</b></p> <p>In wet years, flows would be similar in February through September; reduced flows in November through January (up to 15 percent); and increased in October (16 percent). In above-normal years, flows would be similar in April through December and reduced flows in January through March (up to 15 percent). In below-normal years, flows would be similar in April through November and reduced flows in December through March (up to 24 percent). In dry years, flows would be similar in January through November and reduced flows in December (up to 7 percent). In critical dry years, flows would be similar in all months.</p> <p><b>Delta Outflow</b></p> <p>In wet years, average monthly Delta outflow would be increased in July through November, January, and April and May (up to 13,666 cfs) and reduced in December, February, March, and June (up to 1,713 cfs). In dry years, average monthly Delta outflow would be increased in July through May (up to 3,384 cfs) and reduced in June (526 cfs).</p> <p><b>Reverse Flows in Old and Middle Rivers</b></p> <p>In wet years, OMR flows would be more positive in September through February, April and May (up to 10,017 cfs) and more negative in March and June through August (up to 964 cfs). In dry years, OMR flows would be more positive in September through June (up to 4,724 cfs) and more negative in July and August (up to 2,620 cfs).</p>	



1 **Table 5.116 Comparison of CVP and SWP Water Supply Deliveries under the No**  
 2 **Action Alternative and Alternatives 1 through 5 to the Second Basis of Comparison**

Alternative	Potential Change	Consideration for Mitigation Measures
No Action Alternative	<p>Long-term average annual exports would be 1,051 TAF (18 percent) less under the No Action Alternative as compared to the Second Basis of Comparison.</p> <p>Deliveries to CVP North of Delta agricultural water service contractors would be reduced by 16 percent over the long-term conditions, 30 percent in dry years, and 34 percent in critical dry years.</p> <p>Deliveries to CVP North of Delta M&amp;I contractors would be similar in total; however, deliveries to the American River CVP contractors would be reduced by 6 percent over the long-term conditions, 8 percent in dry years, and 6 percent in critical dry years.</p> <p>Deliveries to CVP South of Delta agricultural water service contractors would be reduced by 23 percent over the long-term conditions, 32 percent in dry years, and 33 percent in critical dry years.</p> <p>Deliveries to CVP South of Delta M&amp;I contractors would be reduced by 10 percent over the long-term conditions, 9 percent in dry years, and 5 percent in critical dry years.</p> <p>Deliveries to the Eastside contractors would be similar under the long-term conditions and in dry years but were reduced by 12 percent in critical dry years.</p> <p>Deliveries under Table A contracts without Article 21 water to SWP North of Delta water contractors would be reduced by 18 percent over the long-term conditions, 18 percent in dry years, and 20 percent in critical dry years.</p> <p>Deliveries under Table A contracts without Article 21 water to SWP South of Delta water contractors would be reduced by 18 percent over the long-term conditions, 19 percent in dry years, and 22 percent in critical dry years.</p>	Not considered for this comparison.
Alternative 1	Water supply conditions identical under Alternative 1 as under Second Basis of Comparison.	None needed.
Alternative 2	Same water supply effects as described for No Action Alternative as compared to the Second Basis of Comparison.	Not considered for this comparison.
Alternative 3	<p>Long-term average annual exports would be 326 TAF (6 percent) less under Alternative 3 as compared to the Second Basis of Comparison.</p> <p>Deliveries to CVP North of Delta agricultural water service contractors would be reduced by 5 percent over the long-term conditions, 9 percent in dry years, and 11 percent in critical dry years.</p> <p>Deliveries to CVP North of Delta M&amp;I contractors (including American River CVP contractors) would be similar in long-term conditions and dry and critical dry years.</p> <p>Deliveries to CVP South of Delta agricultural water service contractors would be similar over the long-term conditions and reduced by 8 percent in dry years and 14 percent in critical dry years.</p> <p>Deliveries to CVP South of Delta M&amp;I contractors would be similar in long-term conditions and dry and critical dry years.</p> <p>Deliveries to the Eastside contractors would be similar under long-term conditions and dry and critical dry years.</p> <p>Deliveries under Table A contracts without Article 21 water to SWP North of Delta water contractors would be similar over the long-term conditions and in dry years and reduced by 10 percent in critical dry years.</p>	Not considered for this comparison.

Alternative	Potential Change	Consideration for Mitigation Measures
	Deliveries under Table A contracts without Article 21 water to SWP South of Delta water contractors would be similar over the long-term conditions and in dry years and reduced by 11 percent in critical dry years.	
Alternative 4	Water supply conditions identical under Alternative 4 as under Second Basis of Comparison.	None needed.
Alternative 5	<p>Long-term average annual exports would be 1,096 TAF (19 percent) less under Alternative 5 as compared to the Second Basis of Comparison.</p> <p>Deliveries to CVP North of Delta agricultural water service contractors would be reduced by 16 percent over the long-term conditions, 30 percent in dry years, and 31 percent in critical dry years.</p> <p>Deliveries to CVP North of Delta M&amp;I contractors would be similar in long-term conditions and dry and critical dry years; however, American River Contractors would be reduced by 6 percent over the long-term conditions, 9 percent in dry years, and 8 percent in critical dry years.</p> <p>Deliveries to CVP South of Delta agricultural water service contractors would be reduced by 24 percent over the long-term conditions, 33 percent in dry years, and 33 percent in critical dry years.</p> <p>Deliveries to CVP South of Delta M&amp;I contractors would be reduced by 10 percent in long-term conditions, 8 percent in dry years, and 6 percent in critical dry years.</p> <p>Deliveries to the Eastside contractors would be reduced by 5 percent under long-term conditions and dry years and reduced by 19 percent in critical dry years.</p> <p>Deliveries under Table A contracts without Article 21 water to SWP North of Delta water contractors would be reduced by 19 percent over the long-term conditions, 18 percent in dry years, and 21 percent in critical dry years.</p> <p>Deliveries under Table A contracts without Article 21 water to SWP South of Delta water contractors would be reduced by 19 percent over the long-term conditions, 20 percent in dry years, and 23 percent in critical dry years.</p>	Not considered for this comparison.

Note: Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools, incremental differences of 5 percent or less between alternatives and the Second Basis of Comparison are considered to be "similar."

1 **5.4.3.8 Potential Mitigation Measures**

2 Mitigation measures are presented in this section to avoid, minimize, rectify,  
 3 reduce, eliminate, or compensate for adverse environmental effects of  
 4 Alternatives 1 through 5 as compared to the No Action Alternative. Mitigation  
 5 measures were not included to address adverse impacts under the alternatives as  
 6 compared to the Second Basis of Comparison because this analysis was included  
 7 in this EIS for information purposes only.

8 **5.4.3.8.1 Surface Water Conditions**

9 As described above and summarized in Table 5.113, implementation of  
 10 Alternatives 1 through 5 as compared to the No Action Alternative would result in  
 11 reductions in river flows downstream of CVP and SWP reservoirs and Delta  
 12 outflow, and increased negative OMR flows. Environmental effects associated  
 13 with changes in these physical conditions are related to impacts on biological  
 14 resources (as described in Chapter 9, Fish and Aquatic Resources, and  
 15 Chapter 10, Terrestrial Biological Resources), and recreation resources

1 (as described in Chapter 15, Recreation Resources). Mitigation measures, if  
2 needed, related to environmental changes caused by changes in surface water  
3 conditions are presented in Chapters 9, 10, and 15.

4 **5.4.3.8.2 CVP and SWP Water Supply Deliveries**

5 Implementation of Alternatives 1 through 4 would not result in adverse impacts to  
6 CVP and SWP water deliveries as compared to the No Action Alternative, as  
7 summarized in Table 5.114. Therefore, no mitigation measures are required.

8 Implementation of Alternative 5 would result in up to 8 percent reductions of  
9 CVP water deliveries to the Eastside Contractors (Stockton East Water District  
10 and Central San Joaquin Water Conservation District) in critical dry years. A  
11 potential mitigation measure for this reduction in critical dry years would be:

- 12 • Reclamation would support water transfers from other basin water rights  
13 holders to the Eastside Contractors. .

14 **5.4.3.9 Cumulative Effects Analysis**

15 As described in Chapter 3, the cumulative effects analysis considers projects,  
16 programs, and policies that are not speculative and are based upon known or  
17 reasonably foreseeable long-range plans, regulations, operating agreements, or  
18 other information that establishes them as reasonably foreseeable.

19 The cumulative effects analysis Alternatives 1 through 5 for Water Supplies are  
20 summarized in Table 5.117.

1  
2

**Table 5.117 Summary of Cumulative Effects on Water Supply Deliveries under Alternatives 1 through 5 as Compared to the No Action Alternative**

Scenarios	Actions	Cumulative Effects of Actions
<p>Past &amp; Present, and Future Actions Included in All Alternatives in Year 2030</p>	<p>Consistent with Affected Environment conditions plus:</p> <p>Actions in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives), including climate change and sea level rise</p> <p>Actions not included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives):</p> <ul style="list-style-type: none"> <li>• Implementation of Federal and state policies and programs, including Clean Water Act (e.g., Total Maximum Daily Loads); Safe Drinking Water Act; Clean Air Act; and flood management programs</li> <li>• General plans for 2030.</li> <li>• Trinity River Restoration Program.</li> <li>• Central Valley Project Improvement Act programs</li> <li>• Iron Mountain Mine Superfund Site</li> <li>• Nimbus Fish Hatchery Fish Passage Project</li> <li>• Folsom Dam Water Control Manual Update</li> <li>• FERC Relicensing for the Middle Fork of the American River Project</li> <li>• Lower Mokelumne River Spawning Habitat Improvement Project</li> <li>• Dutch Slough Tidal Marsh Restoration</li> <li>• Suisun Marsh Habitat Management, Preservation, and Restoration Plan Implementation</li> <li>• Tidal Wetland Restoration: Yolo Ranch, Northern Liberty Island Fish Restoration Project, Prospect Island Restoration Project, and Calhoun Cut/Lindsey Slough Tidal Habitat Restoration Project</li> <li>• San Joaquin River Restoration Program</li> <li>• Stockton Deep Water Ship Channel Dissolved Oxygen Project</li> <li>• Grasslands Bypass Project</li> <li>• Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS)</li> <li>• Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities</li> </ul>	<p><u>These effects would be the same under all alternatives.</u></p> <p>Climate change and sea level rise, development under the general plans, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce carryover storage in reservoirs, stream flows and Delta outflow, and the availability of CVP and SWP water supplies as compared to past conditions.</p> <p>Some future water quality and habitat projects could modify surface water conditions; however, water supplies are not anticipated to be affected.</p> <p>Future water supply projects are anticipated to both improve water supply reliability due to reduced surface water supplies and to accommodate planned growth in the general plans. Most of these programs were initiated prior to implementation of the 2008 USFWS BO and 2009 NMFS BO which reduced CVP and SWP water supply reliability.</p>

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Scenarios	Actions	Cumulative Effects of Actions
<p>Future Actions Considered as Cumulative Effects Actions in All Alternatives in Year 2030</p>	<p>Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives):</p> <ul style="list-style-type: none"> <li>• Bay-Delta Water Quality Control Plan Update</li> <li>• FERC Relicensing Projects</li> <li>• Bay Delta Conservation Plan (including the California WaterFix alternative)</li> <li>• Shasta Lake Water Resources, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations</li> <li>• El Dorado Water and Power Authority Supplemental Water Rights Project</li> <li>• Sacramento River Water Reliability Project</li> <li>• Semitropic Water Storage District Delta Wetlands</li> <li>• North Bay Aqueduct Alternative Intake</li> <li>• Irrigated Lands Regulatory Program</li> <li>• San Luis Reservoir Low Point Improvement Project</li> <li>• <i>Westlands Water District v. United States Settlement</i></li> <li>• Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects that did not have completed environmental documents during preparation of the EIS)</li> </ul>	<p><u>These effects would be the same under all alternatives.</u></p> <p>Most of the future reasonably foreseeable actions are anticipated to reduce water supply impacts due to climate change, sea level rise, increased water allocated to improve habitat conditions, and future growth.</p> <p>Some of the reasonably foreseeable actions related to improved water quality and habitat conditions (e.g., Water Quality Control Plan Update and FERC Relicensing Projects), could in further reductions in CVP and SWP water deliveries.</p>
<p>No Action Alternative with Associated Cumulative Effects Actions in Year 2030</p>	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO</p>	<p>Implementation of No Action Alternative would result in changes stream flows, increased Delta outflow, and reduced CVP and SWP water supplies as compared to historical conditions prior to the BOs.</p> <p>The availability of future water supply projects (discussed above) could reduce the effects of reduced CVP and SWP water supplies. However, these actions also could result in less water for future growth as compared to future conditions without the No Action Alternative.</p>

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Scenarios	Actions	Cumulative Effects of Actions
<p>Alternatives 1 and 4 with Associated Cumulative Effects Actions in Year 2030</p>	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)</p>	<p>Implementation of Alternatives 1 and 4 with reasonably foreseeable actions would result in changes in stream flows, reduced Delta outflows, and increased CVP and SWP water supplies as compared to the No Action Alternative with the added actions.</p> <p>The future water supply projects (discussed above) would be more available to provide water for future growth as compared to future conditions with the No Action Alternative.</p>
<p>Alternative 2 with Associated Cumulative Effects Actions in Year 2030</p>	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions No implementation of structural improvements or other actions that require further study to develop a more detailed action description.</p>	<p>Implementation of Alternative 2 with reasonably foreseeable actions for water supplies would be the same as for the No Action Alternative with the added actions.</p>
<p>Alternative 3 with Associated Cumulative Effects Actions in Year 2030</p>	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant) Slight increase in positive Old and Middle River flows in the winter and spring months</p>	<p>Implementation of Alternative 3 with reasonably foreseeable actions would result in changes in stream flows, reduced Delta outflows, and increased CVP and SWP water supplies as compared to the No Action Alternative with the added actions.</p> <p>The future water supply projects (discussed above) would be more available to provide water for future growth as compared to future conditions with the No Action Alternative.</p>
<p>Alternative 5 with Associated Cumulative Effects Actions in Year 2030</p>	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO Positive Old and Middle River flows and increased Delta outflow in spring months</p>	<p>Implementation of Alternative 5 with reasonably foreseeable actions would result in changes in stream flows, increased Delta outflows, and reduced CVP and SWP water supplies as compared to the No Action Alternative with the added actions.</p> <p>The availability of future water supply projects (discussed above) could reduce the effects of reduced CVP and SWP water supplies. However, these actions also could result in less water for future growth as compared to future conditions under the No Action Alternative.</p>

## 1    **5.5        References**

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- 6 • 5.2 California Major Water Supply Facilities
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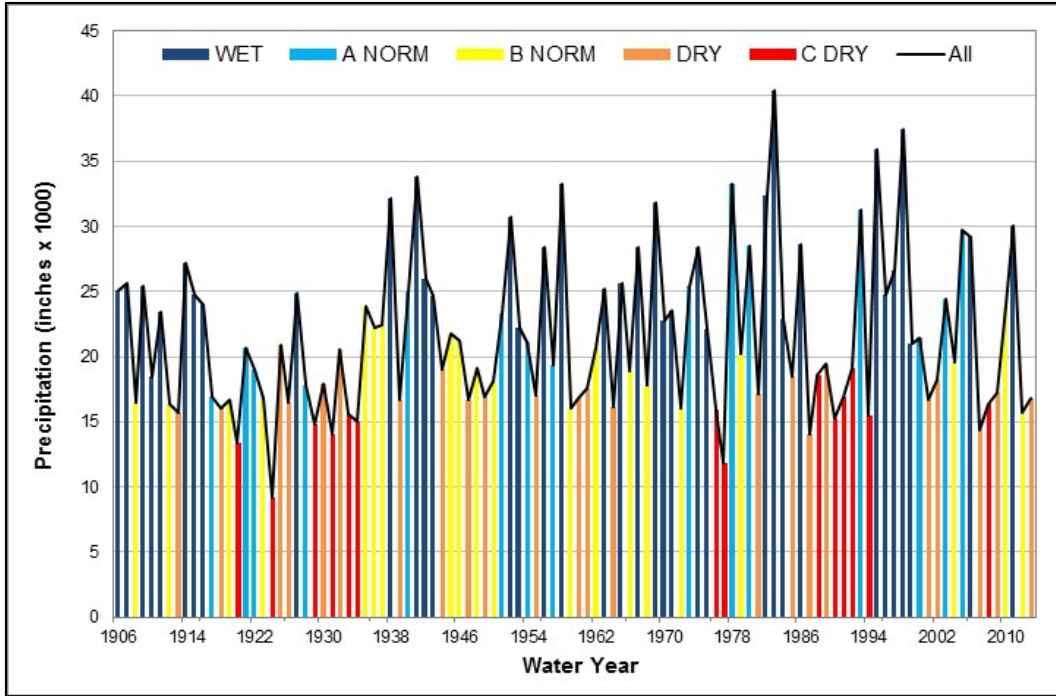
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34 Average Flow
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- 14 • 5.79 Old and Middle River, Dry Year Long-Term Average Flow



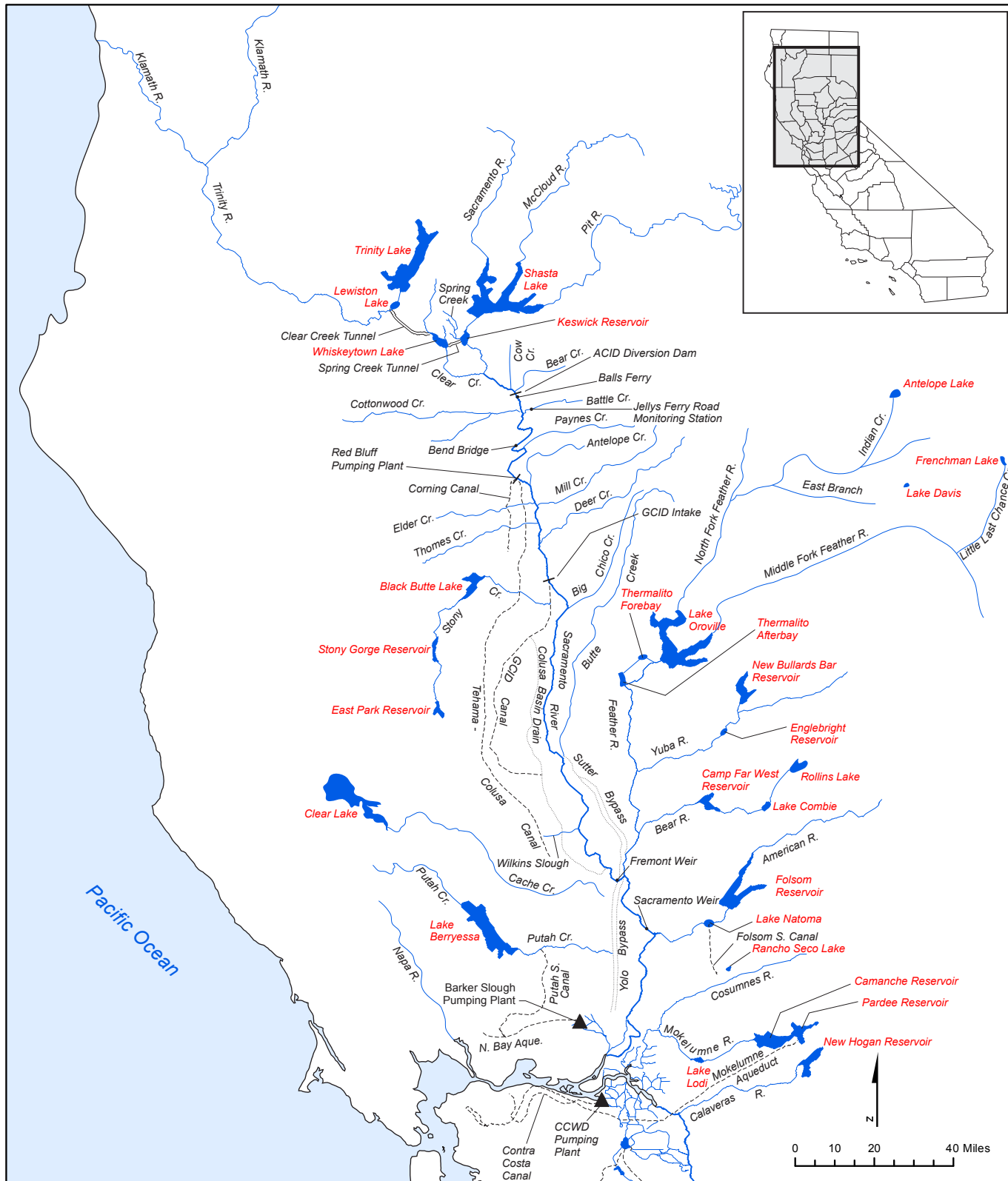
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2 **Figure 5.1 California Precipitation Trends**

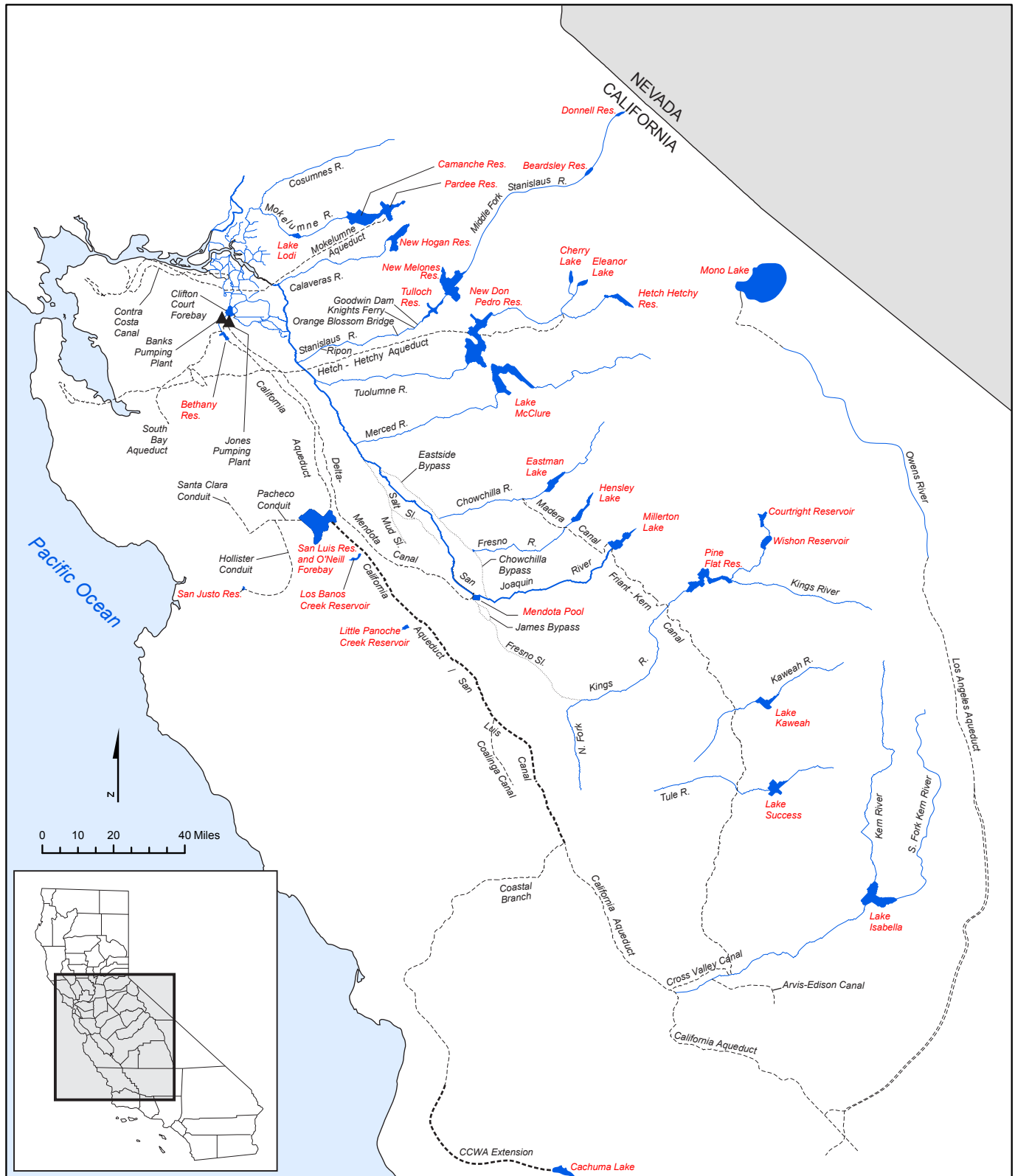


## 5.2 California Major Water Supply Facilities

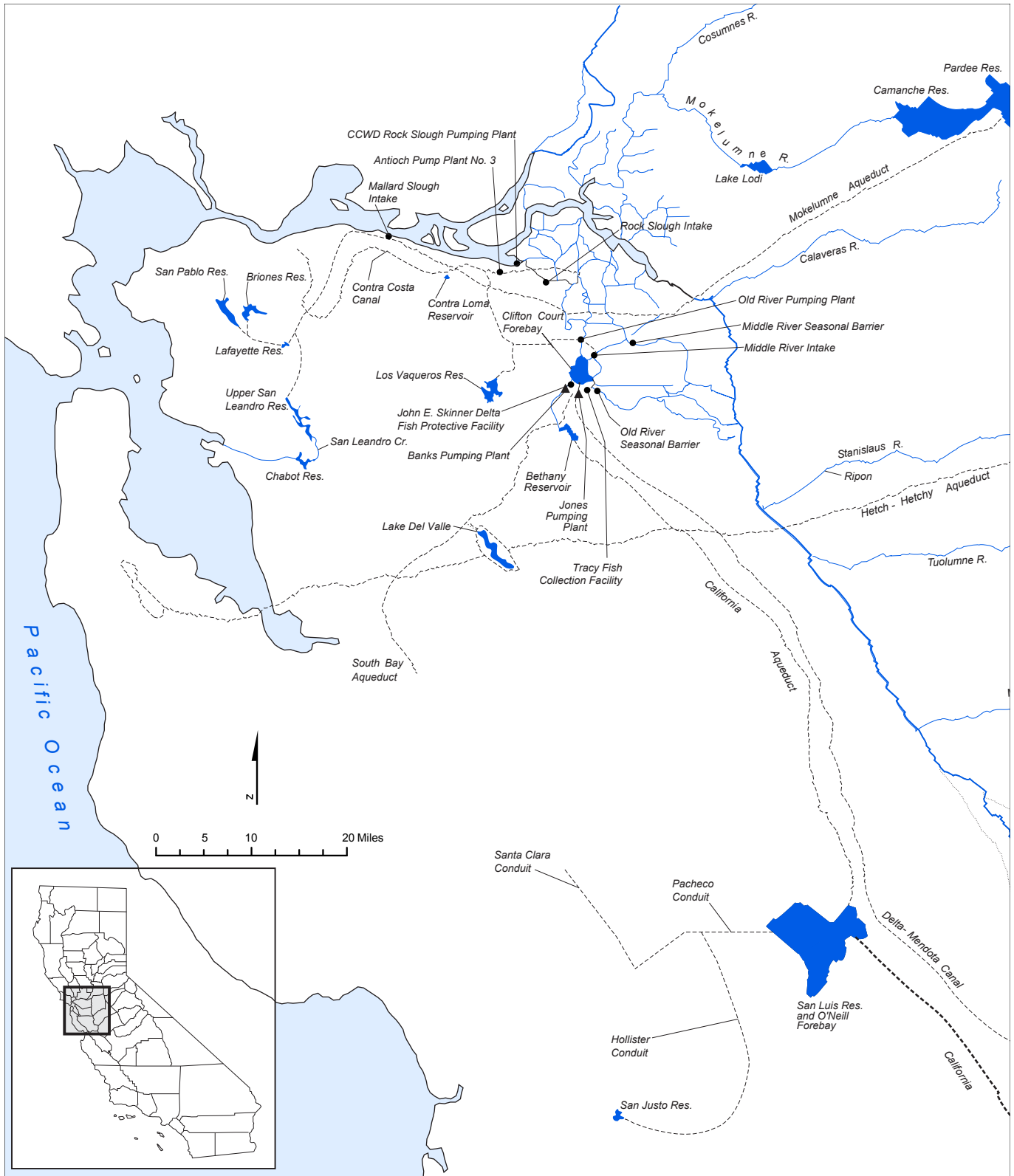




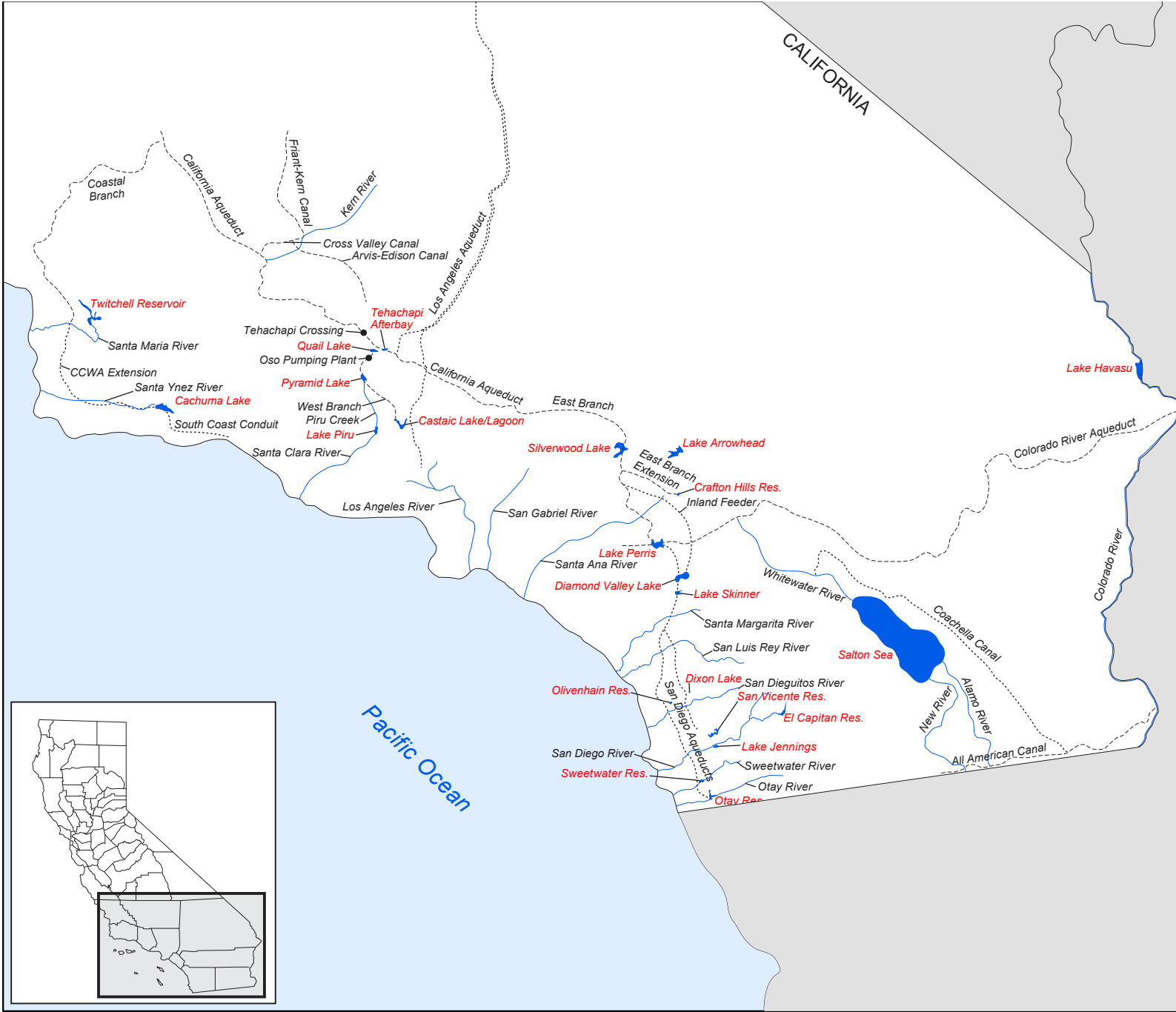
5.3 Northern California Major Water Supply Facilities



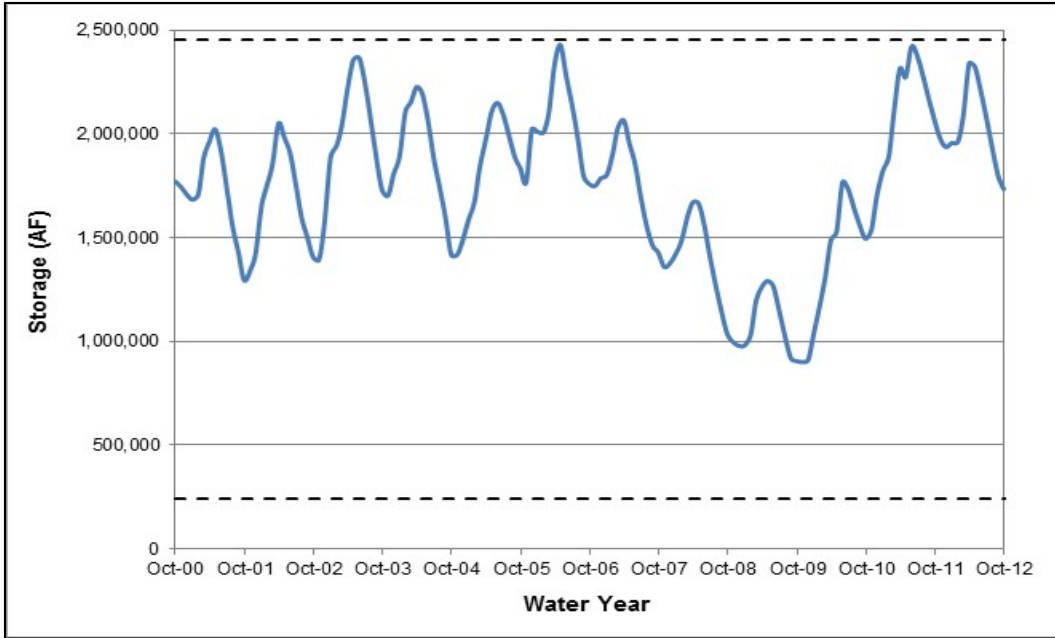
5.4 San Joaquin Valley and Tulare Lake Major Water Supply Facilities



**5.5 San Francisco Bay Area Major Water Supply Facilities**

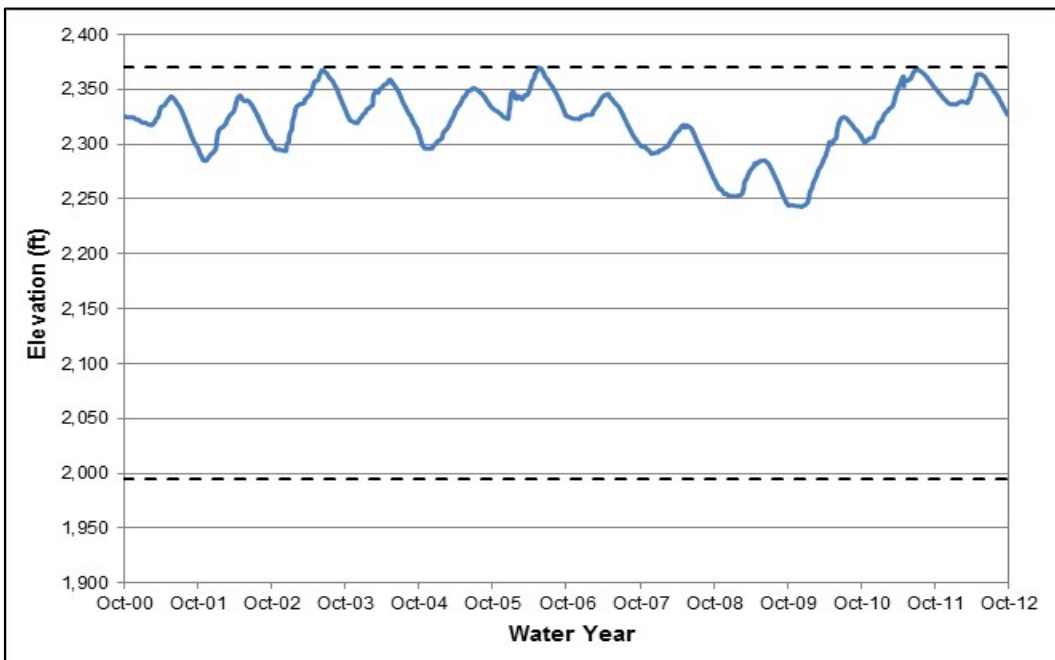


5.6 Central Coast and Southern California Major Water Supply Facilities



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2 **Figure 5.7 Historical Water Years 2001-2012 Trinity Lake Storage<sup>1</sup>**

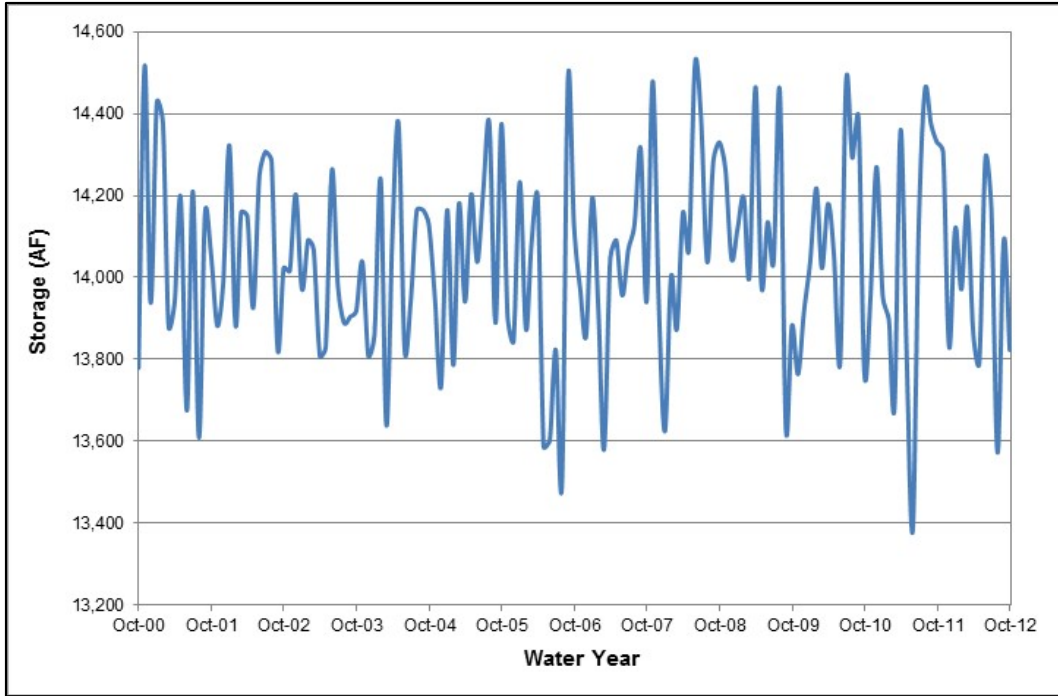


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4 **Figure 5.8 Historical Water Years 2001-2012 Trinity Lake Elevation<sup>2</sup>**

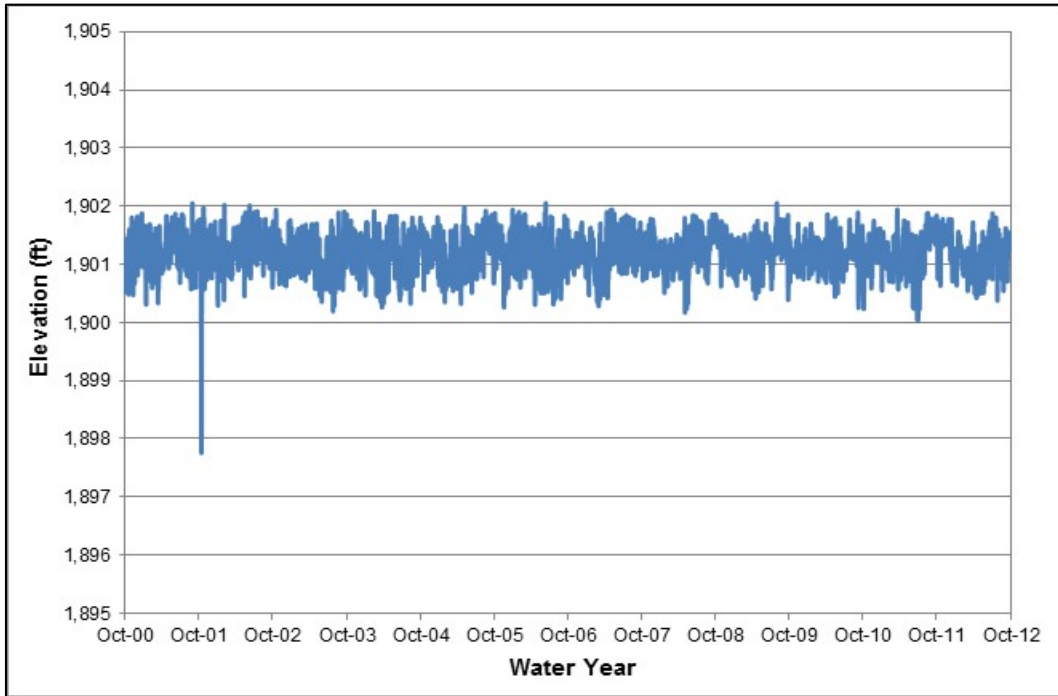
<sup>1</sup> The minimum storage line of 240,000 AF was taken from CalSim II. The maximum storage line of 2,448,000 AF was taken from the California Data Exchange Center website <http://cdec.water.ca.gov/misc/resinfo.html>.

<sup>2</sup> The minimum elevation line of 1995 ft was taken from Reclamation's website [http://www.usbr.gov/projects/Facility.jsp?fac\\_Name=Trinity+Dam&groupName=Dimensions](http://www.usbr.gov/projects/Facility.jsp?fac_Name=Trinity+Dam&groupName=Dimensions). The maximum elevation line of 2,370 ft was provided by Reclamation.



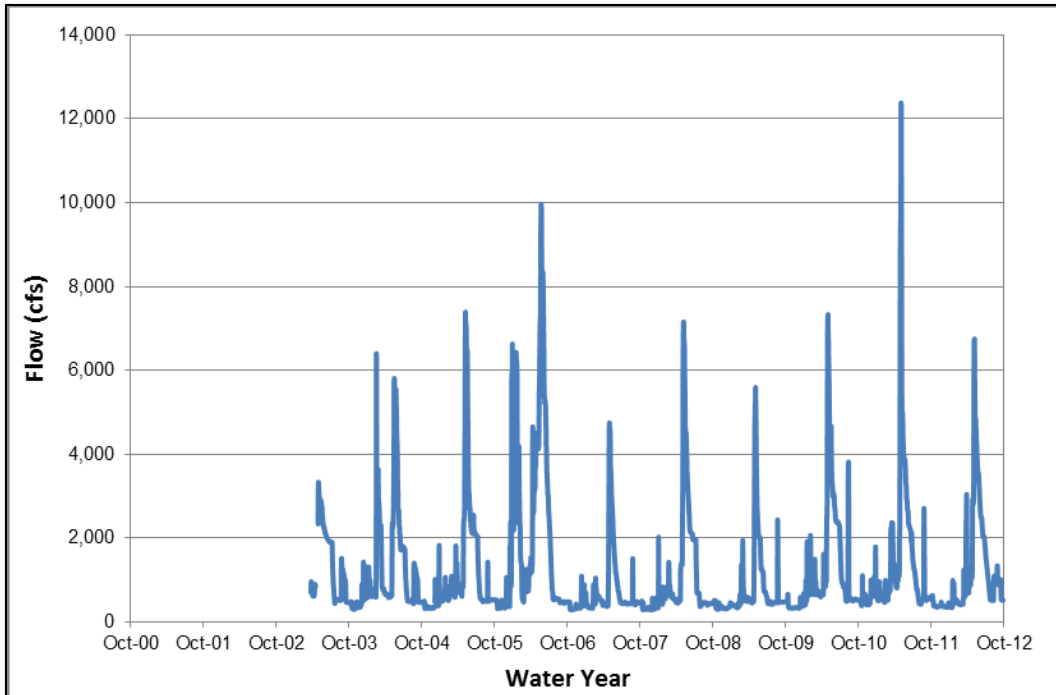
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2 **Figure 5.9 Historical Water Years 2001-2012 Lewiston Reservoir Storage**



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4 **Figure 5.10 Historical Water Years 2001-2012 Lewiston Reservoir Elevation**

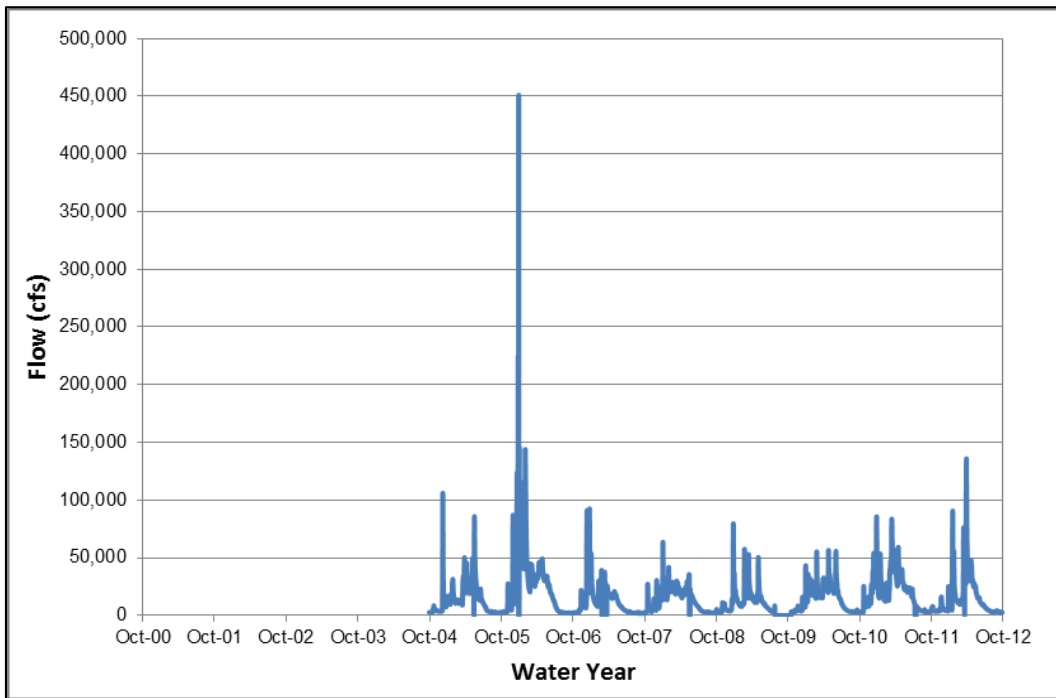


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**Figure 5.11 Historical Water Years 2003-2012 Trinity River Mean Daily Flows at Douglas City**

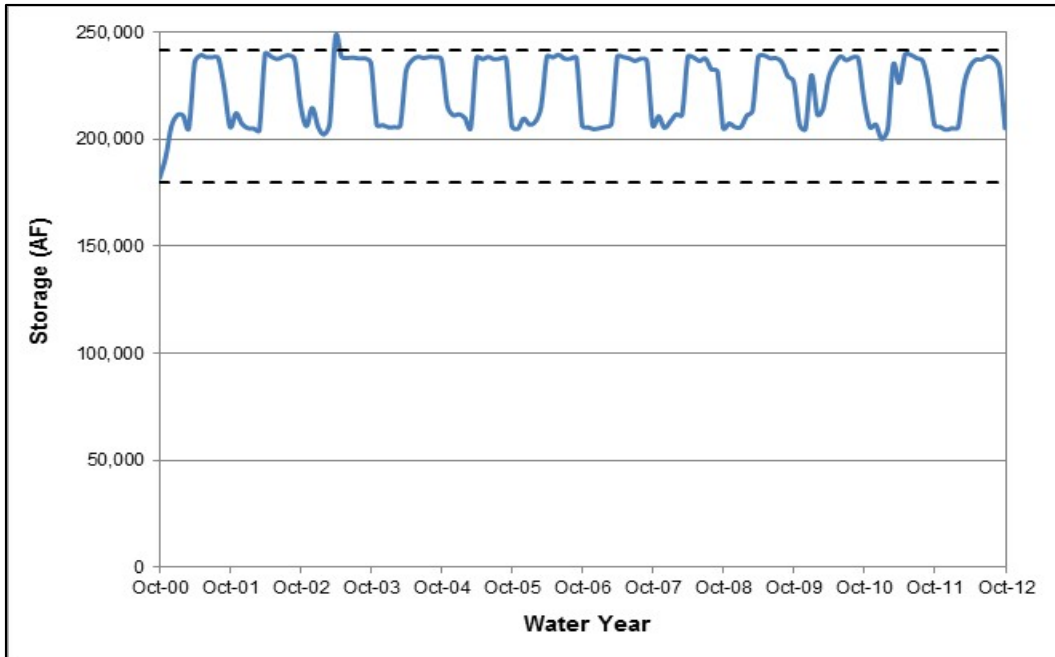


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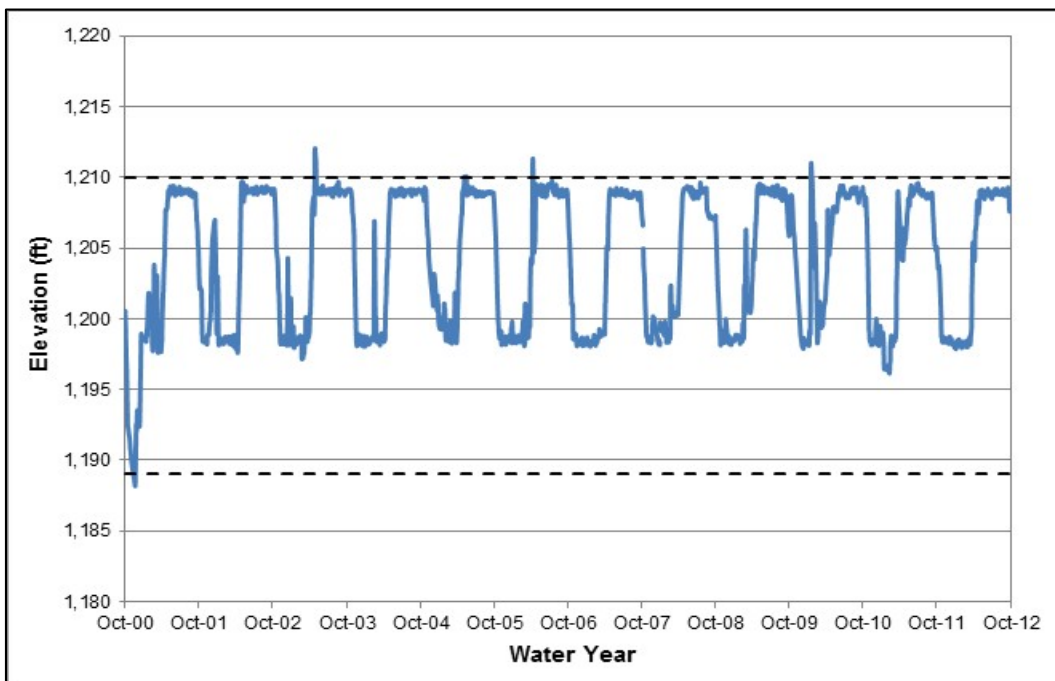
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**Figure 5.12 Historical Water Years 2005-2012 Klamath River Mean Daily Flows at Klamath**



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2 **Figure 5.13 Historical Water Years 2001-2012 Whiskeytown Lake Storage<sup>3</sup>**



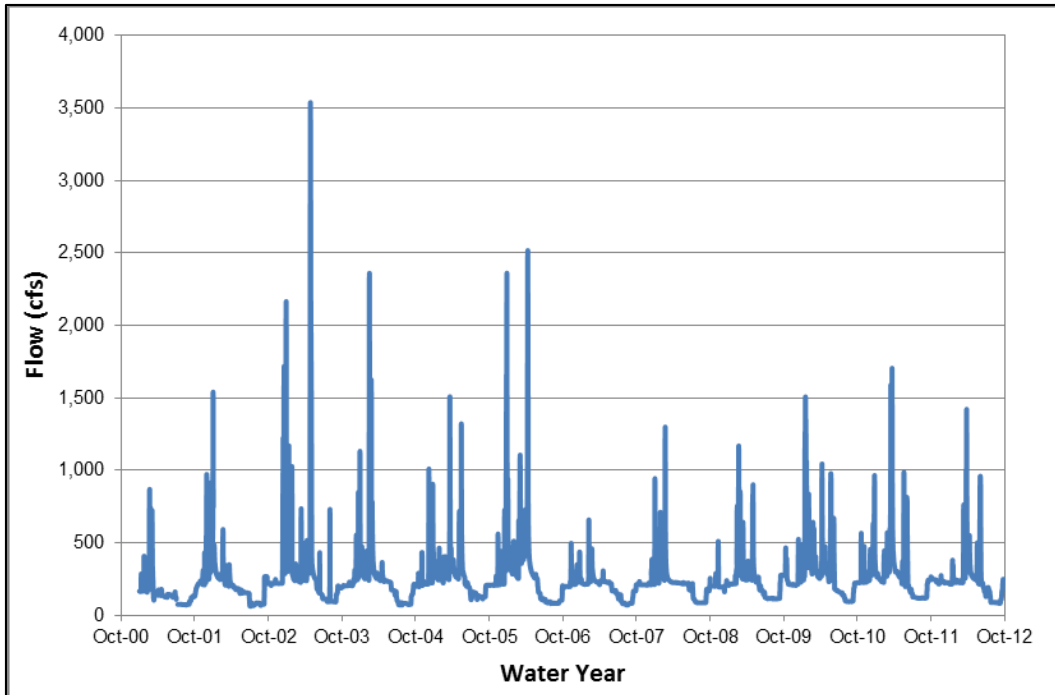
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4 **Figure 5.14 Historical Water Years 2001-2012 Whiskeytown Lake Elevation<sup>4</sup>**

<sup>3</sup> The minimum storage line of 180,000 AF was taken from CalSim II. The maximum storage line of 241,000 AF was taken from the California Data Exchange Center website <http://cdec.water.ca.gov/misc/resinfo.html>.

<sup>4</sup> The minimum elevation line of 1190 ft was taken from CalSim II. The maximum elevation line of 1,210 ft was provided by Reclamation.

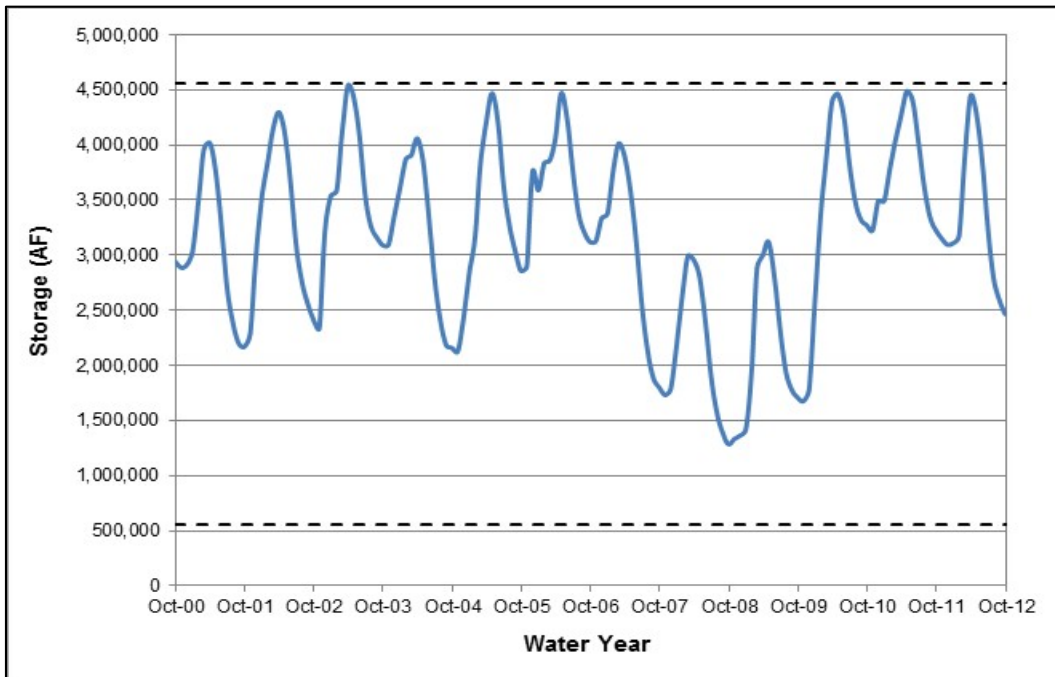




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**Figure 5.15 Historical Water Years 2001-2012 Clear Creek Mean Daily Flows at Igo**

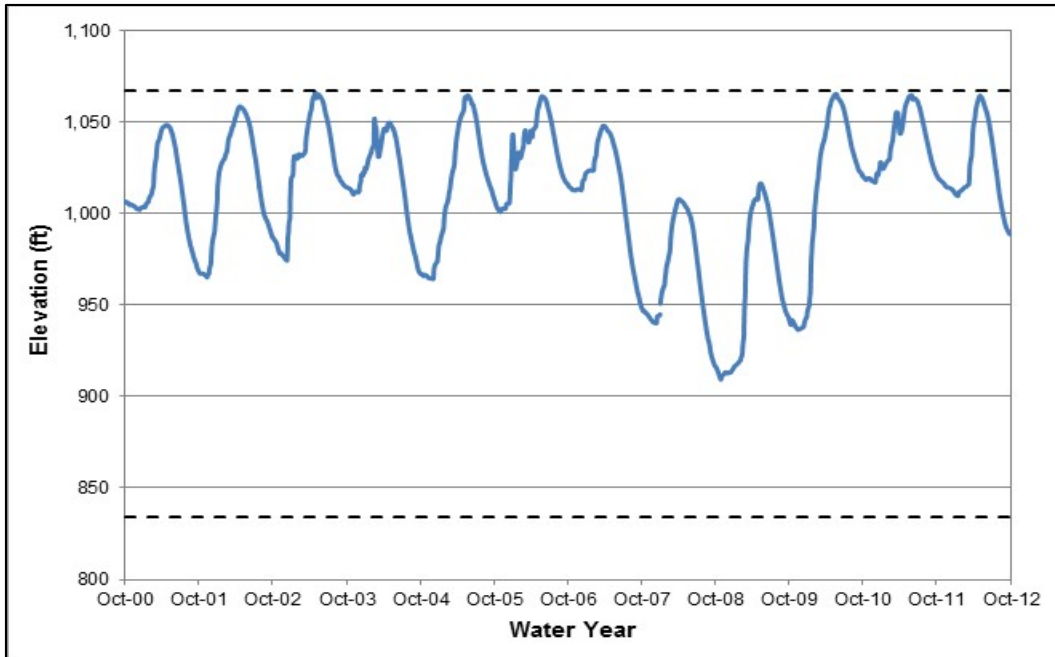


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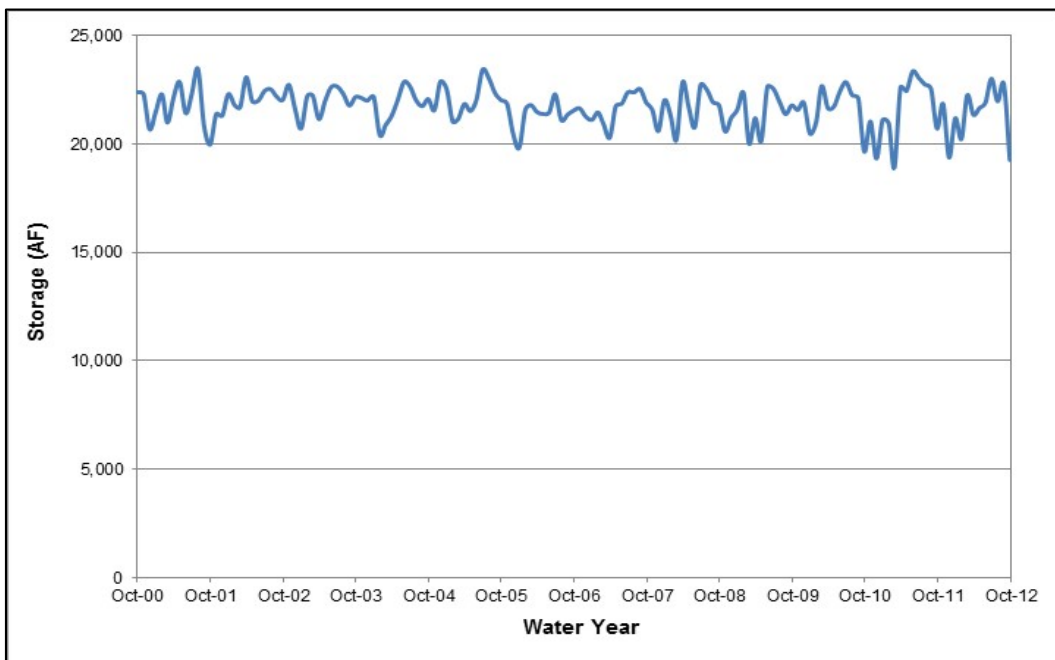
**Figure 5.16 Historical Water Years 2001-2012 Shasta Lake Storage<sup>5</sup>**

<sup>5</sup> The minimum storage line of 550,000 AF was taken from CalSim II. The maximum storage line of 4,552,000 AF was taken from the California Data Exchange Center website <http://cdec.water.ca.gov/misc/resinfo.html>.



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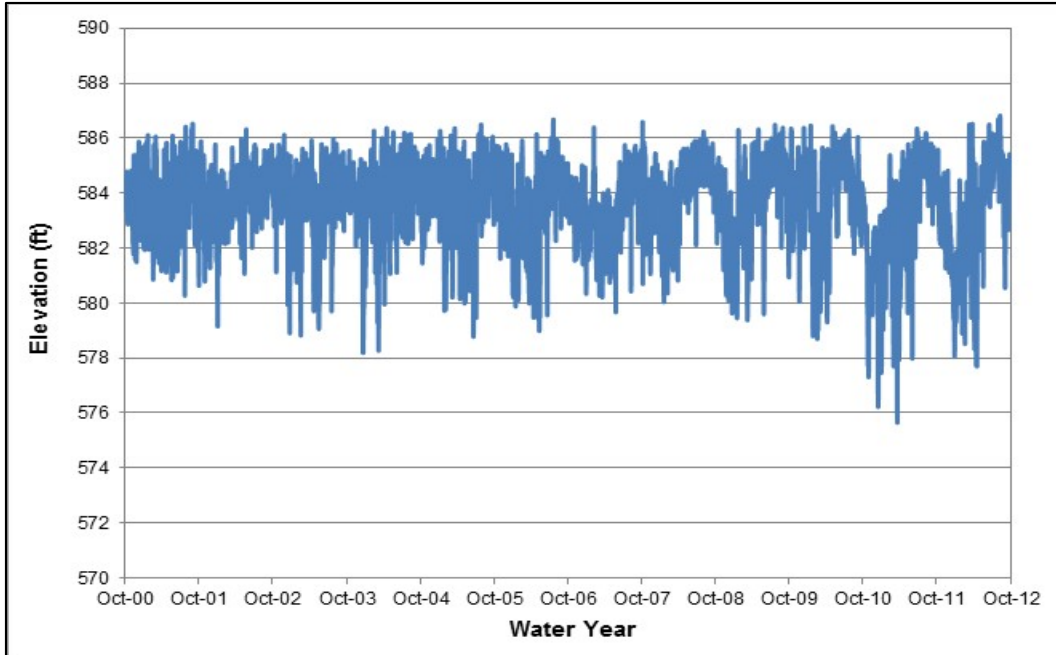
2 **Figure 5.17 Historical Water Years 2001-2012 Shasta Lake Elevation<sup>6</sup>**



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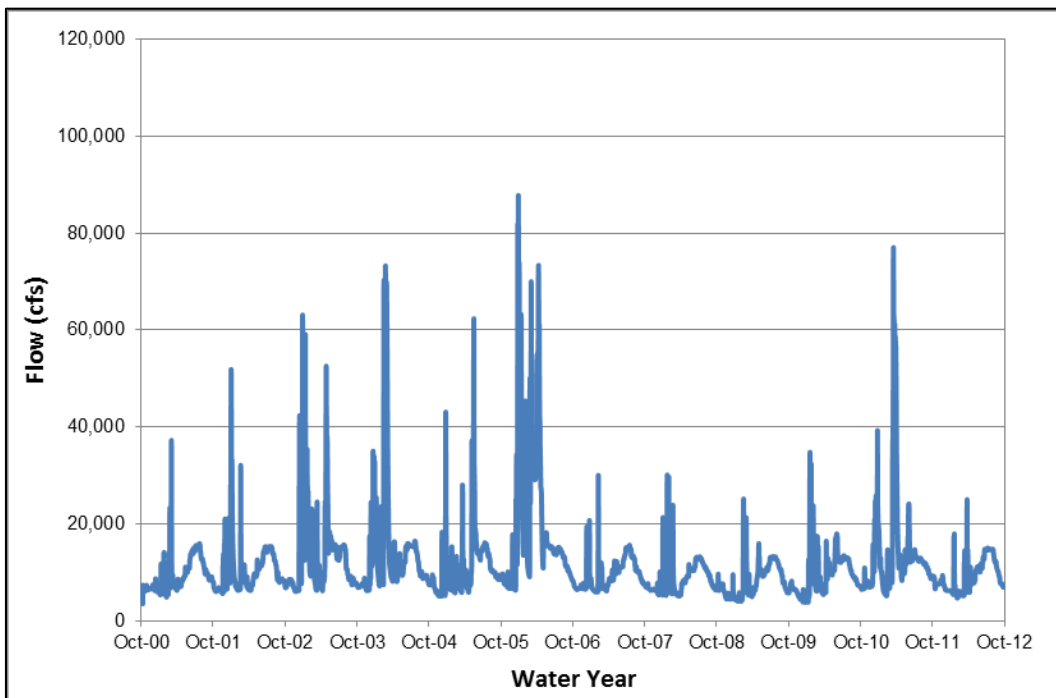
4 **Figure 5.18 Historical Water Year 2001 - 2012 Keswick Reservoir Storage**

<sup>6</sup> The minimum elevation line of 834 ft was taken from CalSim II. The maximum elevation line of 1,067 ft was provided by Reclamation.



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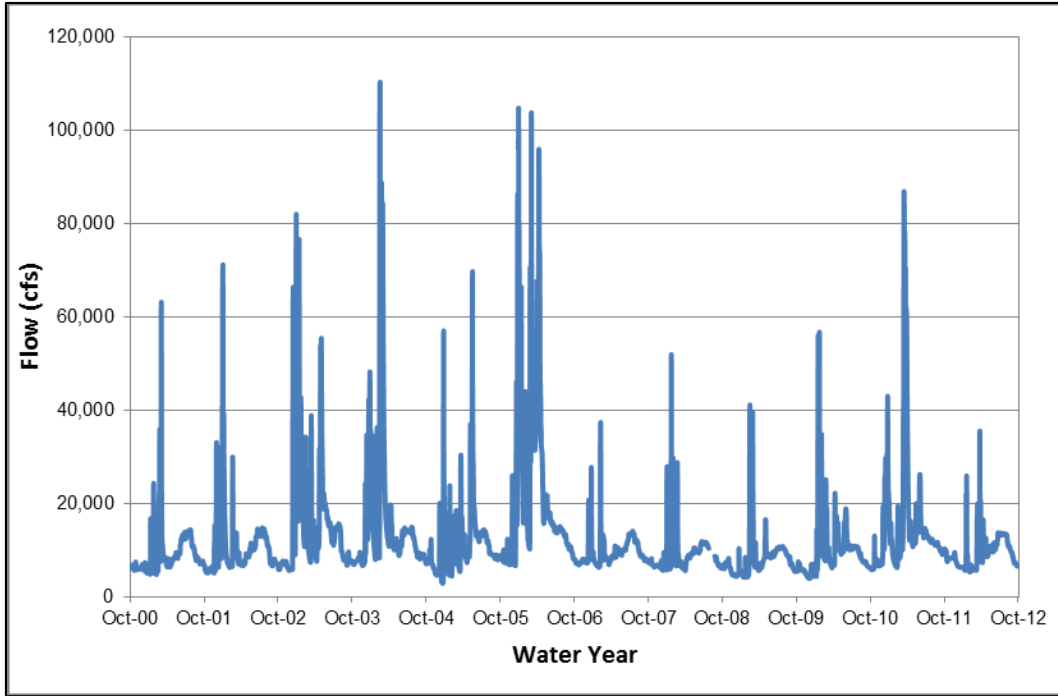
2 **Figure 5.19 Historical Water Year 2001 - 2012 Keswick Reservoir Elevation**



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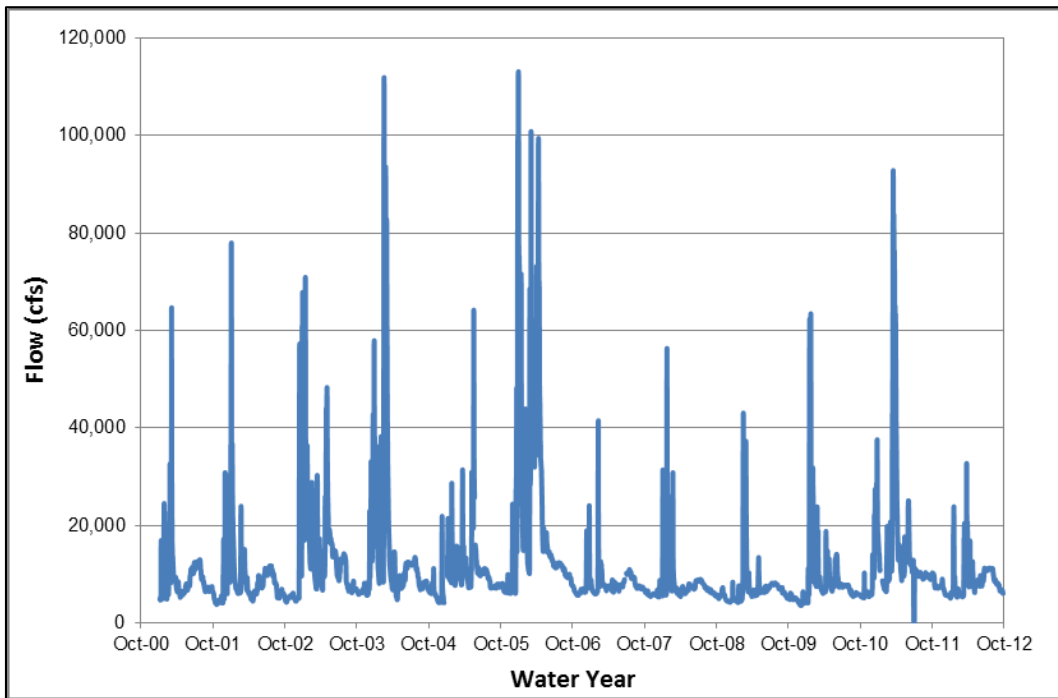
4 **Figure 5.20 Historical Water Year 2001 - 2012 Sacramento River Mean Daily Flows at Bend Bridge**

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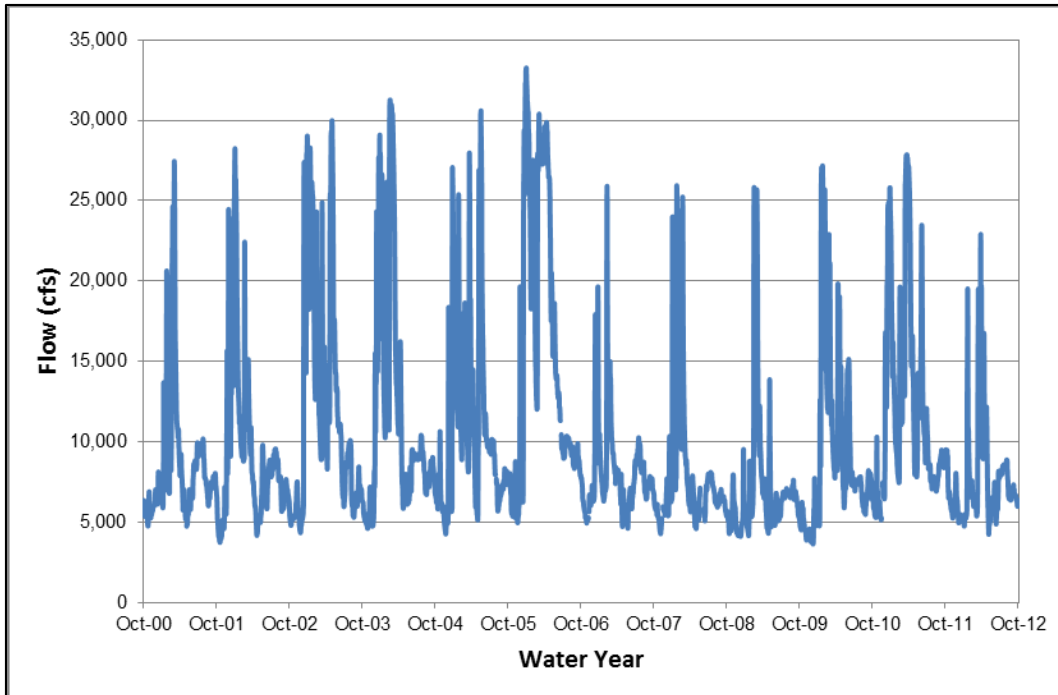
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2 **Figure 5.21 Historical Water Year 2001 - 2012 Sacramento River Mean Daily Flows**  
3 **at Vina Bridge**



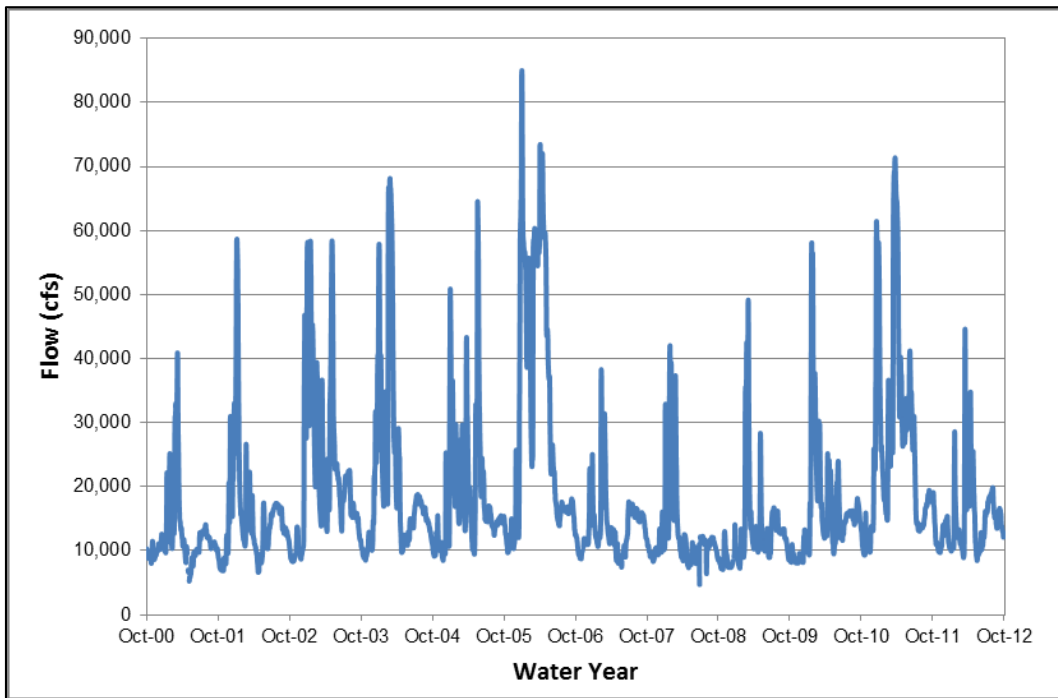
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5 **Figure 5.22 Historical Water Year 2001 - 2012 Sacramento River Mean Daily Flows**  
6 **at Hamilton City**



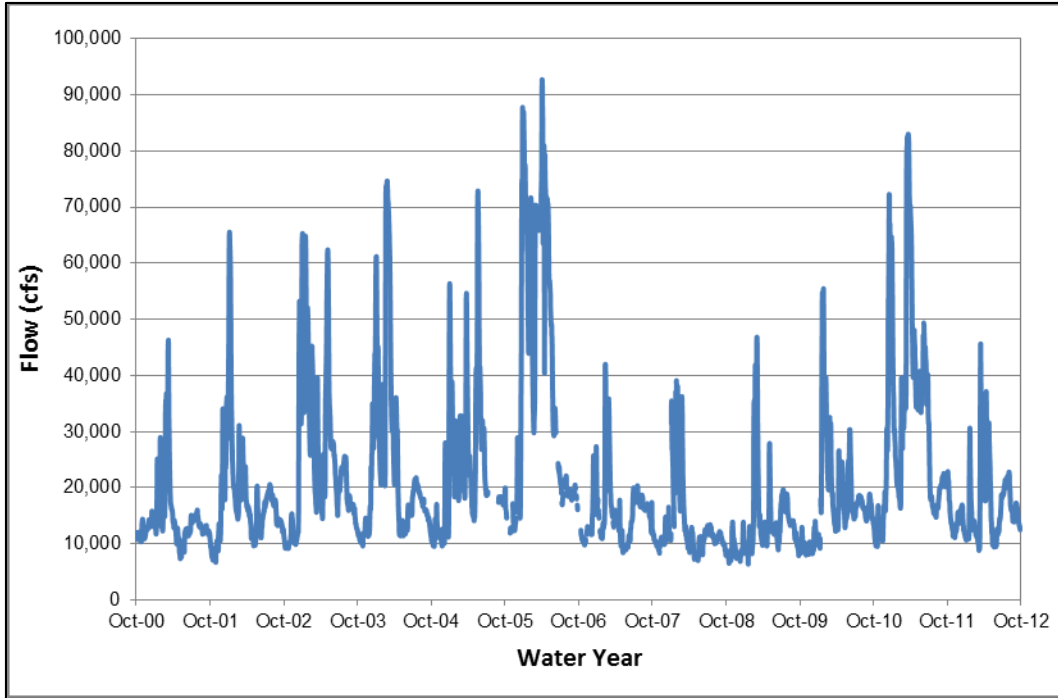
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2 **Figure 5.23 Historical Water Year 2001 - 2012 Sacramento River Mean Daily Flows**  
3 **at Wilkins Slough**



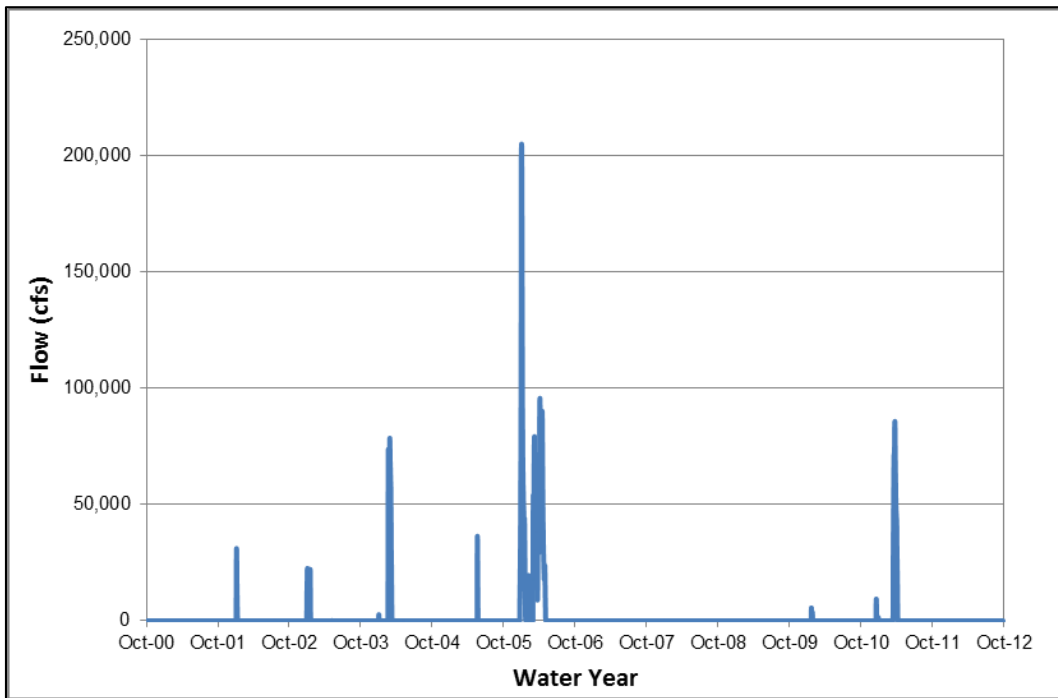
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5 **Figure 5.24 Historical Water Year 2001 - 2012 Sacramento River Mean Daily Flows**  
6 **at Verona**



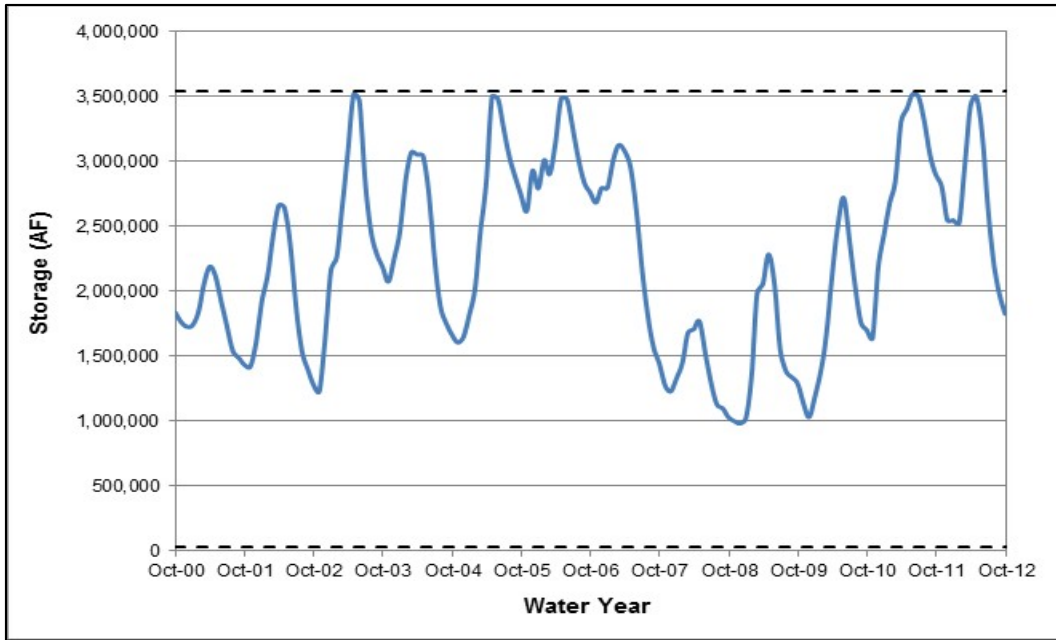
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2 **Figure 5.25 Historical Water Year 2001 - 2012 Sacramento River Mean Daily Flows**  
3 **at Freeport**



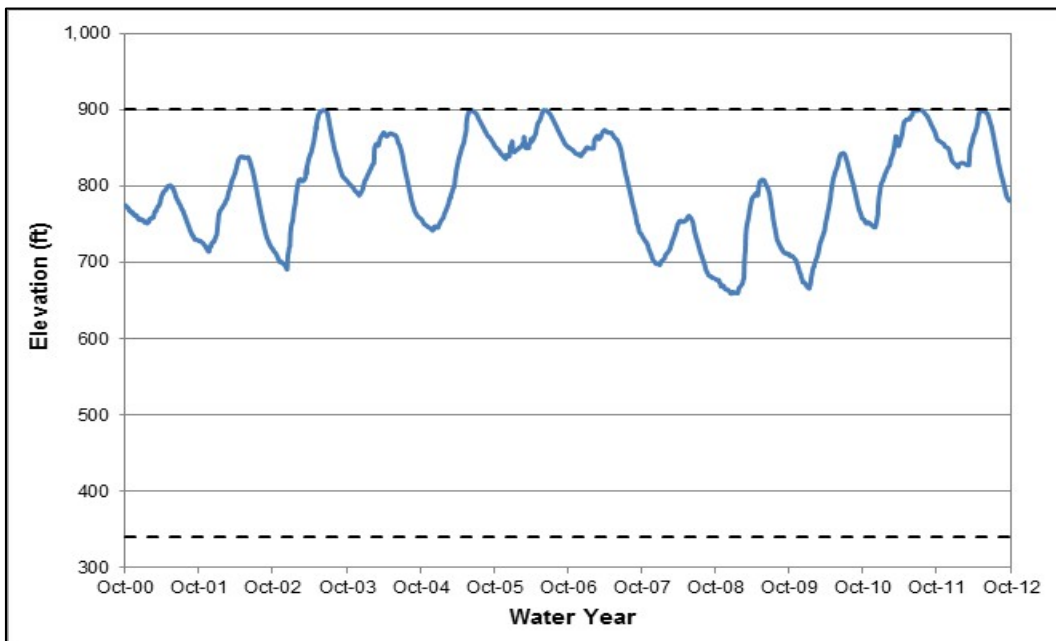
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5 **Figure 5.26 Historical Water Year 2001 - 2012 Flows into Yolo Bypass over Fremont**  
6 **Weir**



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2 **Figure 5.27 Historical Water Year 2001 - 2012 Lake Oroville Storage<sup>7</sup>**

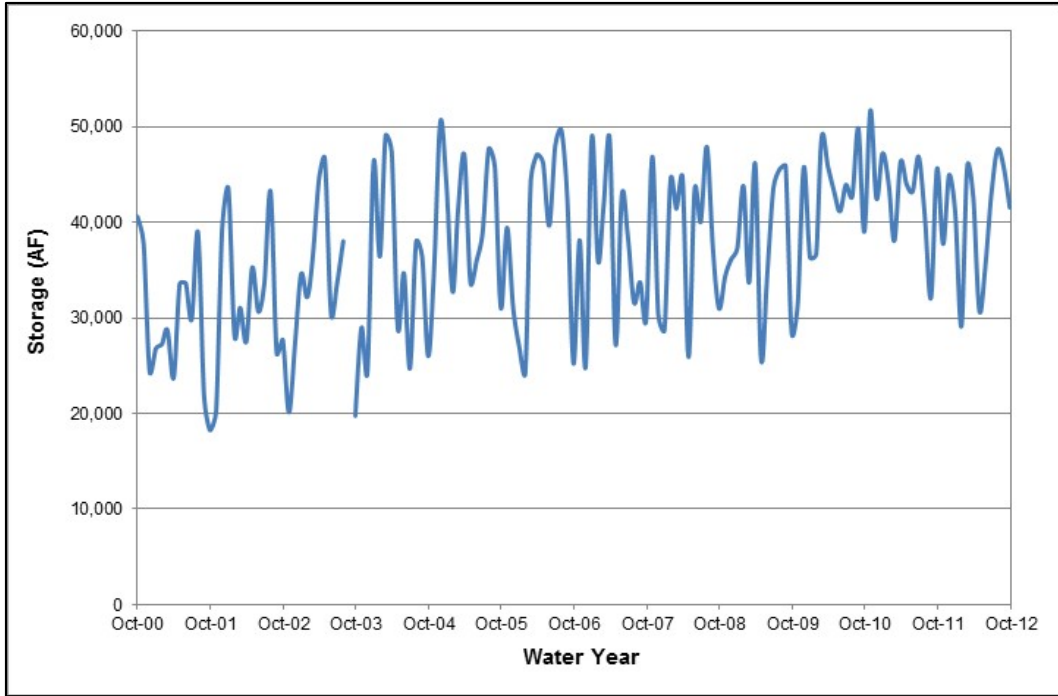


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4 **Figure 5.28 Historical Water Year 2001 - 2012 Lake Oroville Elevation<sup>8</sup>**

<sup>7</sup> The minimum storage line of 30,000 AF was taken from CalSim II. The maximum storage line of 3,537,577 AF was taken from the California Data Exchange Center website <http://cdec.water.ca.gov/misc/resinfo.html>.

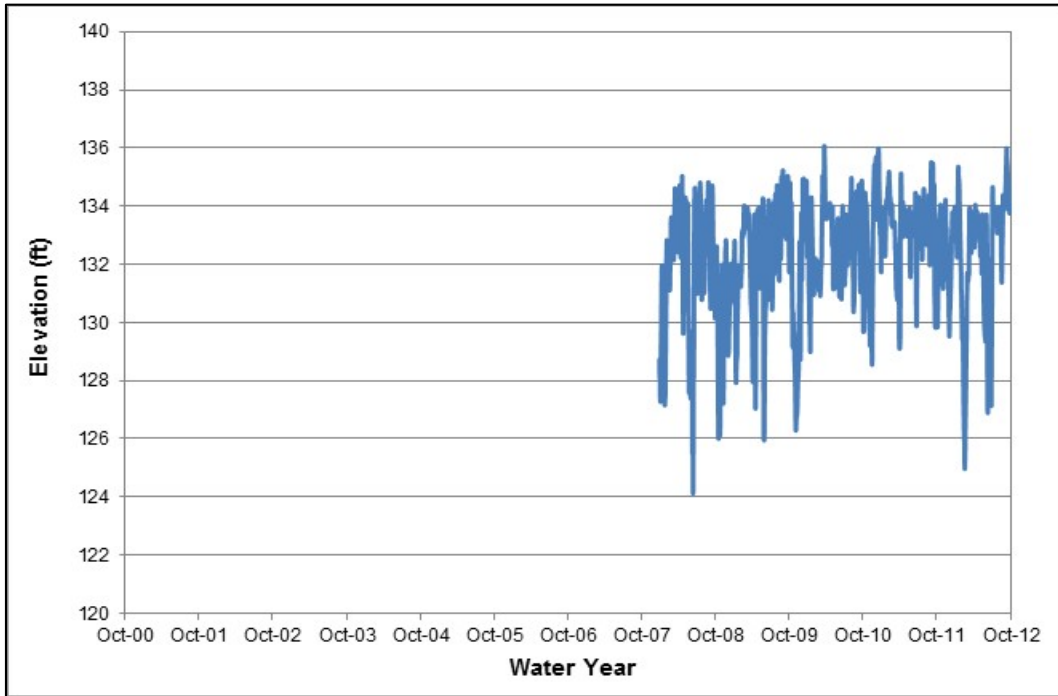
<sup>8</sup> The minimum elevation line of 340 ft was taken from CalSim II. The maximum elevation line of 900 ft was provided by Reclamation. Erroneous data on 7/9/2005 was deleted.



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**Figure 5.29 Historical Water Year 2001 - 2012 Thermalito Reservoir Storage**

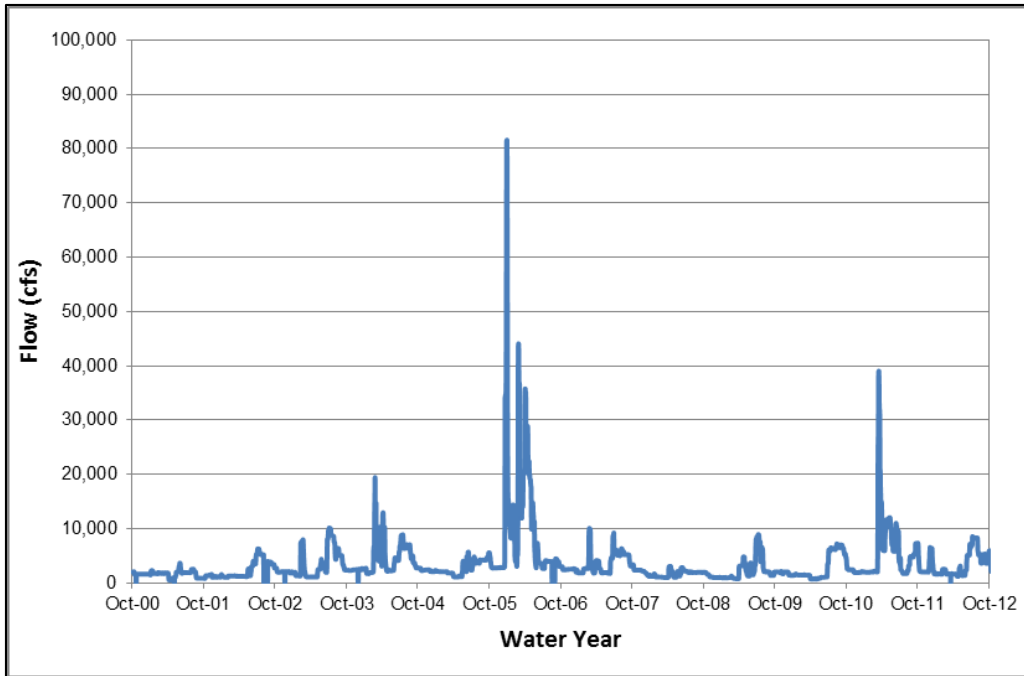


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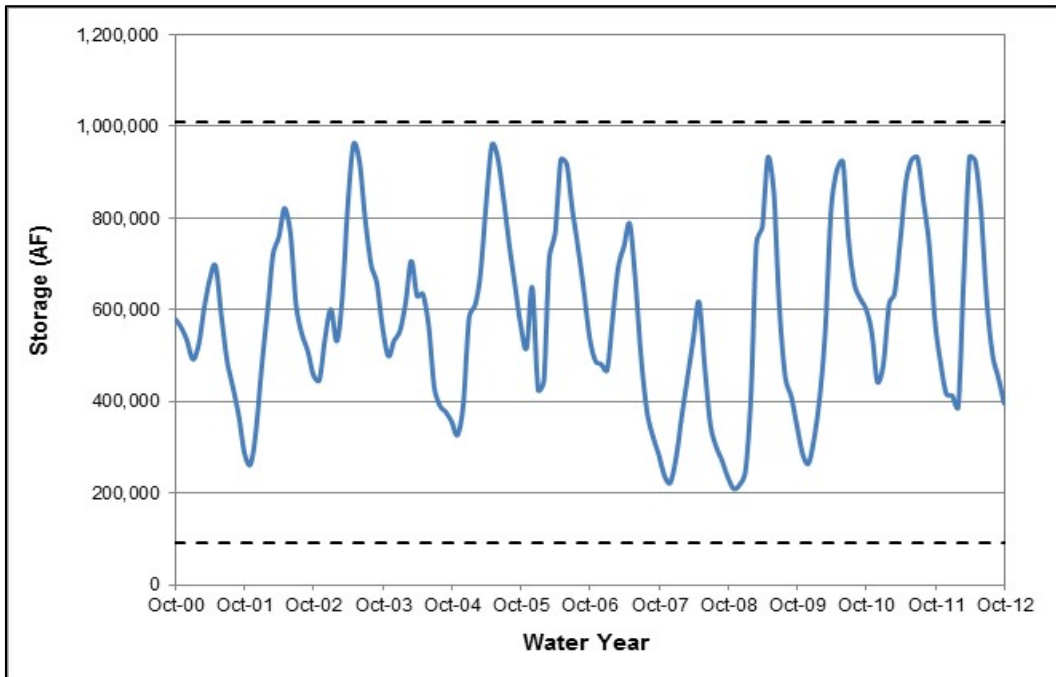
**Figure 5.30 Historical Water Year 2008 - 2012 Thermalito Reservoir Elevation**





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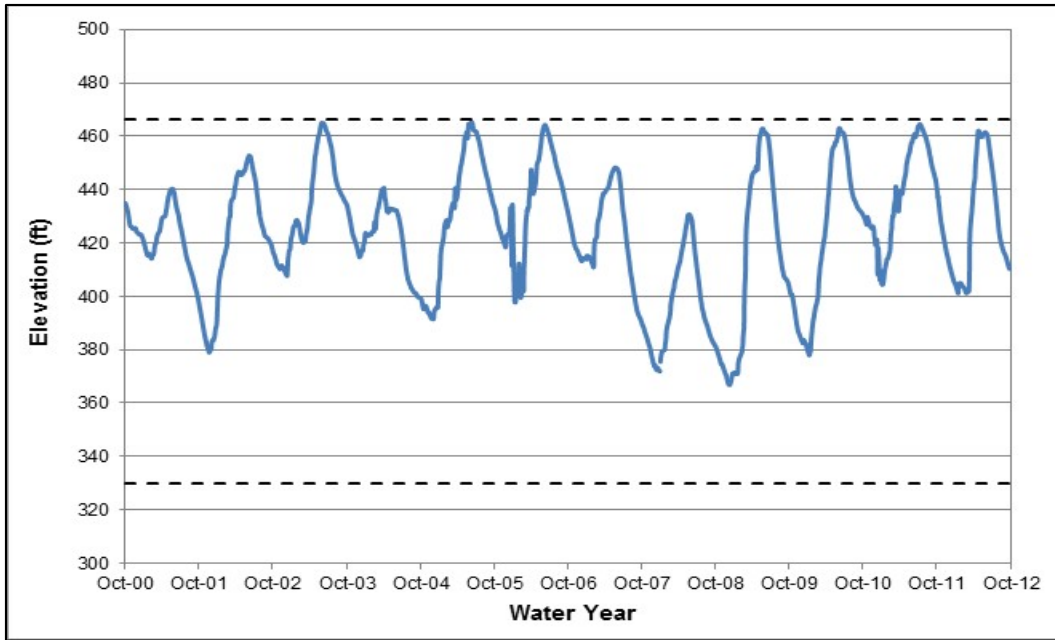
**Figure 5.31 Historical Water Year 2001 - 2012 Feather River Mean Daily Flows near Gridley**



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**Figure 5.32 Historical Water Year 2001 - 2012 Folsom Lake Storage<sup>9</sup>**

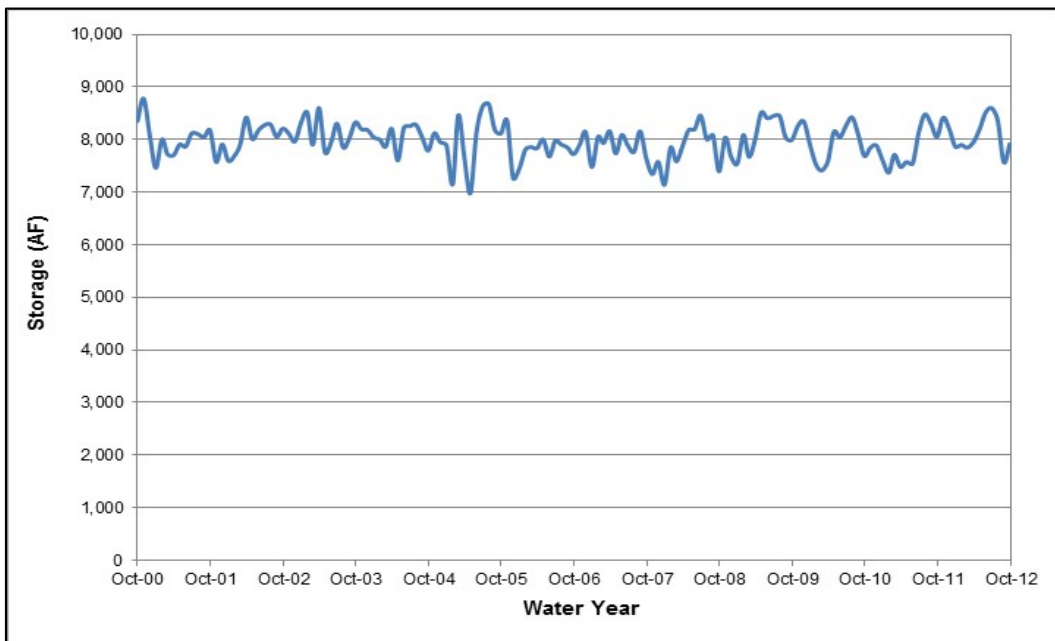
<sup>9</sup> The minimum storage line of 90,000 AF was taken from CalSim II. The maximum storage line of 977,000 AF was taken from the California Data Exchange Center website <http://cdec.water.ca.gov/misc/resinfo.html>.



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**Figure 5.33 Historical Water Year 2001 - 2012 Folsom Lake Elevation<sup>10</sup>**

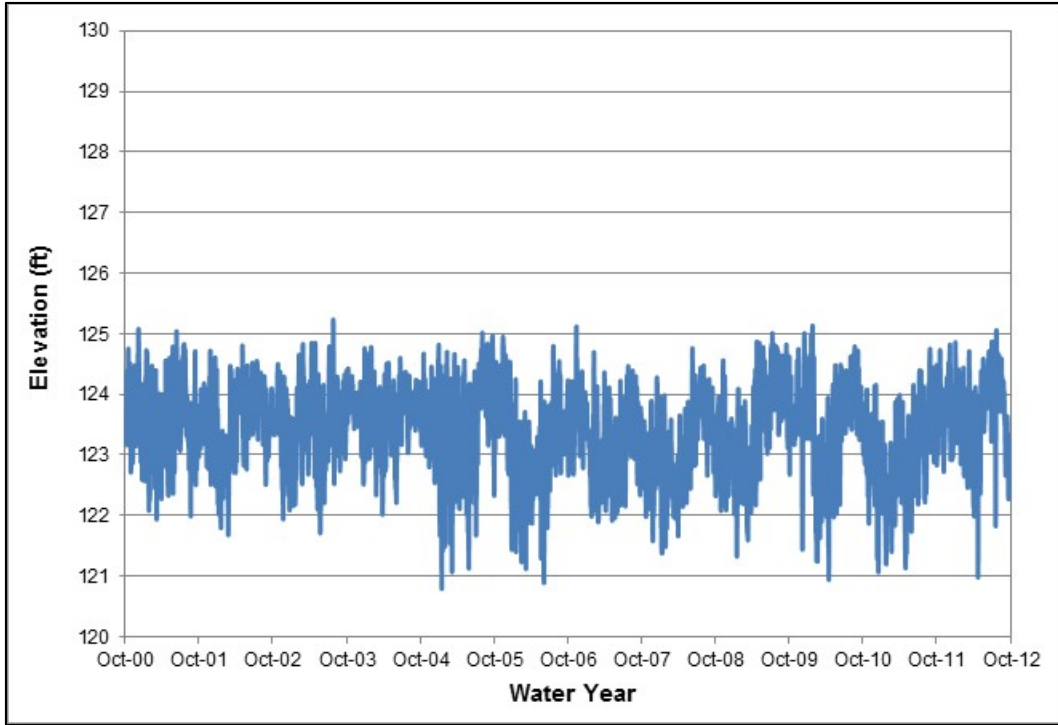


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**Figure 5.34 Historical Water Year 2001 - 2012 Lake Natoma Storage**

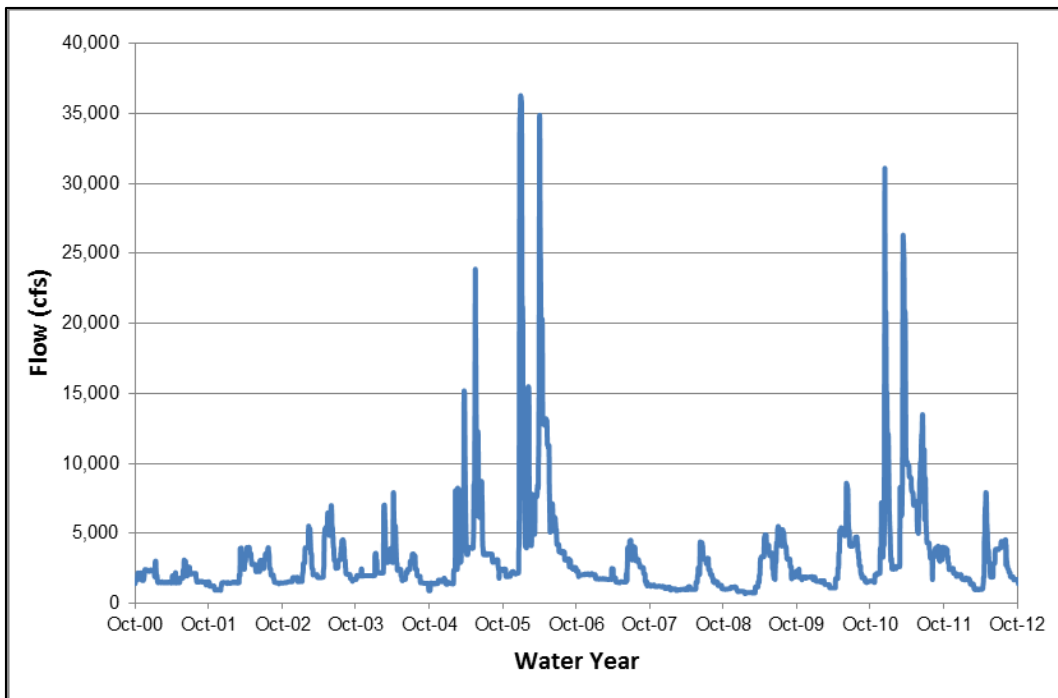
<sup>10</sup> The minimum elevation line of 330 ft was taken from CalSim II. The maximum elevation line of 466 ft was provided by Reclamation.



1

2

**Figure 5.35 Historical Water Year 2001 - 2012 Lake Natoma Elevation**

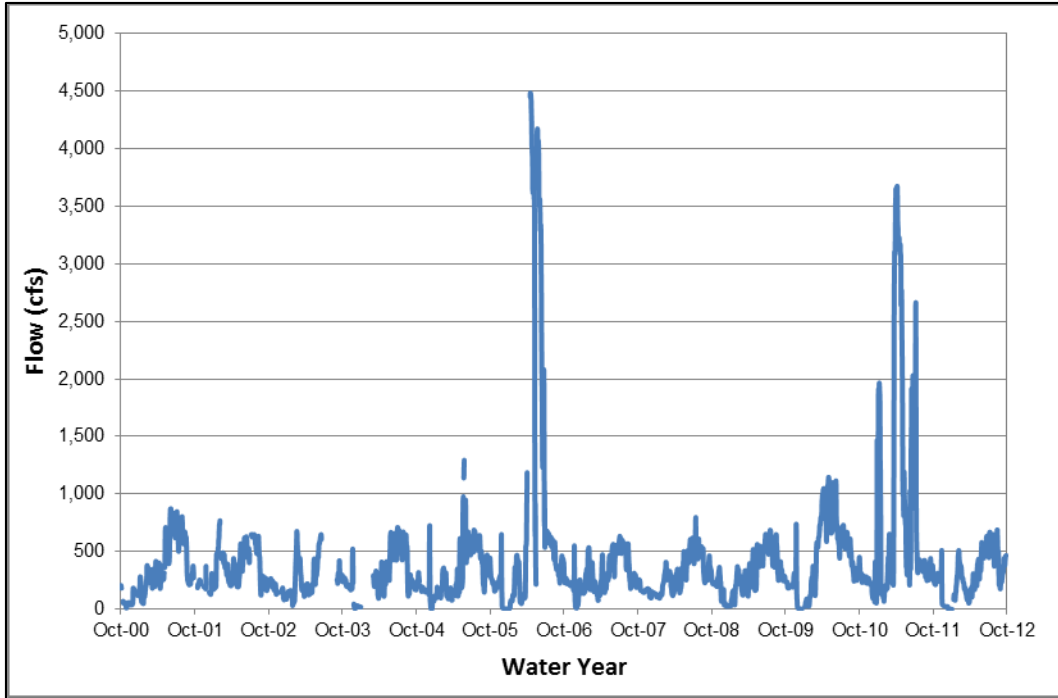


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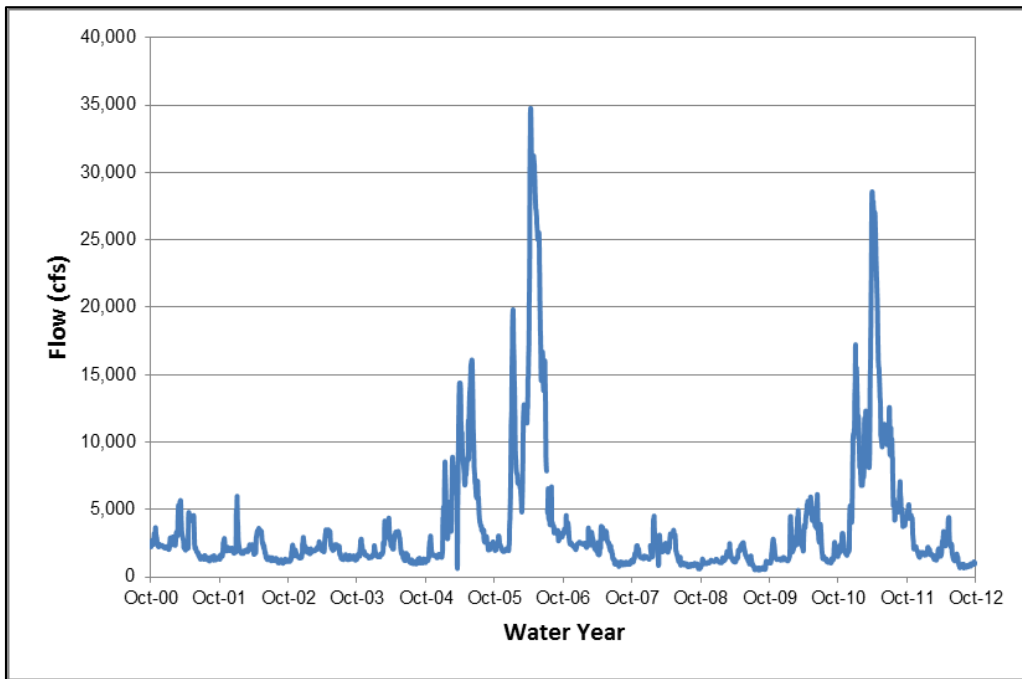
5

**Figure 5.36 Historical Water Year 2001 - 2012 American River Mean Daily Flows at Fair Oaks**



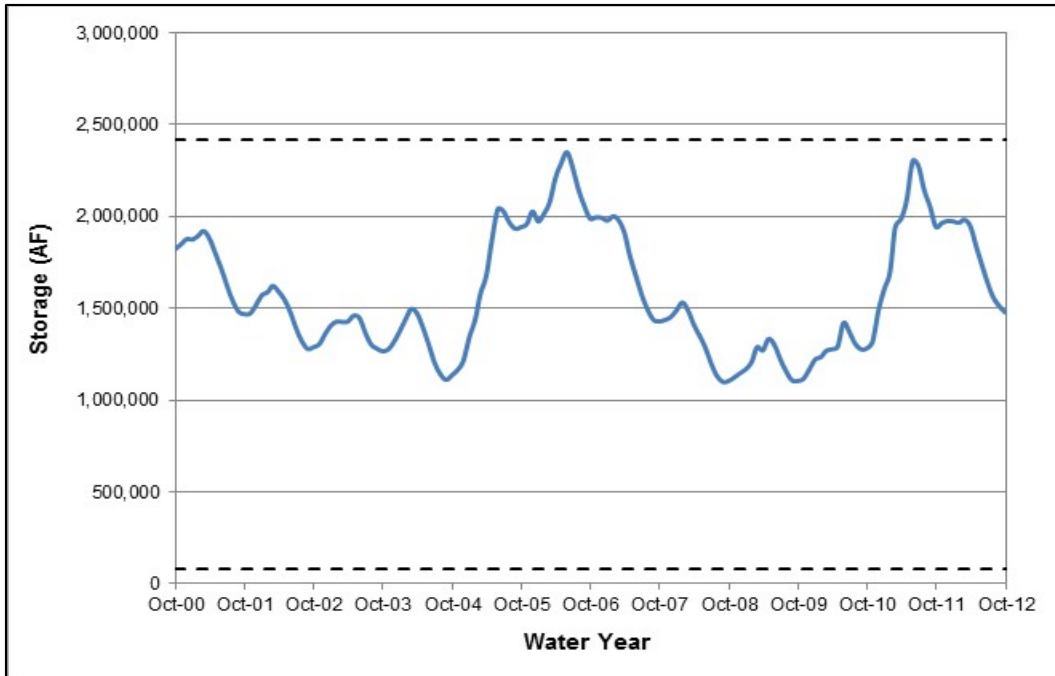
1

2 **Figure 5.37 Historical Water Year 2001 - 2012 San Joaquin River Mean Daily Flows**  
3 **at Mendota**



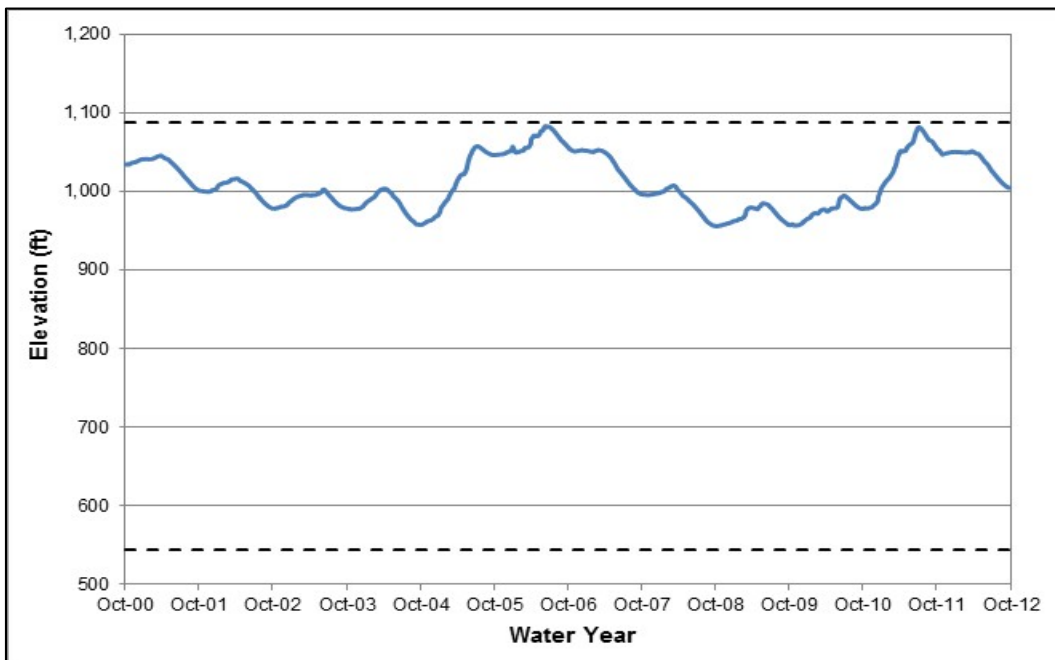
4

5 **Figure 5.38 Historical Water Year 2001 - 2012 San Joaquin River Mean Daily Flows**  
6 **at Vernalis**



1

2 **Figure 5.39 Historical Water Year 2001 - 2012 New Melones Reservoir Storage<sup>11</sup>**

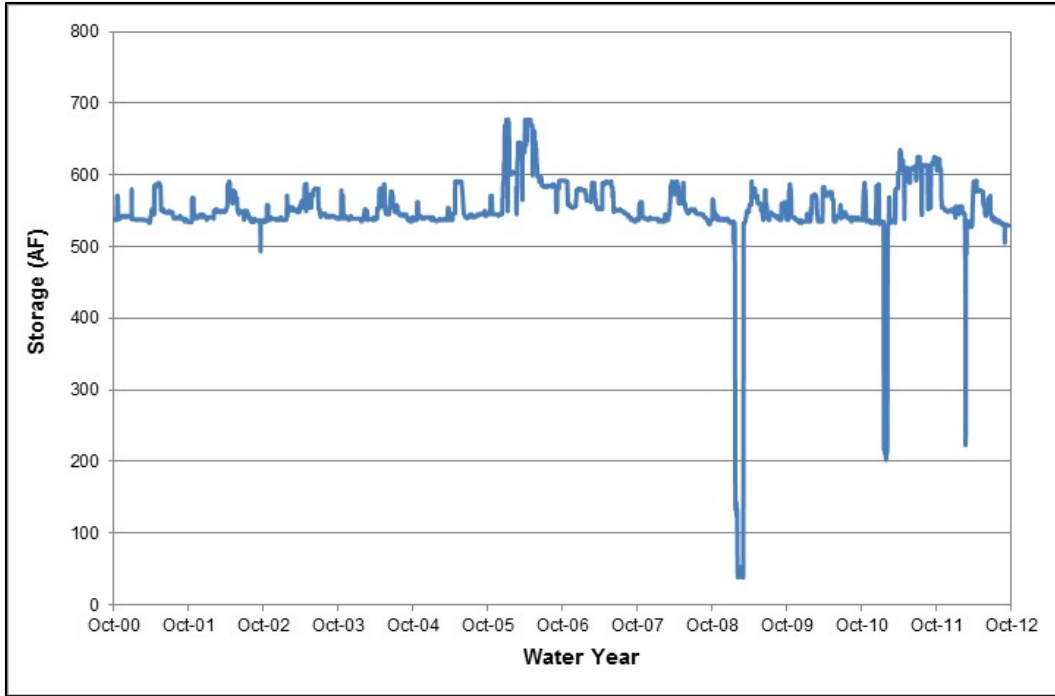


3

4 **Figure 5.40 Historical Water Year 2001 - 2012 New Melones Reservoir Elevation<sup>12</sup>**

<sup>11</sup> The minimum storage line of 80,000 AF was taken from CalSim II. The maximum storage line of 2,400,000 AF was taken from the California Data Exchange Center website <http://cdec.water.ca.gov/misc/resinfo.html>.

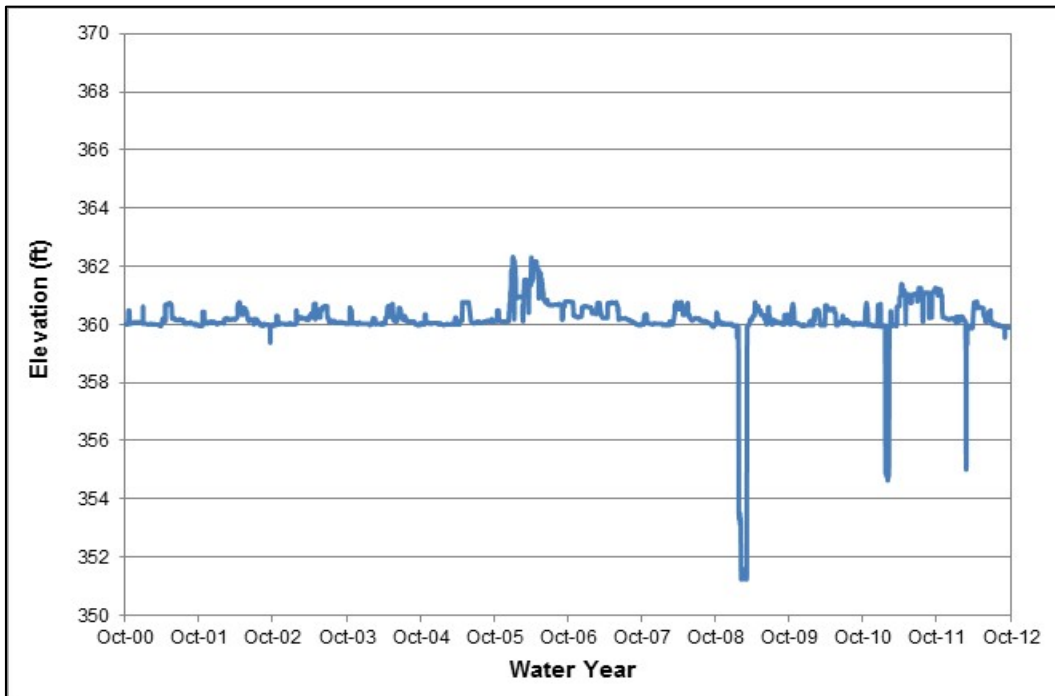
<sup>12</sup> The dead pool elevation of 543 feet and normal pool elevation of 1,088 feet was taken from CalSim II.



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**Figure 5.41 Historical Water Year 2001 - 2012 Goodwin Reservoir Storage**

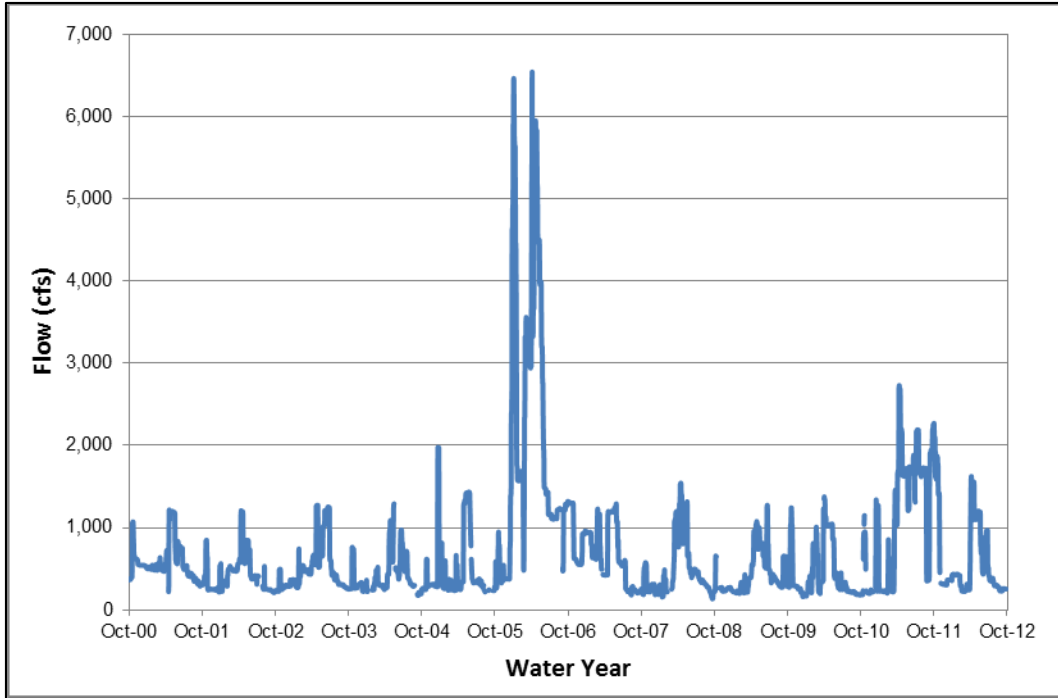


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**Figure 5.42 Historical Water Year 2001 - 2012 Goodwin Reservoir Elevation<sup>13</sup>**

<sup>13</sup> Erroneous data on 10/30/2002 was removed.

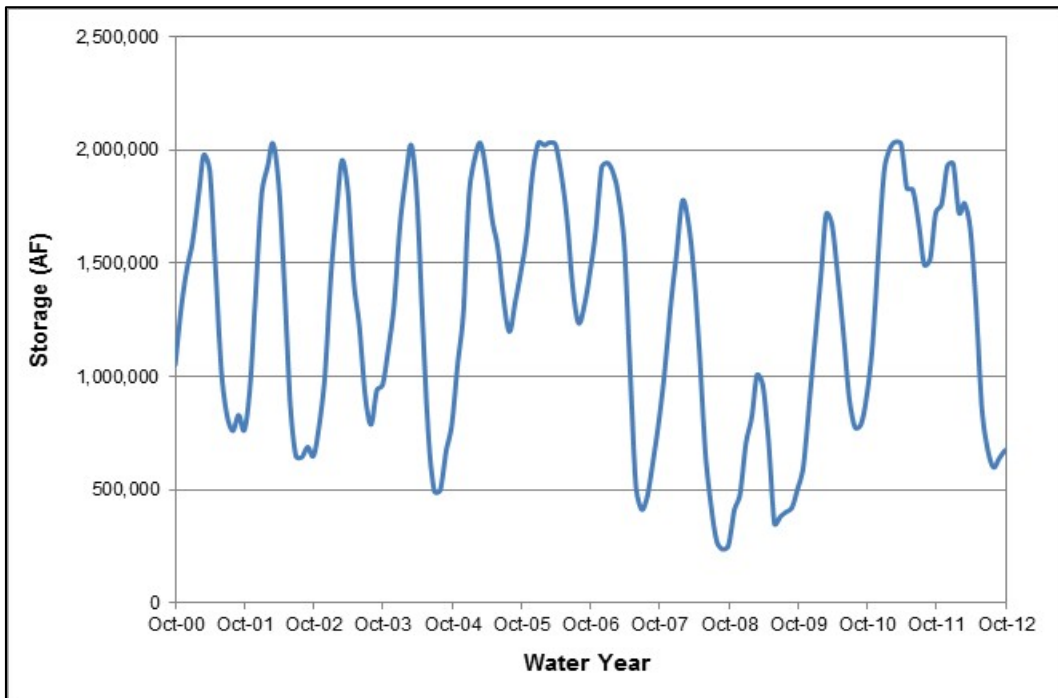


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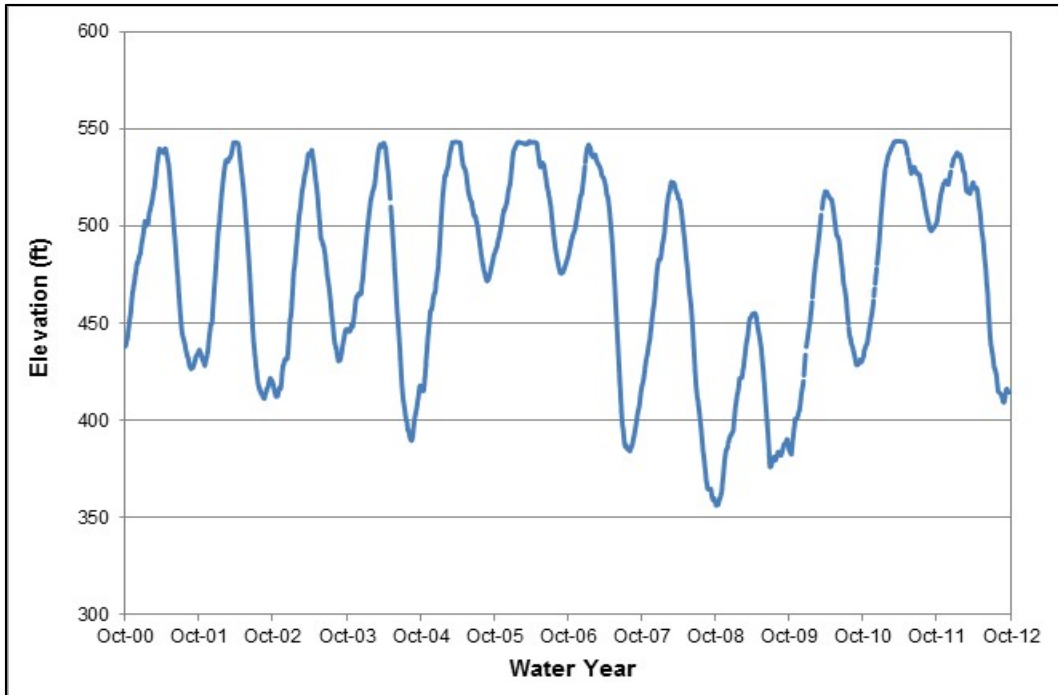
**Figure 5.43 Historical Water Year 2001 - 2012 Stanislaus River Mean Daily Flows at Orange Blossom Bridge**



4

5

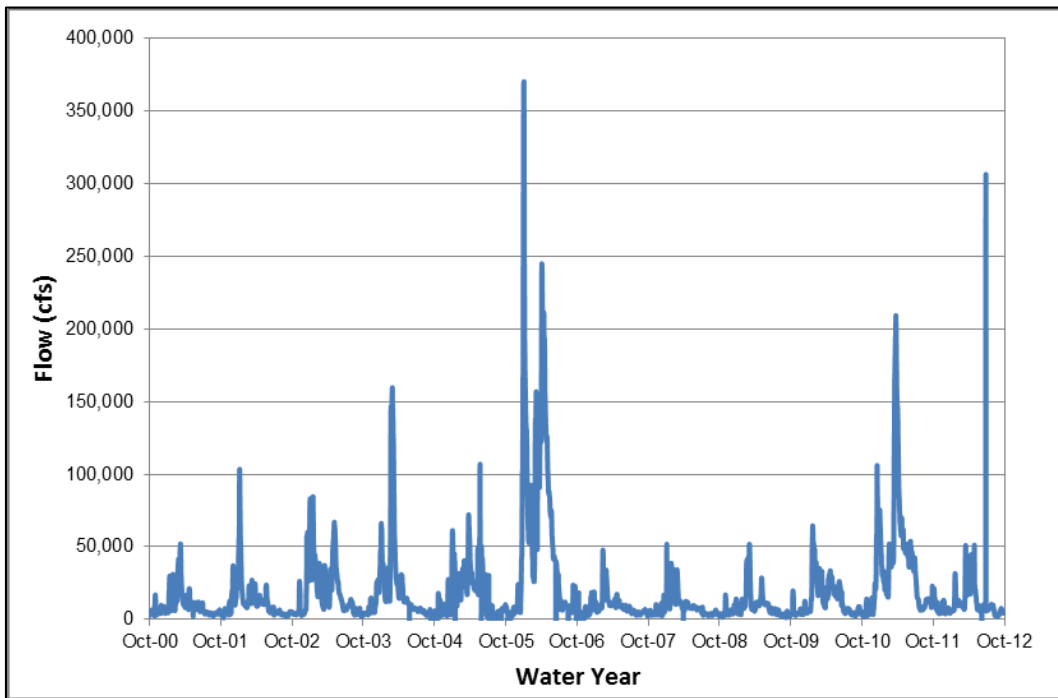
**Figure 5.44 Historical Water Year 2001 - 2012 San Luis Reservoir Storage**



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2

**Figure 5.45 Historical Water Year 2001 - 2012 San Luis Reservoir Elevation<sup>14</sup>**



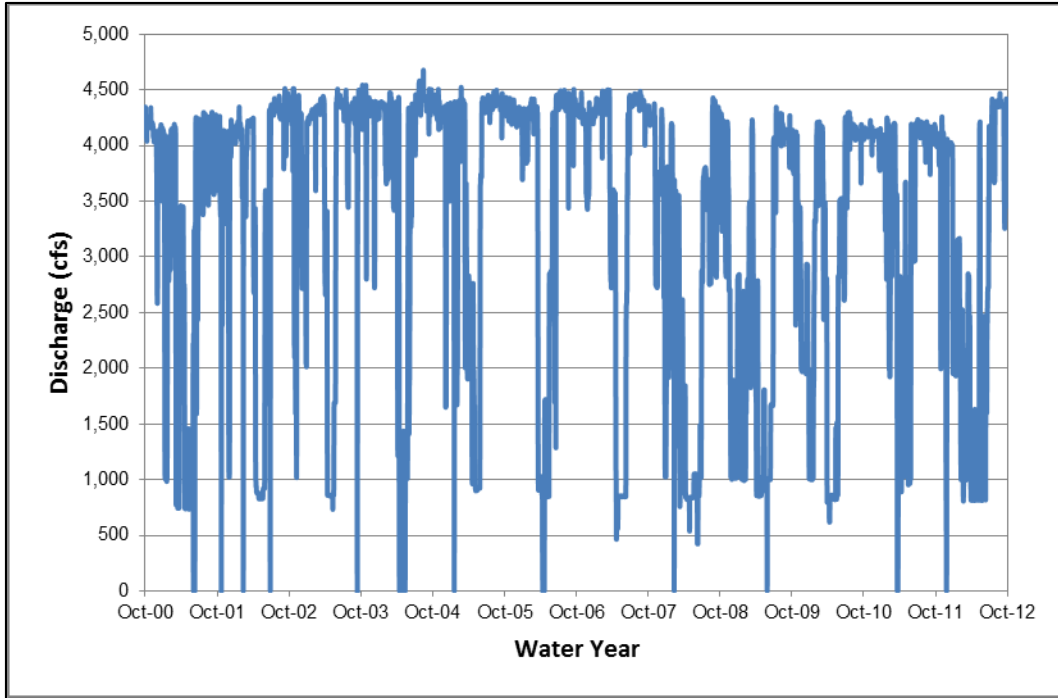
3

4

**Figure 5.46 Historical Water Year 2001 - 2012 Delta Outflow Mean Daily Flows**

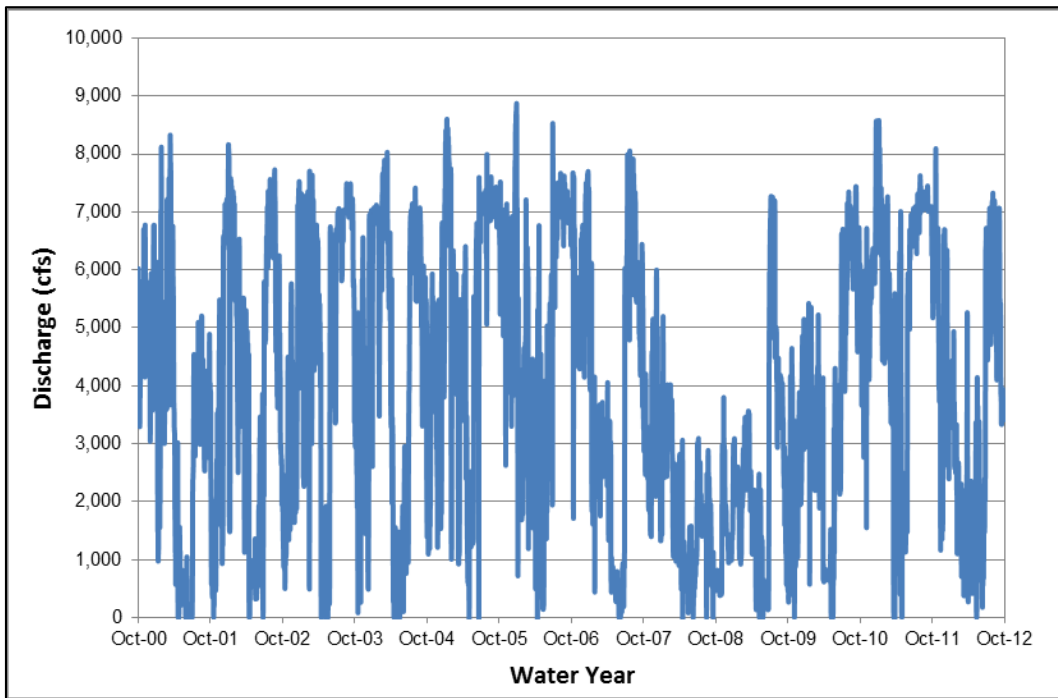
<sup>14</sup> Erroneous data on 10/13/2003, 9/18/2007, and 7/19/2010 was removed.





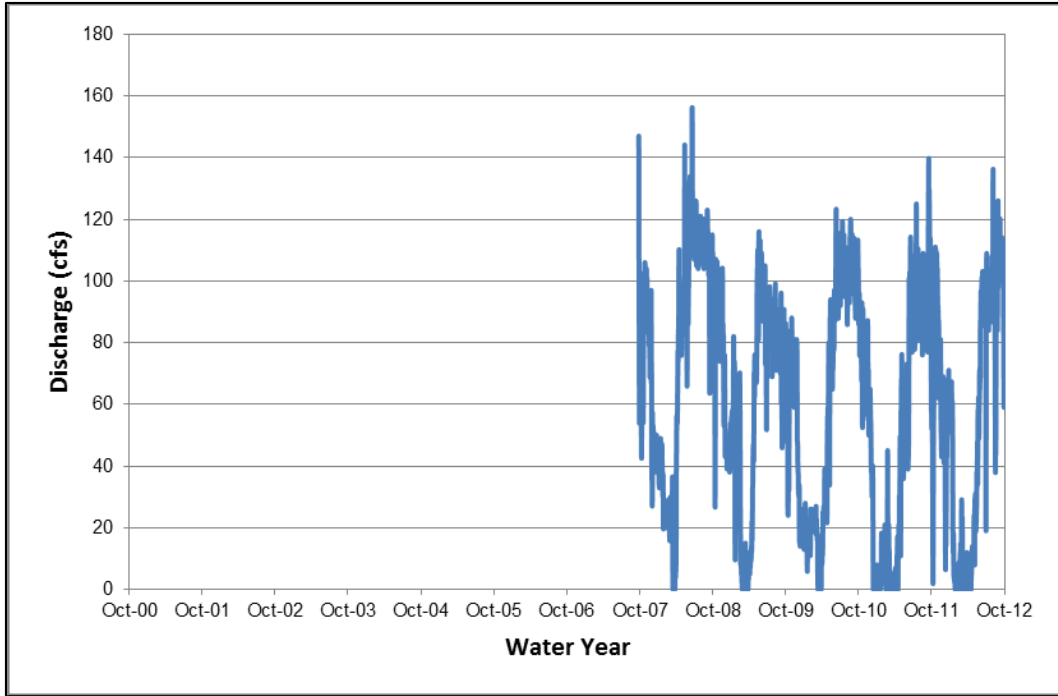
1

2 **Figure 5.47 Historical Water Year 2001 - 2012 Jones Pumping Plant Mean Daily**  
3 **Flows**



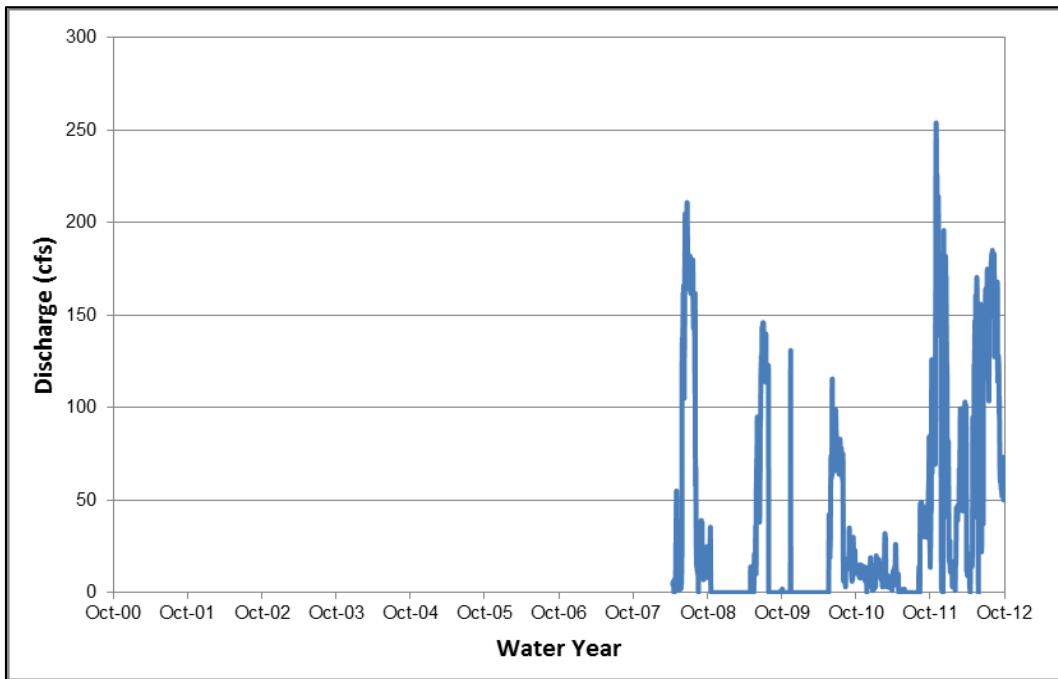
4

5 **Figure 5.48 Historical Water Year 2001 - 2012 Banks Pumping Plant Mean Daily**  
6 **Flows**



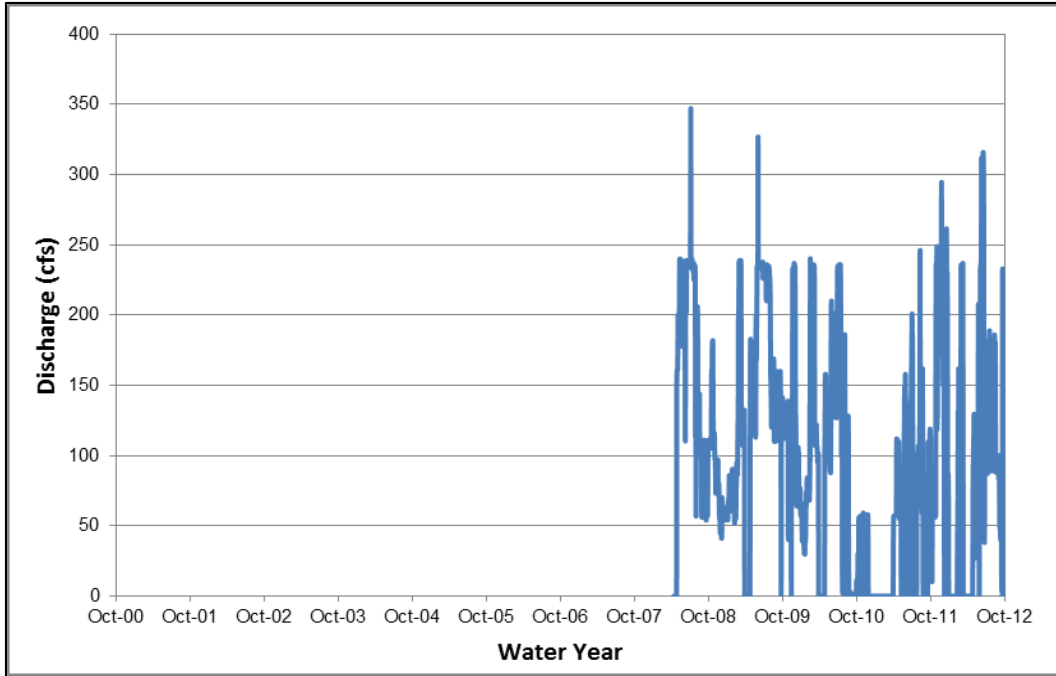
1

2 **Figure 5.49 Historical Water Year 2008 - 2012 Barker Slough Pumping Plant Mean**  
3 **Daily Flows**



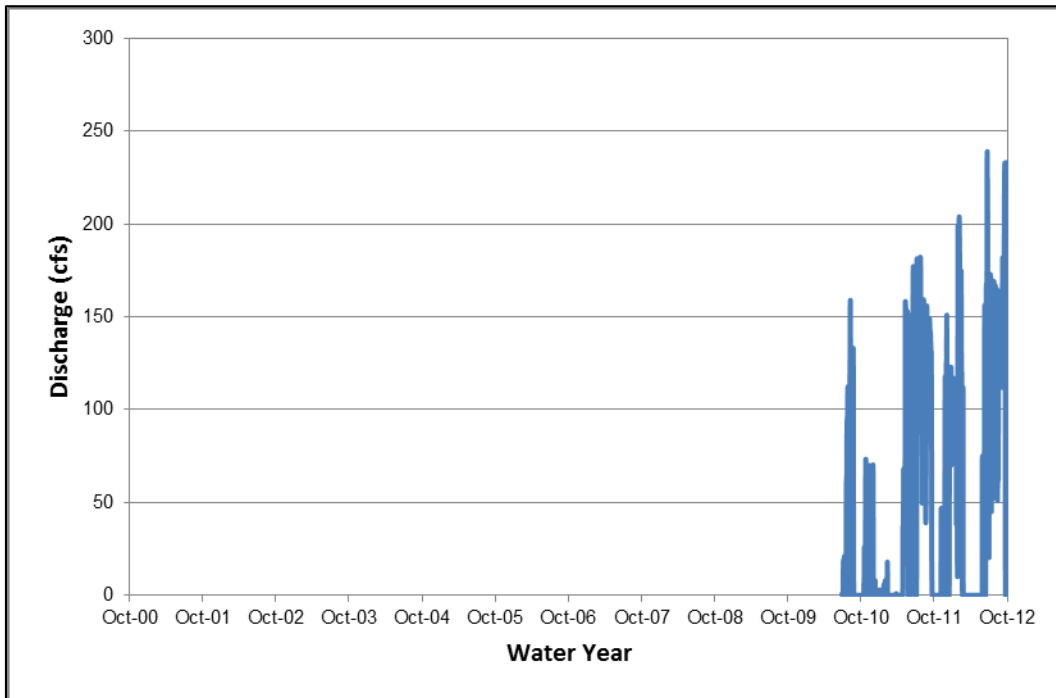
4

5 **Figure 5.50 Water Year 2008 – 2012 Contra Costa Canal Rock Slough Intake Mean**  
6 **Daily Flows**



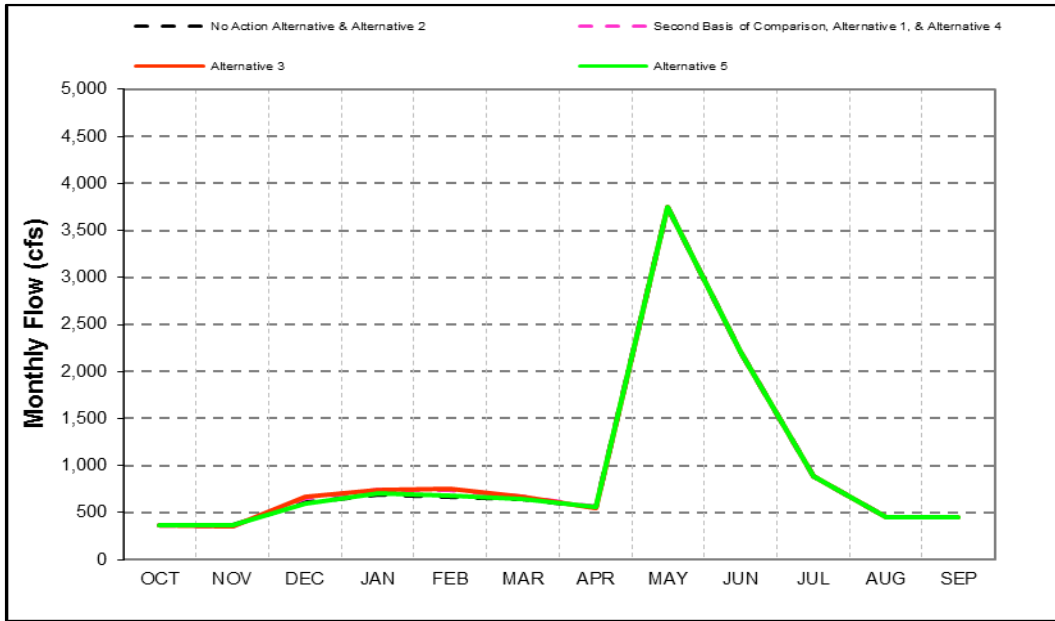
1

2 **Figure 5.51 Historical Water Year 2008 - 2012 Contra Costa Water District Old River**  
3 **Intake Mean Daily Flows**



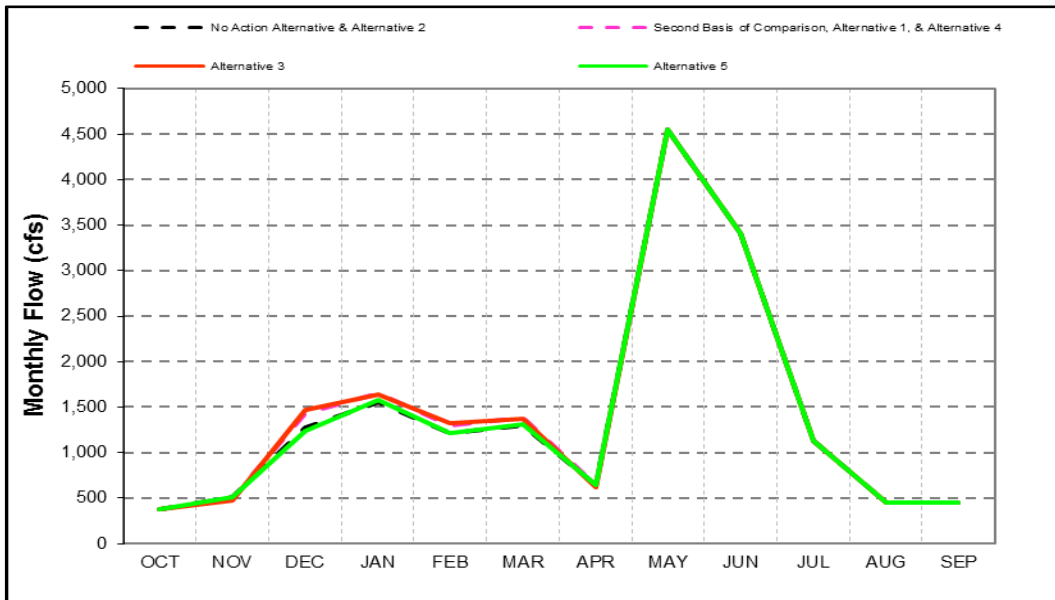
4

5 **Figure 5.52 Historical Water Year 2010 - 2012 Contra Costa Water District Middle**  
6 **River Intake Mean Daily Flows**



1

2 **Figure 5.53 Trinity River below Lewiston Reservoir, Long-Term Average Flow<sup>15</sup>**

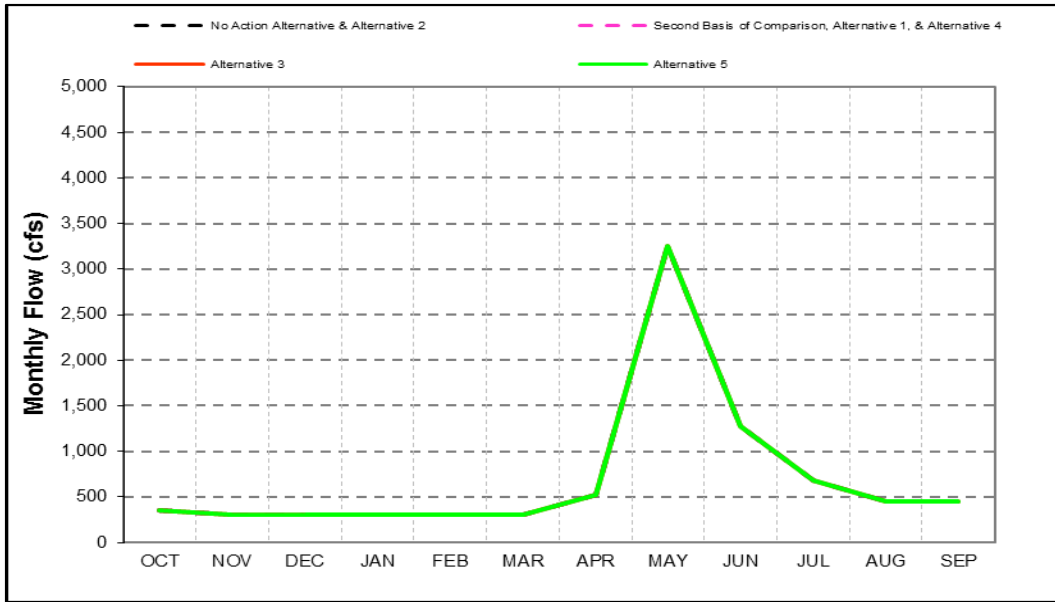


3

4 **Figure 5.54 Trinity River below Lewiston Reservoir, Wet Year Long-Term Average**  
 5 **Flow<sup>15,16</sup>**

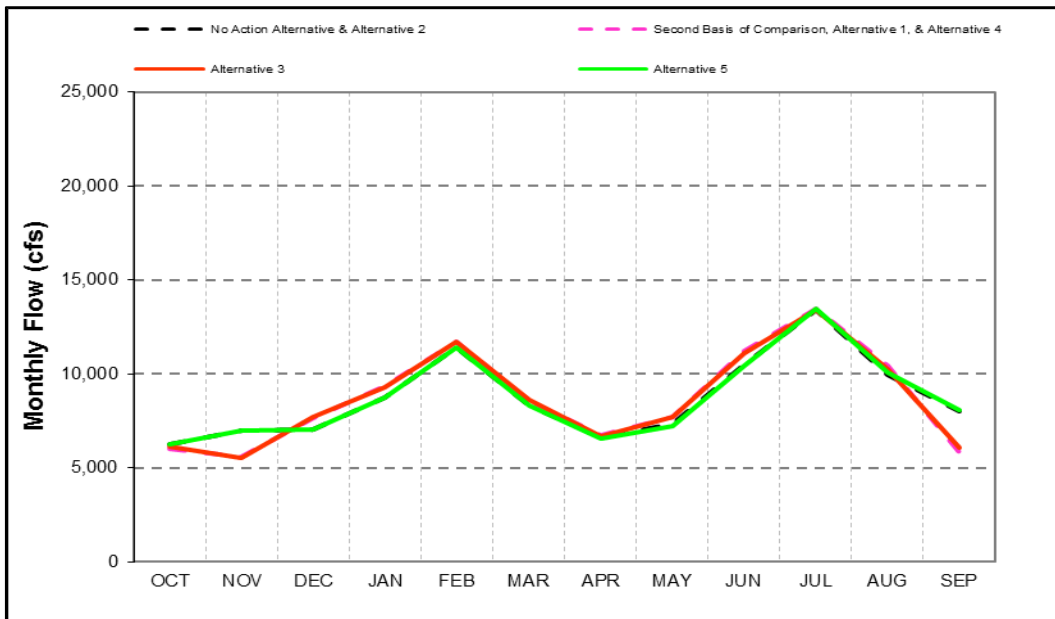
<sup>15</sup> Based on the 82-year simulation period; Notes: 1) All alternatives are simulated with projected hydrology and sea level at Year 2030 conditions. 2) Model results for Alternatives 1, 4, and Second Basis of Comparison are the same, therefore Alternatives 1 and 4 results are not presented. Qualitative differences, if applicable, are discussed in the text. 3) Model results for Alternative 2 and No Action Alternative are the same, therefore Alternative 2 results are not presented. Qualitative differences, if applicable, are discussed in the text.

<sup>16</sup> Wet-Year and Dry-Year as defined by the Sacramento 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999), projected to year 2030



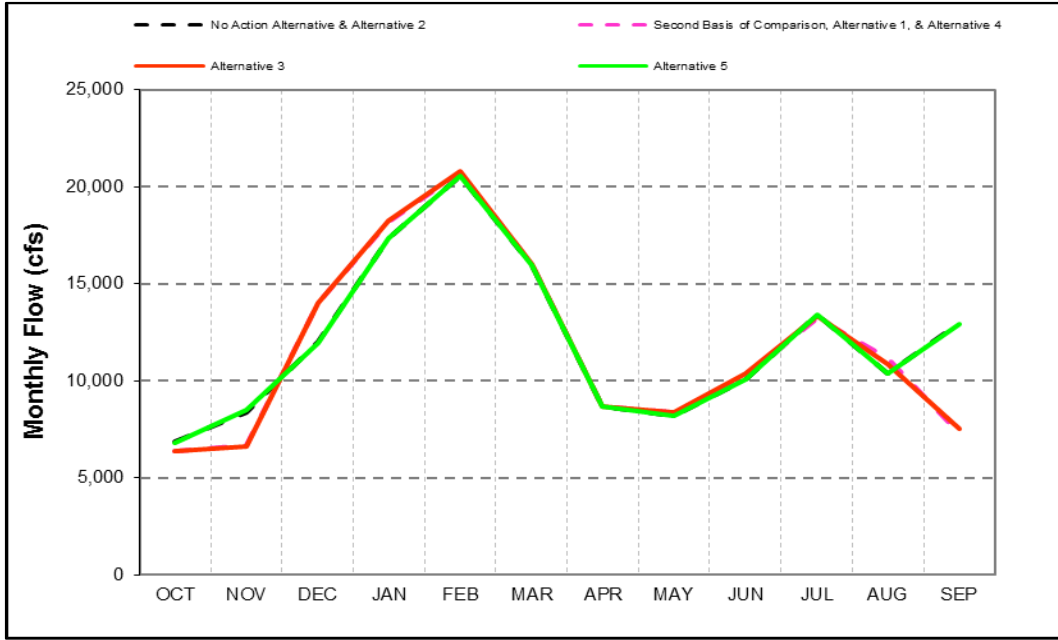
1

2 **Figure 5.55 Trinity River below Lewiston Reservoir, Dry Year Long-Term Average**  
 3 **Flow<sup>15,16</sup>**



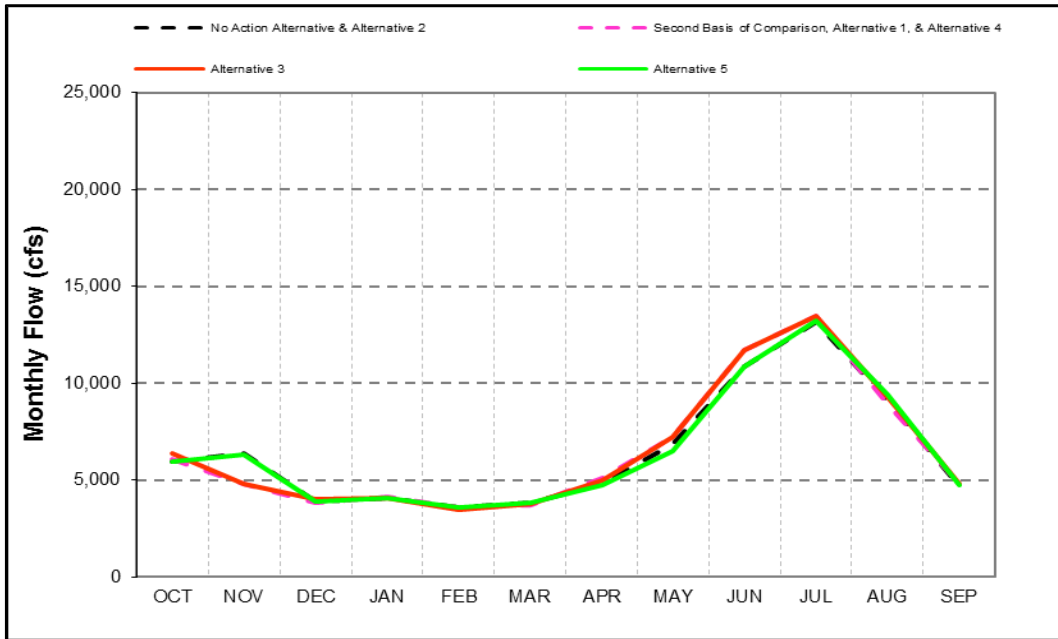
4

5 **Figure 5.56 Sacramento River downstream of Keswick Reservoir, Long-Term**  
 6 **Average Flow<sup>15</sup>**



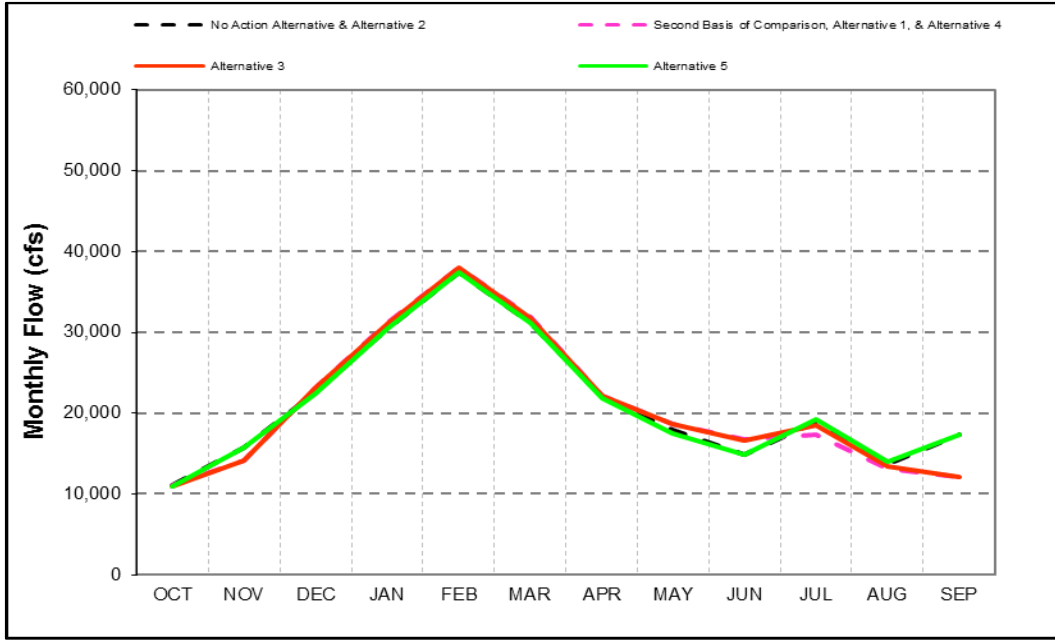
1

2 **Figure 5.57 Sacramento River downstream of Keswick Reservoir, Wet Year Long-**  
 3 **Term Average Flow<sup>15,16</sup>**



4

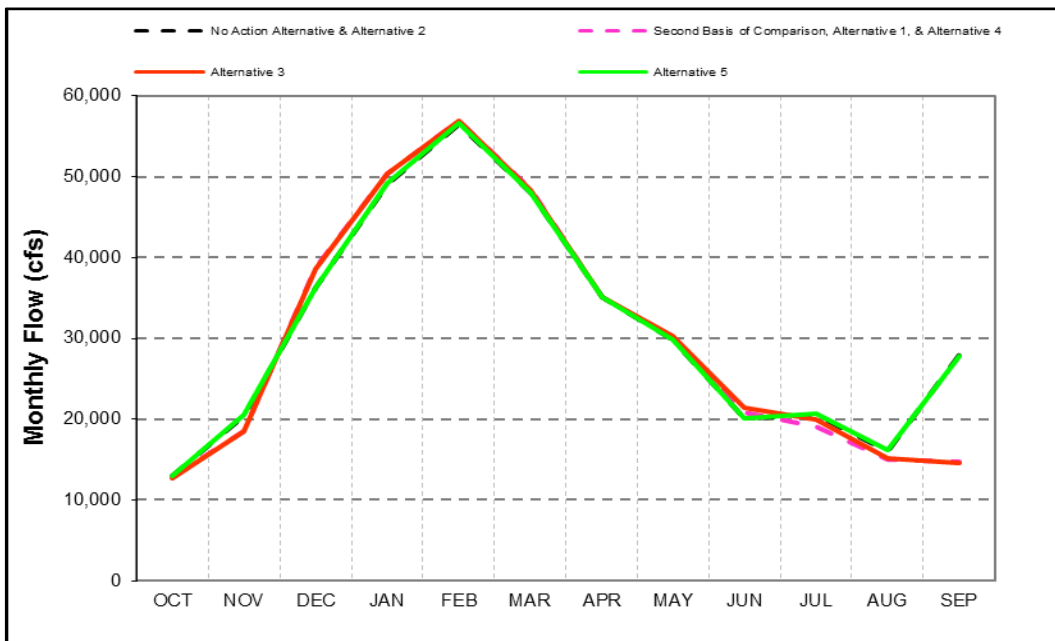
5 **Figure 5.58 Sacramento River downstream of Keswick Reservoir, Dry Year Long-**  
 6 **Term Average Flow<sup>15,16</sup>**



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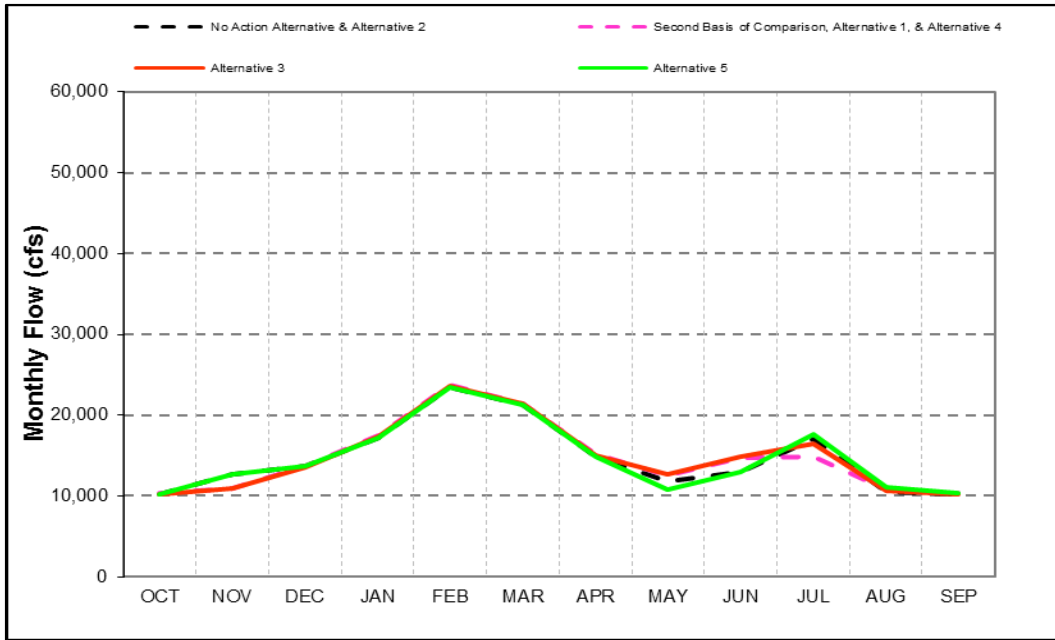
Figure 5.59 Sacramento River at Freeport, Long-Term Average Flow<sup>15</sup>



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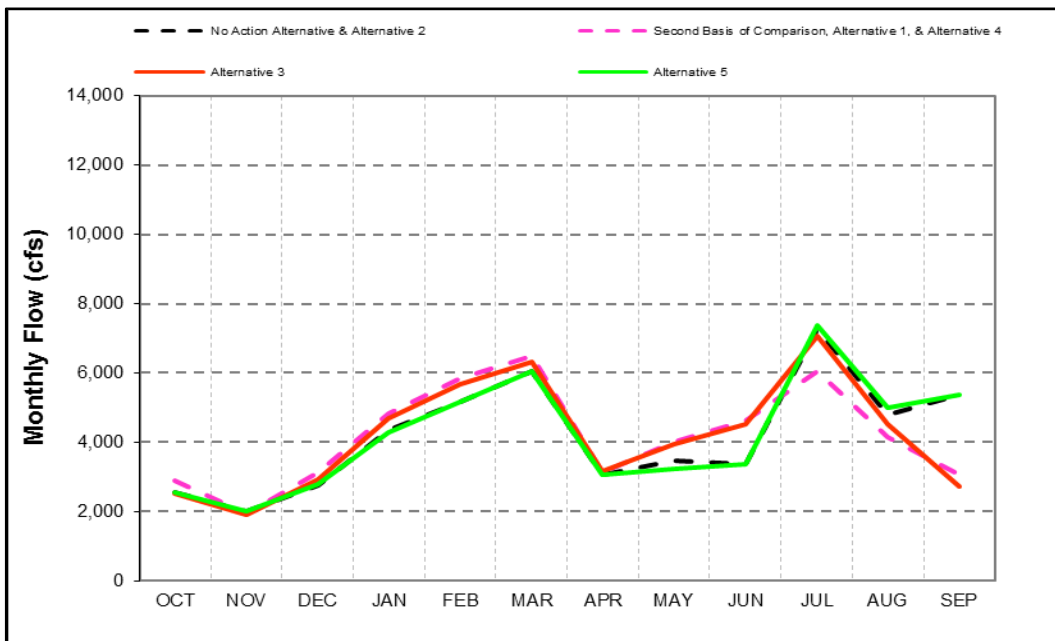
4

Figure 5.60 Sacramento River at Freeport, Wet Year Long-Term Average Flow<sup>15,16</sup>



1

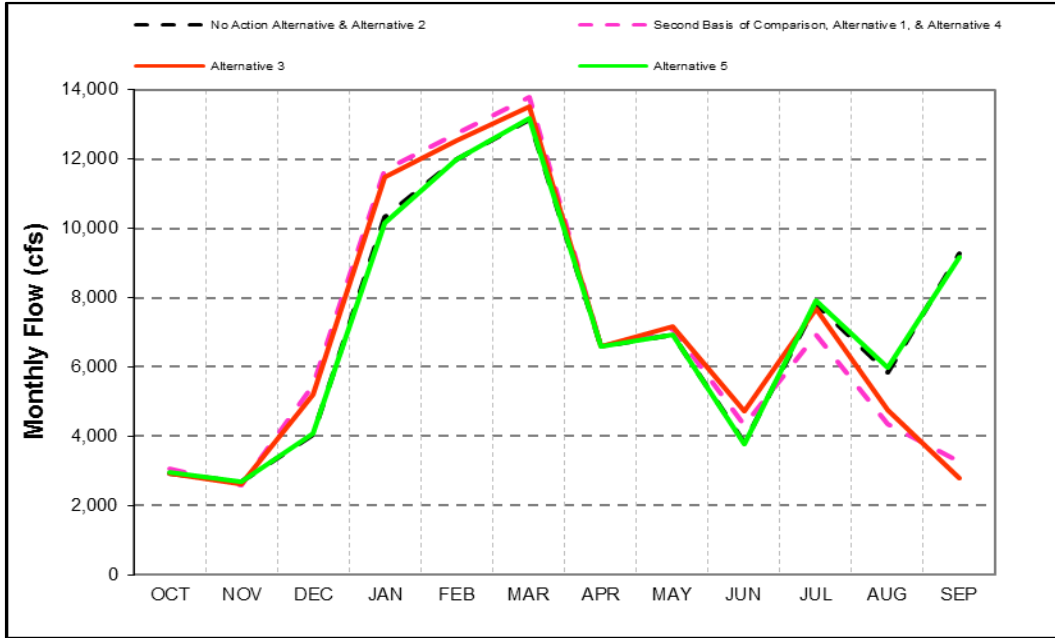
2 **Figure 5.61 Sacramento River at Freeport, Dry Year Long-Term Average Flow<sup>15,16</sup>**



3

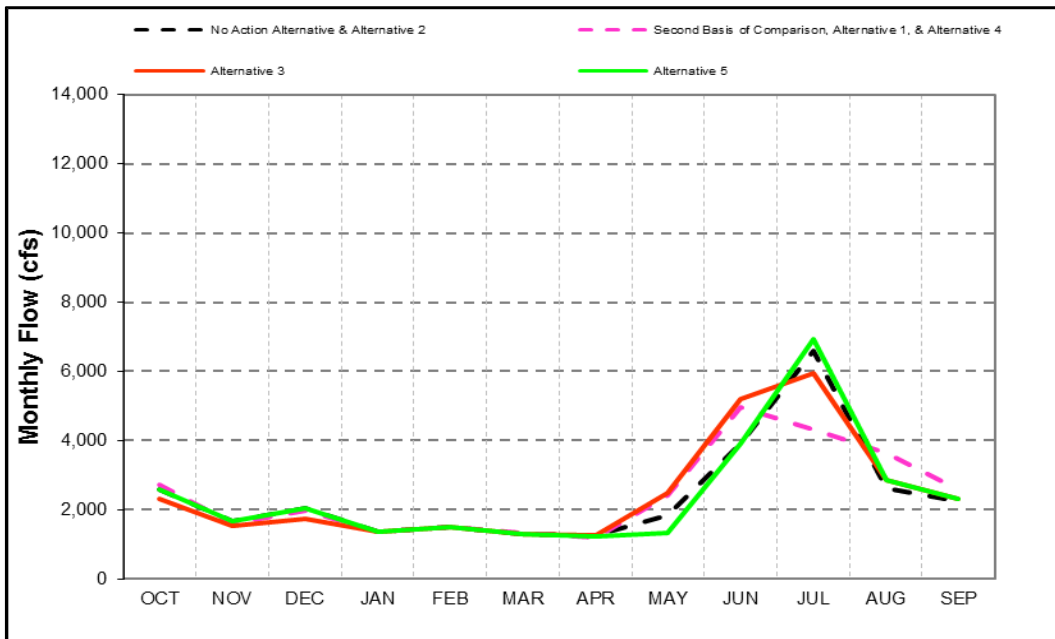
4 **Figure 5.62 Feather River downstream of Thermalito, Long-Term Average Flow<sup>15</sup>**





1

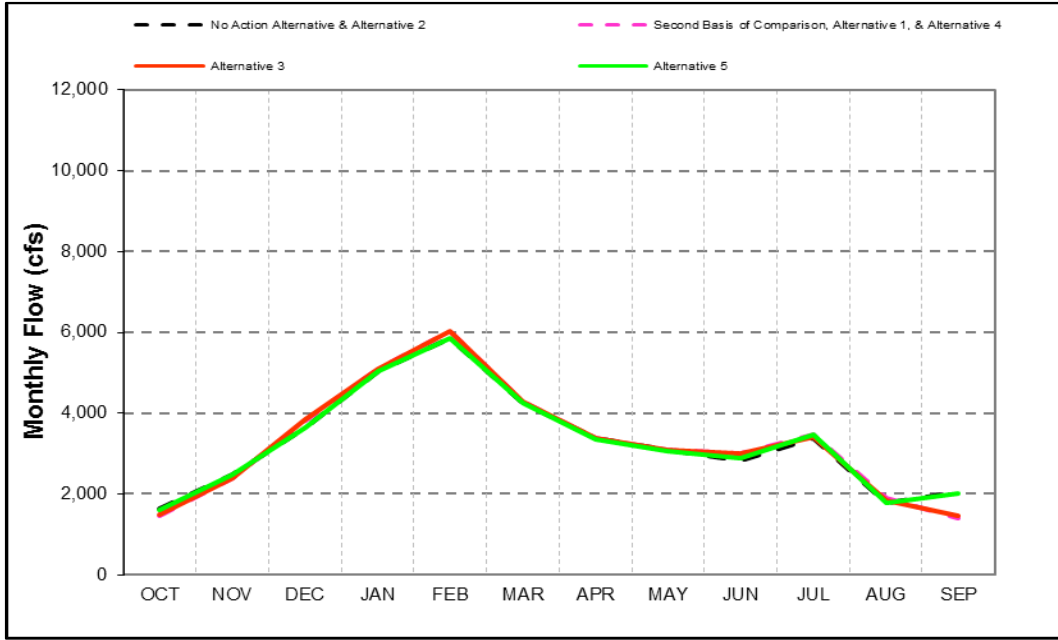
2 **Figure 5.63 Feather River downstream of Thermalito, Wet Year Long-Term Average**  
 3 **Flow<sup>15,16</sup>**



4

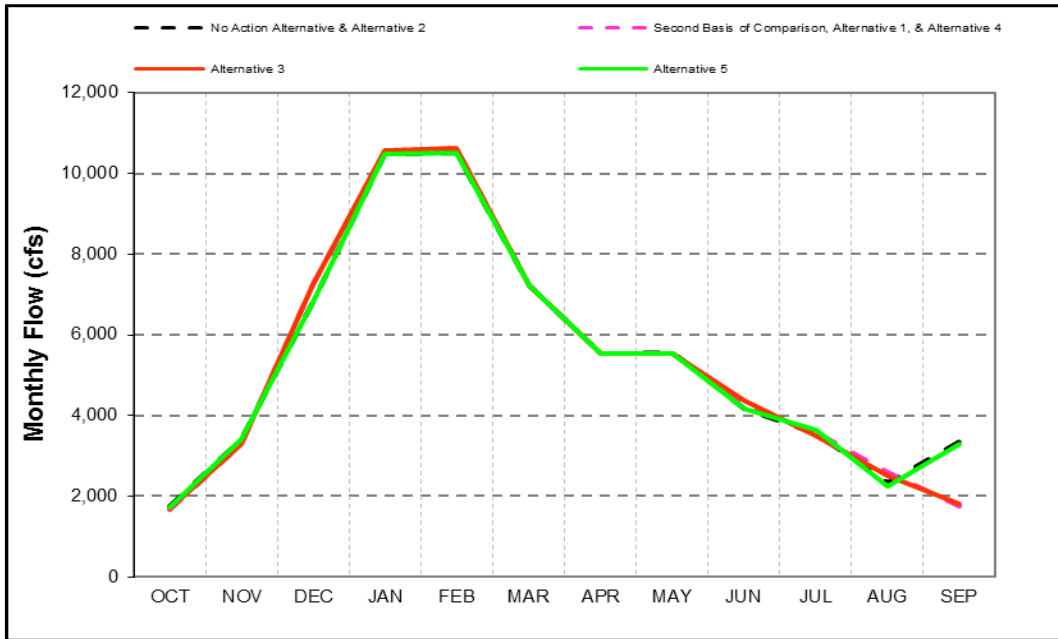
5 **Figure 5.64 Feather River downstream of Thermalito, Dry Year Long-Term Average**  
 6 **Flow<sup>15,16</sup>**

Chapter 5: Surface Water Resources and Water Supply Figures



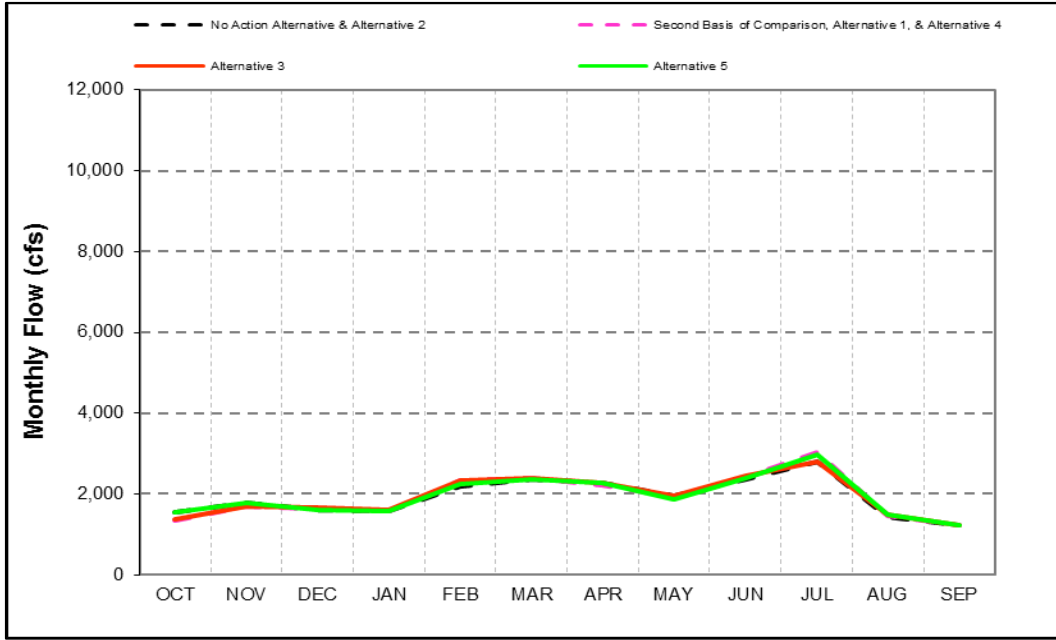
1

2 **Figure 5.65 American River downstream of Nimbus Dam, Long-Term Average**  
 3 **Flow<sup>15</sup>**



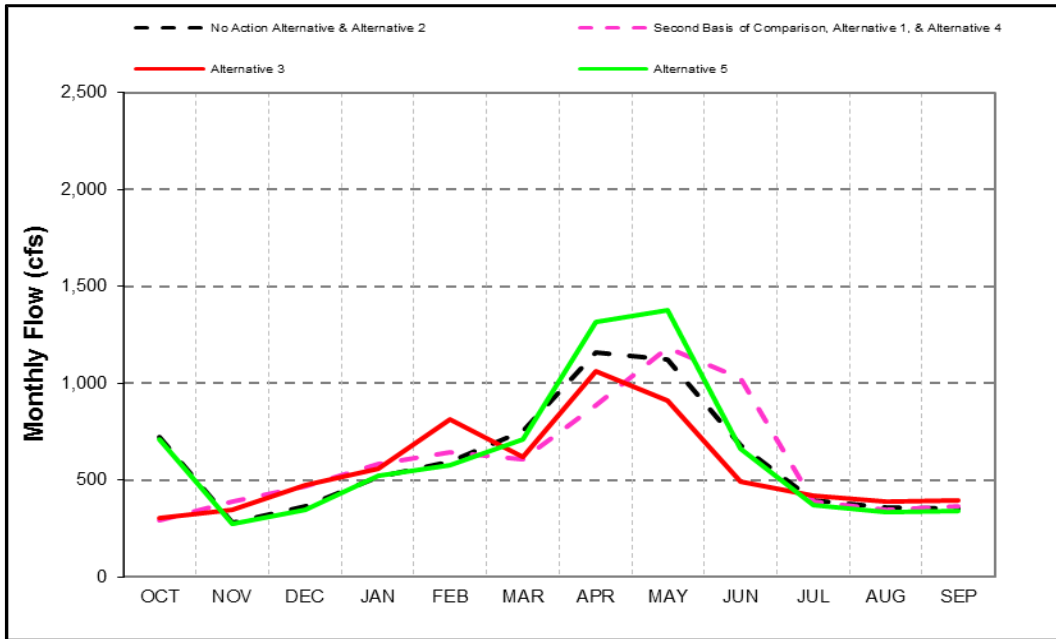
4

5 **Figure 5.66 American River downstream of Nimbus Dam, Wet Year Long-Term**  
 6 **Average Flow<sup>15,16</sup>**



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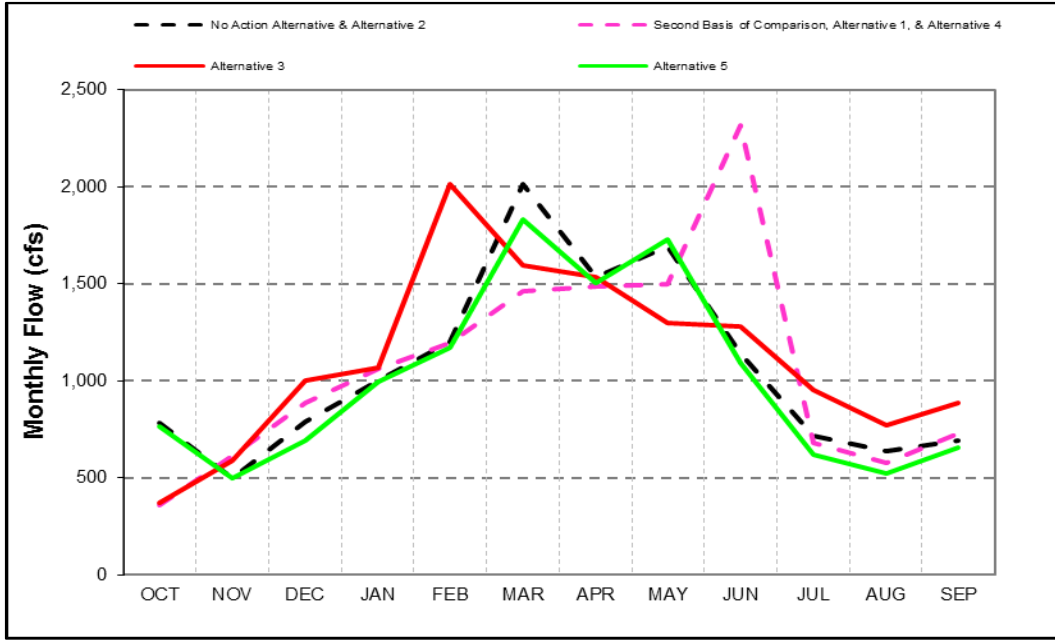
2 **Figure 5.67 American River downstream of Nimbus Dam, Dry Year Long-Term**  
 3 **Average Flow<sup>15,16</sup>**



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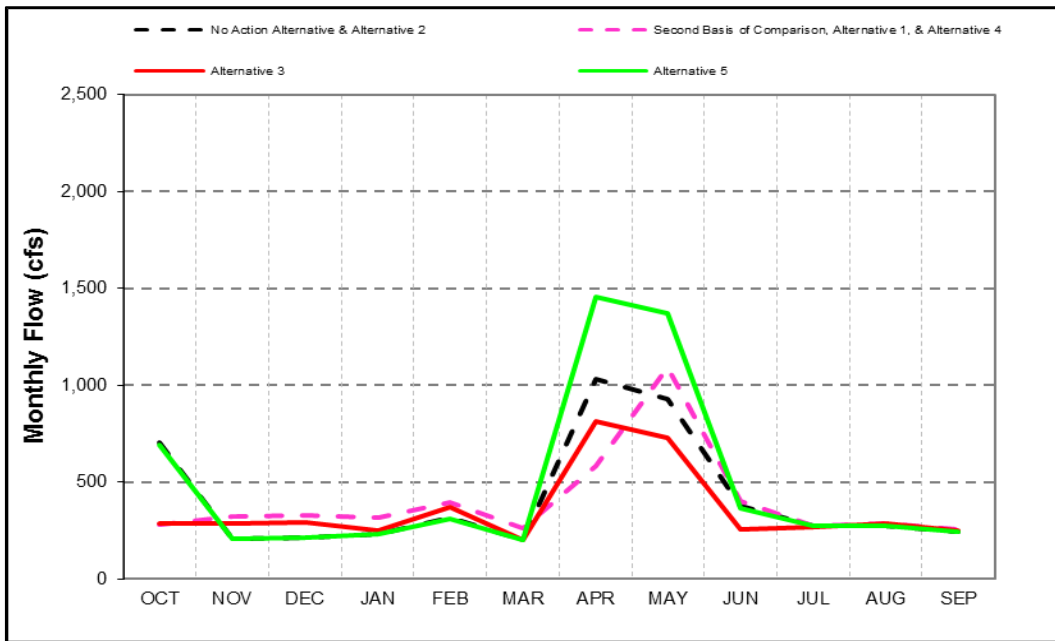
5 **Figure 5.68 Stanislaus River below Goodwin, Long-Term Average Flow<sup>15</sup>**

Chapter 5: Surface Water Resources and Water Supply Figures



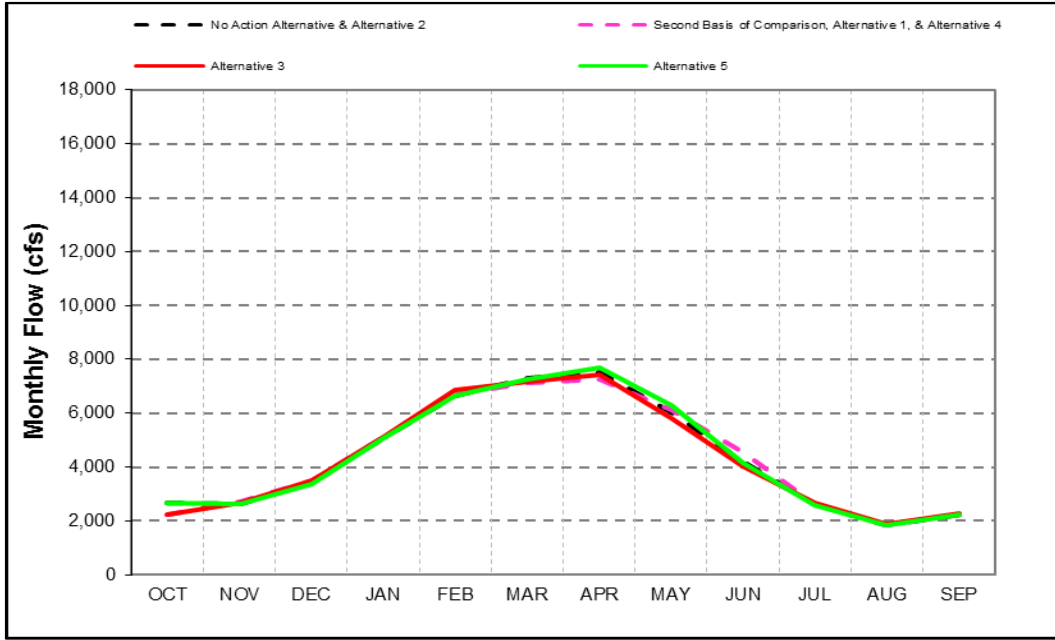
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Figure 5.69 Stanislaus River below Goodwin, Wet Year Long-Term Average Flow<sup>15,16</sup>



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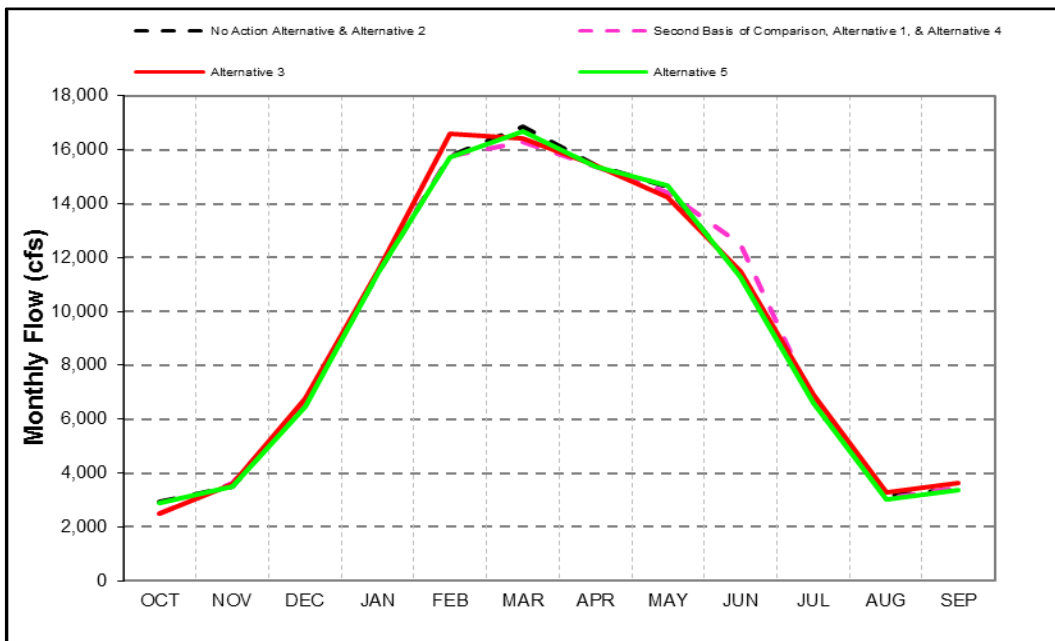
Figure 5.70 Stanislaus River below Goodwin, Dry Year Long-Term Average Flow<sup>15,16</sup>



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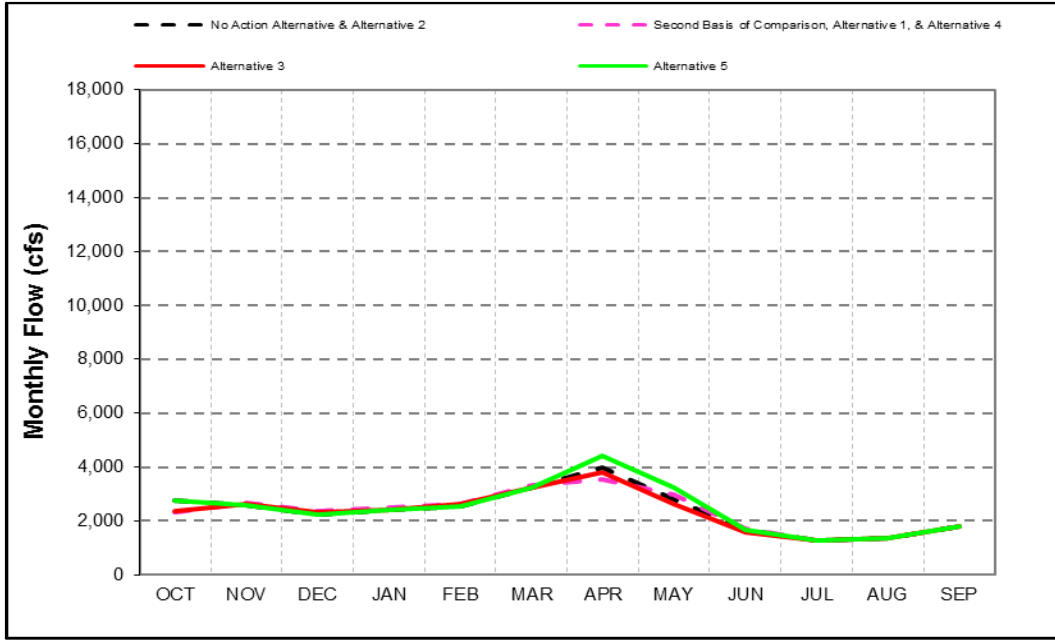
Figure 5.71 San Joaquin River at Vernalis, Long-Term Average Flow<sup>15</sup>



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4

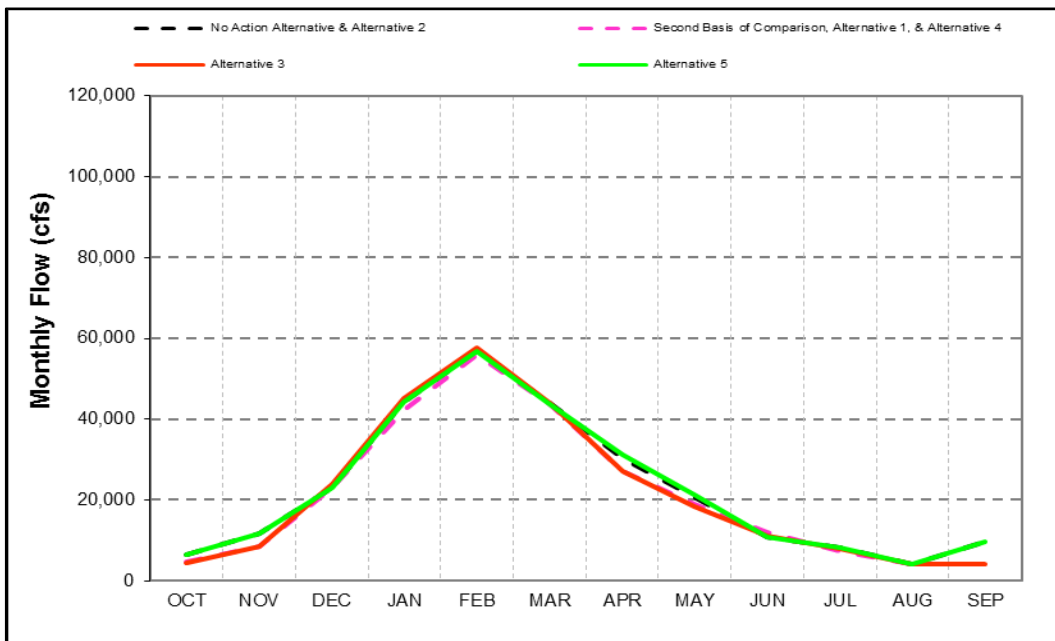
Figure 5.72 San Joaquin River at Vernalis, Wet Year Long-Term Average Flow<sup>15,16</sup>



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2

Figure 5.73 San Joaquin River at Vernalis, Dry Year Long-Term Average Flow<sup>15,16</sup>

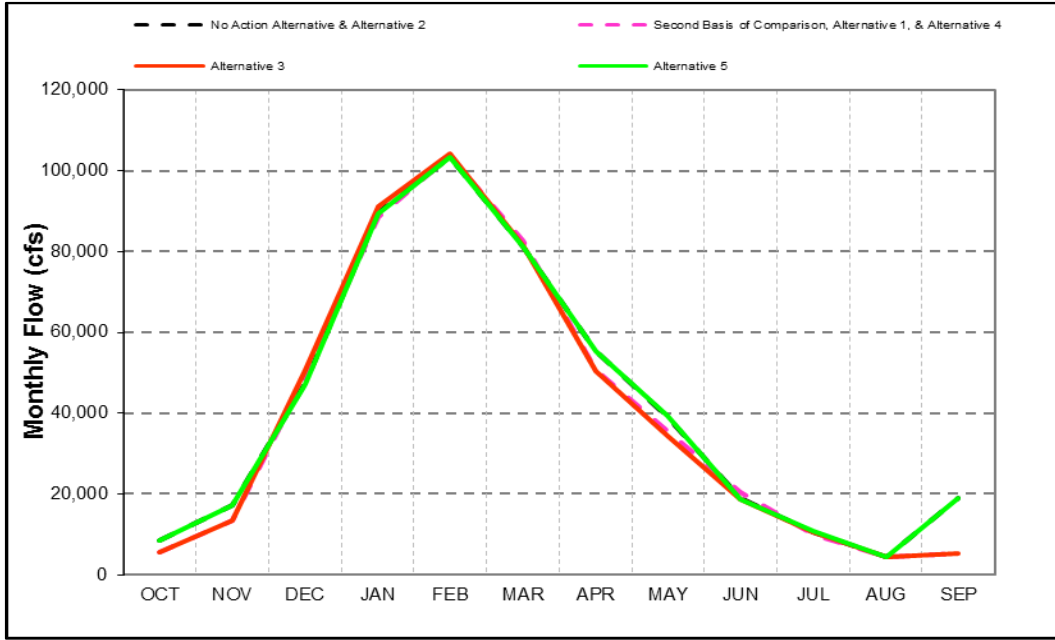


3

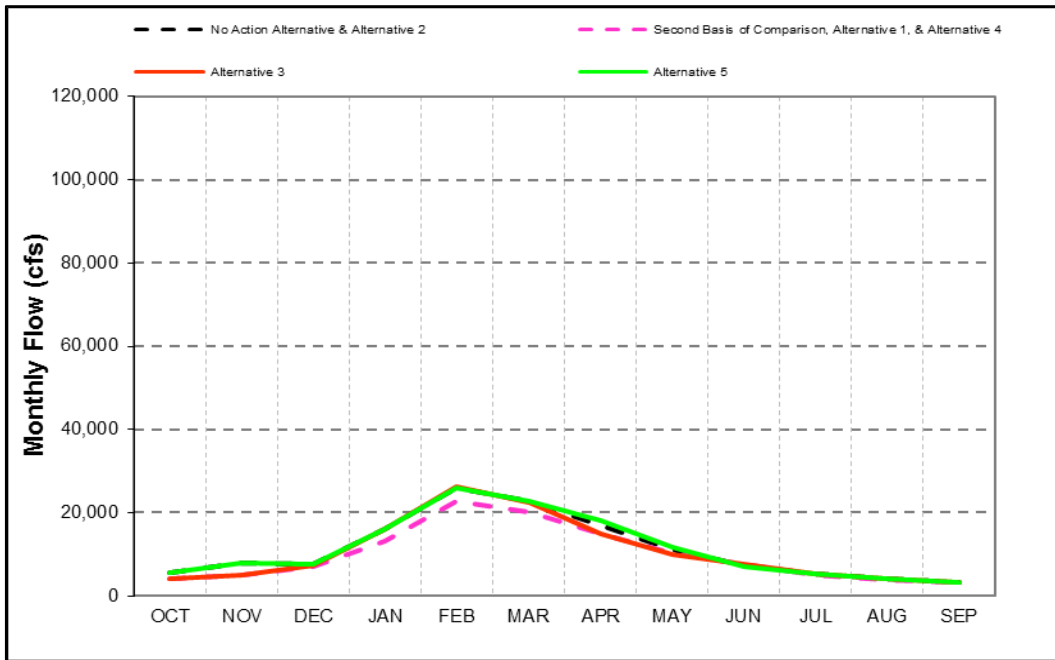
4

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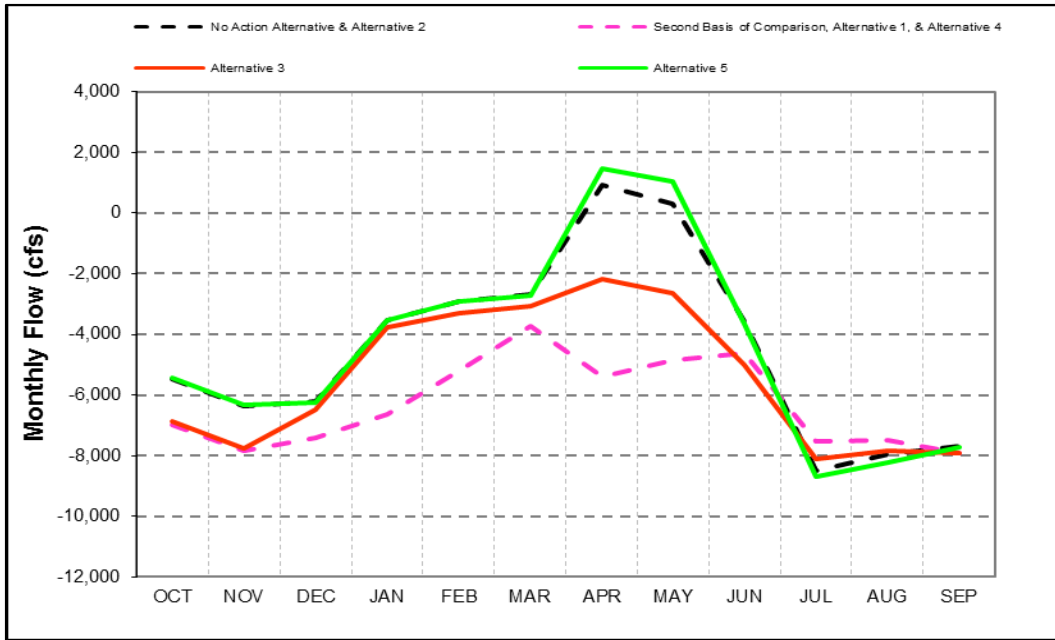
Figure 5.74 Sacramento/San Joaquin River Delta Outflow, Long-Term Average Flow<sup>15</sup>



1  
2 **Figure 5.75 Sacramento/San Joaquin River Delta Outflow, Wet Year Long-Term**  
3 **Average Flow<sup>15</sup>**

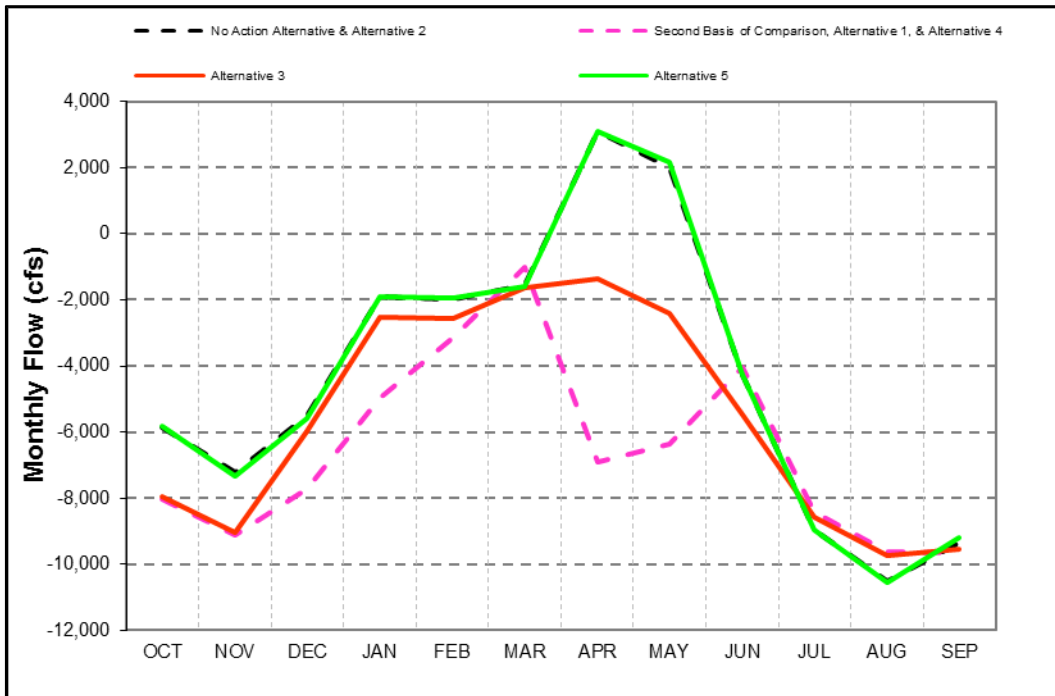


4  
5 **Figure 5.76 Sacramento/San Joaquin River Delta Outflow, Dry Year Long-Term**  
6 **Average Flow<sup>15</sup>**



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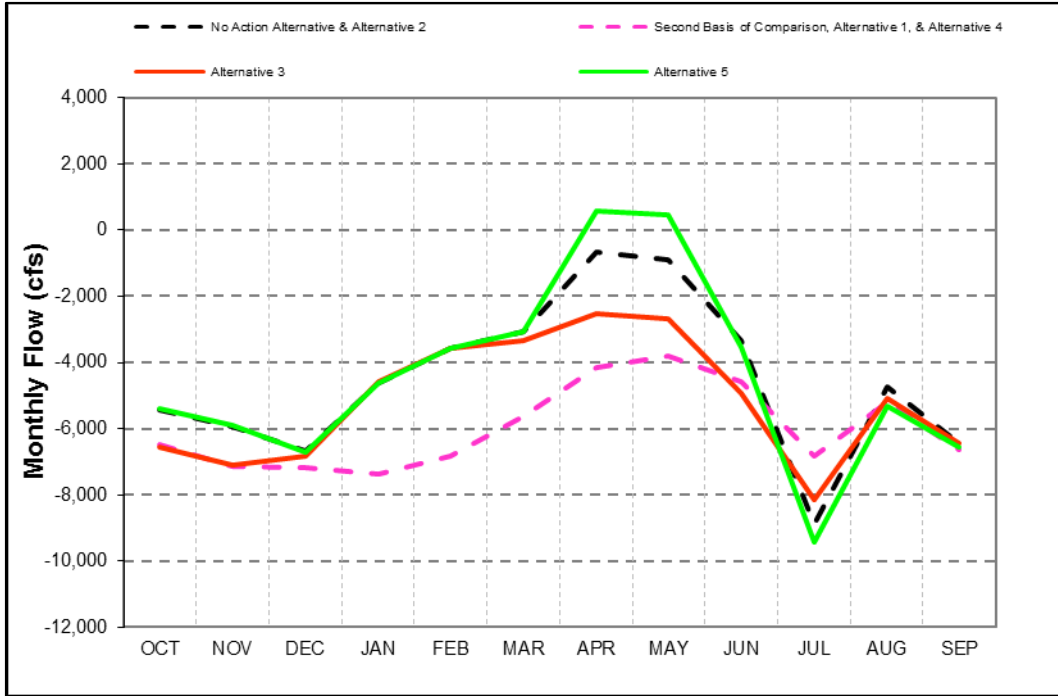
Figure 5.77 Old and Middle River, Long-Term Average Flow<sup>15</sup>



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Figure 5.78 Old and Middle River, Wet Year Long-Term Average Flow<sup>15, 16</sup>





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Figure 5.79 Old and Middle River, Dry Year Long-Term Average Flow<sup>15, 16</sup>

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**Chapter 6****1 Surface Water Quality****2 6.1 Introduction**

3 This chapter describes Surface Water Quality in the study area; and potential  
4 changes that could occur as a result of implementing the alternatives evaluated in  
5 this Environmental Impact Statement (EIS). Implementation of the alternatives  
6 could affect these resources through potential changes in operation of the Central  
7 Valley Project (CVP) and State Water Project (SWP) and ecosystem restoration.

**8 6.2 Regulatory Environment and Compliance**  
**9 Requirements**

10 Potential actions that could be implemented under the alternatives evaluated in  
11 this EIS could affect surface water resources impacted by changes in the  
12 operations of CVP or SWP reservoirs and in the vicinity of and lands served by  
13 CVP and SWP water supplies. Actions located on public agency lands; or  
14 implemented, funded, or approved by Federal and state agencies would need to be  
15 compliant with appropriate Federal and state agency policies and regulations, as  
16 summarized in Chapter 4, Approach to Environmental Analyses.

17 Several of the Federal and state laws and regulations that provide quantitative  
18 criteria to determine compliance also are summarized in this subsection of this  
19 chapter to provide context for information provided in the remaining sections of  
20 this chapter.

**21 6.2.1 Federal Water Pollution Control Act Amendments of 1972**  
**22 (Clean Water Act)**

23 The Federal Water Pollution Control Act Amendments of 1972, also known as the  
24 Clean Water Act (CWA), established the institutional structure for the U.S.  
25 Environmental Protection Agency (USEPA) to regulate discharges of pollutants  
26 into the waters of the United States, establish water quality standards, conduct  
27 planning studies, and provide funding for specific grant projects. The CWA was  
28 further amended through the CWA of 1977 and the Water Quality Act of 1987.  
29 The California State Water Resources Control Board (SWRCB) has been  
30 designated by the USEPA to develop and enforce water quality objectives and  
31 implementation plans in California, as described below under State Policies and  
32 Regulations.

33 The California RWQCBs have adopted, and the SWRCB has approved, water  
34 quality control plans (basin plans) for each watershed basin in the State. The  
35 basin plans designate the beneficial uses of waters within each watershed basin,  
36 and water quality objectives designed to protect those uses pursuant to

1 Section 303 of the CWA. The beneficial uses together with the water quality  
 2 objectives that are contained in the basin plans constitute State water quality  
 3 standards.

4 Under the CWA section 303(d), the USEPA identifies and ranks water bodies for  
 5 which existing pollution controls are insufficient to attain or maintain water  
 6 quality standards based upon information prepared by all states, territories, and  
 7 authorized Indian tribes (referred to collectively as “states” in the CWA). This  
 8 list of impaired waters for each state comprises the state’s 303(d) list. Each state  
 9 must establish priority rankings and develop Total Maximum Daily Load  
 10 (TMDL) values for all impaired waters. TMDLs calculate the greatest pollutant  
 11 load that a water body can receive and still meet water quality standards and  
 12 designated beneficial uses.

13 Section 305(b) of the CWA requires every state to submit a biennial water quality  
 14 assessment of all state waters. These state-wide reports serve as the basis for  
 15 USEPA’s national Water Quality Inventory Report to Congress. Each water body  
 16 is assessed regarding its ability to support the most common beneficial uses:  
 17 aquatic life, drinking water supply, fish consumption, non-contact recreation,  
 18 shell fishing, and swimming; also known as core beneficial uses (SWRCB  
 19 2010a).The USEPA requires states to integrate the 303(d) and 305(b) reports. For  
 20 California, this report is called the California 303(d)/305(b) Integrated Report,  
 21 and is prepared by the SWRCB using Integrated Reports submitted by each  
 22 RWQCB (SWRCB 2010a). The 303(d) and 305(b) processes are further  
 23 explained below under State Policies and Regulations.

24 The California Environmental Protection Agency, SWRCB, and RWQCBs have  
 25 identified numerous water bodies within the project area that do not comply with  
 26 applicable water quality standards and either adopted or are developing TMDLs,  
 27 shown below in Table 6.1.

28 **Table 6.1 Constituents of Concern per the 303(d) list within the Study Area**

Region	Waterbody	Constituent of Concern	TMDL Status <sup>1</sup>
Trinity and Lower Klamath Rivers	Trinity Lake (was Claire Engle Lake)	Mercury	Expected: 2019
	Trinity River HU, Lower Trinity HA; Trinity River HU, Middle HA; Trinity River HU, South Fork HA; Trinity River, Upper HA; Trinity River HU, Upper HA, Trinity River, East Fork	Sedimentation/Siltation, Temperature <sup>2</sup> , Mercury <sup>3</sup>	Approved: 2001
	Klamath River HU, Lower HA, Klamath Glen HAS	Nutrients, Organic, Enrichment/Low Dissolved Oxygen, Water Temperature	Approved: 2010
		Sedimentation/Siltation	Expected: 2025

Region	Waterbody	Constituent of Concern	TMDL Status <sup>1</sup>
Sacramento River Basin	Shasta Lake (where West Squaw Creek Enters); Keswick Reservoir (portion downstream from Spring Creek); Spring Creek, Lower (Iron Mountain Mine to Keswick Reservoir)	Acid Mine Drainage <sup>4</sup> , Cadmium, Copper, Zinc	Expected: 2020
	Shasta Lake; Whiskeytown Lake (areas near Oak Bottom, Brandy Creek Campgrounds and Whiskeytown); Clear Creek (below Whiskeytown Lake, Shasta County)	Mercury	Expected: 2021
	Sacramento River (Keswick Dam to the Delta) <sup>5</sup>	Unknown Toxicity	Expected: 2019
		Chlordane <sup>6</sup> , DDT, Mercury <sup>7</sup> , PCBs, Dieldrin <sup>8</sup>	Expected: 2021
	Colusa Basin Drain	Diazinon	Expected: 2008
		Malathion	Expected: 2010
		Azinphos-methyl (Guthion), Group A Pesticides, Unknown Toxicity	Expected: 2019
		DDT, Dieldrin, E. coli, Low Dissolved Oxygen, Mercury, Carbofuran	Expected: 2021
	Oroville Lake; Feather River, Lower (Lake Oroville Dam to Confluence with Sacramento River), Yuba River, Lower <sup>9</sup>	Group A Pesticides	Expected: 2011
		Chlorpyrifos, Unknown Toxicity	Expected: 2019
		Mercury, PCBs	Expected: 2021
	Folsom Lake; Natoma, Lake; American River, Lower (Nimbus Dam to confluence with Sacramento River) <sup>10</sup>	Mercury	Expected: 2019
		Unknown Toxicity, PCBs	Expected: 2021
	Cache Creek, Lower (Clear Lake Dam to Cache Creek Settling Basin near Yolo Bypass)	Mercury	Approved: 2007
Unknown Toxicity		Expected: 2019	
Boron		Expected: 2021	
San Joaquin River and Tulare Basins	Mendota Pool; Panoche Creek (Silver Creek to Belmont Avenue)	Mercury <sup>11</sup>	Expected: 2021
		Selenium	Expected: 2019
		Sediment Toxicity <sup>12</sup>	Expected: 2021
		Sedimentation/Siltation <sup>12</sup>	Expected: 2007

Chapter 6: Surface Water Quality

Region	Waterbody	Constituent of Concern	TMDL Status <sup>1</sup>
	Agatha Canal (Merced County); Grasslands Marshes; Mud Slough, North (downstream of San Luis Drain); Salt Slough (upstream from confluence with San Joaquin River) <sup>13</sup>	Selenium <sup>14</sup>	Approved: 2002
		Chlorpyrifos	Approved: 2008
		Boron, Electrical Conductivity, Pesticides, Unknown Toxicity <sup>15</sup>	Expected: 2019
		Escherichia coli, Mercury, pH, Prometryn	Expected: 2021
	San Luis Reservoir	Mercury	Expected: 2021
	O'Neil Forebay		Expected: 2012
	Millerton Lake; San Joaquin River (Friant Dam to Stanislaus River) <sup>16</sup>	Selenium <sup>17, 18</sup>	Approved: 2002
		Chlorpyrifos, Diazinon <sup>19</sup>	Approved: 2007
		DDE20, DDT, Group A Pesticides	Expected: 2011
			Expected: 2012
		Boron <sup>21</sup> , Invasive Species <sup>23</sup> , Unknown Toxicity	Expected: 2019
		Arsenic <sup>24</sup> , Electrical Conductivity <sup>18, 22</sup> , Mercury <sup>18</sup> , Water Temperature <sup>26</sup>	Expected: 2021
		alpha.-BHC <sup>20</sup> , Escherichia coli <sup>18, 25</sup> ,	Expected: 2022
	San Joaquin River (Stanislaus River to Delta Boundary)	Chlorpyrifos, Electrical Conductivity	Approved: 2007
		DDE, DDT, Group A Pesticides	Expected: 2011
		Mercury	Expected: 2012
		Toxaphene, Unknown Toxicity	Expected: 2019
		Diuron, Escherichia coli, Water Temperature	Expected: 2021
	Merced River, Lower; Tuolumne River, Lower; New Melones Reservoir; Tulloch Reservoir; Stanislaus River, Lower <sup>27</sup>	Diazinon	Expected: 2010
		Group A Pesticides	Expected: 2011
		Chlorpyrifos, Mercury, Water Temperature	Expected: 2021
		Unknown Toxicity	Expected: 2022
		Invasive Species	Expected: 2019

Region	Waterbody	Constituent of Concern	TMDL Status <sup>1</sup>
	Cosumnes River, Lower (below Michigan Bar; partly in Delta Waterways, eastern portion)	Escherichia coli, Sediment Toxicity	Expected: 2021
	Mokelumne River, Lower (in Delta Waterways, eastern portion)	Copper, Zinc	Expected: 2020
		Chlorpyrifos, Mercury, Dissolved Oxygen, Unknown Toxicity	Expected: 2021
	Calaveras River, Lower (from Stockton Diverting Canal to the San Joaquin River; partly in Delta waterways, eastern portion)	Chlorpyrifos, Diazinon	Approved: 2007
		Pathogens	Approved: 2008
		Organic Enrichment/Low Dissolved Oxygen	Expected: 2012
		Mercury	Expected: 2021
	Kings River, Lower (Island Weir to Stinson and Empire Weirs); Kings River, Lower (Pine Flat Reservoir to Island Weir); Kaweah River (below Terminus Dam, Tulare County); Kaweah River, Lower (includes St Johns River) <sup>28</sup>	Electrical Conductivity, Molybdenum, Toxaphene	Expected: 2015
		Chlorpyrifos <sup>29</sup> , pH <sup>30</sup> , Unknown Toxicity	Expected: 2021
	Sacramento-San Joaquin River Delta	Sacramento San Joaquin Delta	Mercury
PCBs			Expected: 2008
Selenium			Expected: 2010
Chlordane, DDT, Dieldrin			Expected: 2013
Dioxin compounds, Furan Compounds, Invasive Species			Expected: 2019
Delta waterways (central, eastern, northern, northwestern, western portion, southern portions, export area, and Stockton Ship Channel)		Chlorpyrifos <sup>31</sup> , Diazinon, Organic Enrichment/Low Dissolved Oxygen <sup>32</sup>	Approved: 2007
		Pathogens <sup>32</sup>	Expected: 2008
		Mercury	Expected: 2009
		Chlordane <sup>33</sup> , DDT, Dieldrin <sup>33</sup> , Group A Pesticides	Expected: 2011
		Dioxin <sup>32</sup> , Electrical Conductivity <sup>34</sup> , Furan Compounds <sup>32</sup> , Invasive Species, PCBs <sup>35</sup> , Unknown Toxicity	Expected: 2019

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Region	Waterbody	Constituent of Concern	TMDL Status <sup>1</sup>
Suisun Bay and Suisun Marsh	Suisun Bay	Mercury	Approved: 2008
		PCBs	Expected: 2008
		Selenium	Expected: 2010
		Chlordane, DDT, Dieldrin	Expected: 2013
		Dioxin compounds, Furan Compounds, Invasive Species	Expected: 2019
	Suisun Marsh Wetlands	Mercury, Nutrients, Organic Enrichment/Low Dissolved Oxygen, Salinity/TDS/Chlorides	Expected: 2013
San Francisco Bay Region	Carquinez Strait and San Pablo Bay	Mercury	Approved: 2008
		PCBs	Expected: 2008
		Selenium	Expected: 2010
		Chlordane, DDT, Dieldrin	Expected: 2013
		Dioxin compounds, Furan Compounds, Invasive Species	Expected: 2019

1 Source: SWRCB 2011A

2 Notes:

3 1 TMDL status is either expected to be completed or approved by USEPA in the year  
4 specified

5 2 Water temperature is only a constituent of concern for the South Fork Trinity River and  
6 a TMDL is expected to be completed in 2019.

7 3 Mercury is only a constituent of concern for the East Fork Trinity River in the upper  
8 hydrologic area and a TMDL is expected to be completed in 2019.

9 4 Acid Mine Drainage is a constituent of concern at Spring Creek only

10 5 Chlordane, DDT, PCBs, Dieldrin not constituents of concern for Sacramento River  
11 (Keswick Dam to Red Bluff)

12 6 Chlordane not a constituent of concern for Sacramento River (Red Bluff to Knights  
13 Landing)

14 7 Mercury not a constituent of concern for Sacramento River (Keswick Dam to  
15 Cottonwood Creek). Mercury TMDL is expected to be complete in 2012 for Sacramento  
16 River (Knights Landing to the Delta)

17 8 Dieldrin TMDL for Sacramento from Knights Landing to the Delta is expected to be  
18 completed in 2022.



- 1 9 Mercury is the only constituent of concern for Yuba River and a TMDL is expected to be  
 2 complete in 2021. Mercury TMDL expected to be complete in 2021 for Feather River,  
 3 Lower (Lake Oroville Dam to Confluence with Sacramento River). Mercury and PCBs are  
 4 the only constituents of concern for Lake Oroville and TMDLs are expected to be  
 5 complete in 2021 for both constituents.
- 6 10 Mercury is the only constituent of concern for Folsom Lake and Lake Natoma.  
 7 Mercury TMDL is expected to be completed in 2010 for American River, Lower (Nimbus  
 8 Dam to confluence with Sacramento River)
- 9 11 Mercury TMDL for Panoche Creek (Silver Creek to Belmont Avenue) expected to be  
 10 complete in 2020.
- 11 12 Not a constituent of concern for Mendota Pool
- 12 13 pH and selenium are the only constituents of concern for Agatha Canal (Merced  
 13 County). Electrical conductivity and Selenium are the only constituents of concern for  
 14 Grasslands Marshes. Boron, Electrical Conductivity, Pesticides, Selenium, and Unknown  
 15 Toxicity are the only constituents of concern for Mud Slough, North (downstream of San  
 16 Luis Drain). pH, selenium, and pesticides are not constituents of concern for Salt Slough  
 17 (upstream from confluence with San Joaquin River)
- 18 14 The CVRWQCB completed a TMDL for selenium in the lower San Joaquin River  
 19 (downstream of the Merced River) in 2001 and Salt Slough in 1997/1999, and USEPA  
 20 approved this in 2002.
- 21 15 The unknown toxicity TMDL for Mud Slough (downstream of San Luis Drain) is  
 22 expected to be written and complete in 2021.
- 23 16 Mercury is the only constituent of concern for Millerton Lake and a TMDL is expected  
 24 to be complete in 2019.
- 25 17 Selenium is only a constituent of concern in San Joaquin River (Mud Slough to  
 26 Merced River)
- 27 18 Electrical conductivity, Escherichia coli, mercury and selenium are not constituents of  
 28 concern for San Joaquin River (Mendota Pool to Bear Creek). The Electrical Conductivity  
 29 TMDL for San Joaquin River (Bear Creek to Merced River) is expected to be written and  
 30 complete in 2019. The Mercury TMDL for San Joaquin River (Bear Creek to Stanislaus  
 31 River) is expected to be written and complete in 2012.
- 32 19 Diazinon not a constituent of concern for San Joaquin River (Bear Creek to Mud  
 33 Slough and Merced River to Tuolumne River)
- 34 20 DDE and alpha.-BHC is only a constituent of concern in San Joaquin River (Merced  
 35 River to Tuolumne River)
- 36 21 The Boron TMDL for San Joaquin River (Merced to Tuolumne River) was approved by  
 37 the USEPA in 2007. Boron is not a constituent of concern for the San Joaquin River  
 38 (Tuolumne River to Stanislaus River).
- 39 22 The Electrical Conductivity TMDL for San Joaquin River (Tuolumne River to  
 40 Stanislaus River) is expected to be written and complete in 2021.

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- 1 23 Invasive species only a constituent of concern for the San Joaquin River (Friant Dam  
2 to Mendota Pool).
- 3 24 Arsenic not a constituent of concern in San Joaquin River except Bear Creek to Mud  
4 Slough.
- 5 25 Escherichia coli is not a constituent of concern for San Joaquin River (Mendota Pool  
6 to Bear Creek and Merced River to Stanislaus River). The Escherichia coli TMDL for San  
7 Joaquin River (Bear Creek to Mud Slough) is expected to be written and complete in  
8 2021.
- 9 26 Water temperature is only a constituent of concern for San Joaquin River (Merced  
10 River to Stanislaus River)
- 11 27 Mercury is the only constituent of concern for New Melones Reservoir and Tulloch  
12 Reservoir. The diazinon TMDL for lower Merced River and lower Stanislaus River is  
13 expected to be complete in 2008. The Chlorpyrifos TMDL for the lower Merced River is  
14 expected to be complete in 2008. The Mercury TMDL for lower Merced River is expected  
15 to be complete in 2019 and lower Stanislaus River TMDL is expected to be complete in  
16 2020. The Unknown Toxicity TMDL for lower Stanislaus River is expected to be complete  
17 in 2019 and lower Merced River is expected in 2021.
- 18 28 The only constituents of concern for Kings River, Lower (Island Weir to Stinson and  
19 Empire Weirs) are electrical conductivity, toxaphene, molybdenum.
- 20 29 Chlorpyrifos is only a constituent of concern for Kings River, Lower (Pine Flat  
21 Reservoir to Island Weir).
- 22 30 pH is only a constituent of concern for Kaweah River (below Terminus Dam, Tulare  
23 County).
- 24 31 Chlorpyrifos TMDL for Delta waterways (central portion) expected to be complete in  
25 2019. Chlorpyrifos TMDL for Delta waterways (western portion) expected to be complete  
26 in 2006.
- 27 32 Not a constituent of concern for Delta waterways except for Stockton Ship Channel.
- 28 33 Not a constituent of concern for Delta waterways except for northern portion.
- 29 34 Not a constituent of concern for Delta waterways (central, northern, eastern portions,  
30 and Stockton Ship Channel)
- 31 35 Not a constituent of concern for Delta waterways except for the northern portion and  
32 the Stockton Ship Channel.
- 33 National Toxics Rule (NTR) was established by USEPA in accordance with  
34 CWA section 303 to provide ambient water quality criteria for priority toxic  
35 pollutants to protect aquatic life and human health.
- 36 The Secretary of the Interior established the first antidegradation policy in 1968.  
37 In 1975, USEPA included the antidegradation requirements in the Water Quality  
38 Standards Regulation (40 Code of Federal Regulations [CFR] 130.17, 40 CFR  
39 55340-41). The requirements were included in the 1987 CWA amendment in  
40 section 303(d)(4(B)). The Federal antidegradation policy requires states to

1 develop regulations to allow increases in pollutant loadings or changes in surface  
 2 water quality only if: 1) existing surface water uses are maintained and protected,  
 3 and established water quality requirements are met; 2) if water quality  
 4 requirements cannot be maintained by a project, water quality must be maintained  
 5 to fully protect “fishable/swimmable” uses and other existing uses; and 3) for  
 6 Outstanding National Resource Waters water quality criteria where “States may  
 7 allow some limited activities which result in temporary and short-term changes in  
 8 water quality” (Water Quality Standards Regulations) but would not impact  
 9 existing uses or special use of these waters.

## 10 **6.2.2 Major California Water Quality Regulations**

11 The Porter Cologne Water Quality Control Act (Porter-Cologne Act) established  
 12 the SWRCB and divided the state into nine regions, each overseen by a RWQCB.  
 13 The nine RWQCBs have the primary responsibility for the coordination and  
 14 control of water quality within their respective jurisdictional boundaries. The  
 15 SWRCB and the RWQCBs have been delegated Federal authority to implement  
 16 the requirements of the Federal CWA in California. The RWQCBs that have  
 17 jurisdiction over the water bodies in the project area are the NCRWQCB,  
 18 CVRWQCB, SFB RWQCB, Central Coast RWQCB, Los Angeles RWQCB,  
 19 Santa Ana RWQCB, San Diego RWQCB, Lahontan RWQCB, and Colorado  
 20 River RWQCB. The Porter-Cologne Act requires the RWQCBs to prepare and  
 21 periodically update basin plans. Basin plans establish beneficial uses of water,  
 22 water quality objectives, and implementation programs for achieving the  
 23 objectives.

24 The State of California has adopted several water quality policies that are similar  
 25 to federal water quality policies, including the California Toxics Rule (CTR) and  
 26 the Policy for Implementing Toxic Standards for Inland Surface Waters, Enclosed  
 27 Bays, and Estuaries of California (State Implementation Policy).

28 The CTR is applicable to all State waters, as are the USEPA advisory National  
 29 Recommended Water Quality Criteria. Fresh water criteria apply to waters of  
 30 salinity less than 1 parts per thousand 95 percent or more of the time, seawater  
 31 criteria are for water greater than 10 parts per thousand 95 percent or more of the  
 32 time, and estuarine waters use the more stringent of the two possible criteria, in  
 33 absence of estuary-specific criteria.

34 The State Implementation Policy for water quality control, adopted in 2000,  
 35 applies to discharges of toxic pollutants into the inland surface waters, enclosed  
 36 bays, and estuaries of California subject to regulation under the Porter-Cologne  
 37 Act and the Federal CWA. This policy establishes:

- 38 • Implementation provisions for priority pollutant criteria promulgated by the  
 39 USEPA through the NTR and the CTR, and for priority pollutant objectives  
 40 established by RWQCBs in their basin plans;
- 41 • Monitoring requirements for 2,3,7,8-tetrachlorodibenzodioxin (TCDD)  
 42 equivalents; and
- 43 • Chronic toxicity control provisions.

1     **6.2.2.1     Basin Plans**

2     The RWQCBs are required to formulate and adopt basin plans for all areas under  
3     their jurisdiction under the Porter-Cologne Act. Each basin plan must contain  
4     water quality objectives to ensure the reasonable protection of beneficial uses, as  
5     well as a program of implementation for achieving water quality objectives with  
6     the basin plans.

7     Section 13050(f) of the Porter-Cologne Act lists the beneficial uses of the waters  
8     of the state that may be protected against water quality degradation, which include  
9     but are not limited to: domestic, municipal, agricultural, and industrial supply;  
10    power generation; recreation; aesthetic enjoyment; navigation; and preservation  
11    and enhancement of fish, and wildlife and other aquatic resources or preserves.  
12    Basin plans must designate and protect beneficial uses in the region. A uniform  
13    list of beneficial uses is defined by the SWRCB, however each RWQCB may  
14    identify additional beneficial uses specific to local water bodies.

15    Basin plans must adopt water quality standards to protect public health or welfare,  
16    enhance the quality of water, and serve the purposes of the CWA. These water  
17    quality standards include: designated beneficial uses; water quality objectives to  
18    protect the beneficial uses; implementation of the Federal and State policies for  
19    antidegradation; and general policies for application and implementation.

20    The basin plans are subject to modification, considering applicable laws, policies,  
21    technologies, water quality conditions and priorities. Basin plans must be  
22    assessed every three years for the appropriateness of existing standards and  
23    evaluation and prioritization of basin planning issues. In California however,  
24    water bodies are assessed every two years for CWA 303(d) and 305(b)  
25    requirements. Revisions are accomplished through Basin Plan amendments.  
26    Once a Basin Plan amendment is adopted in noticed public hearings, it must be  
27    approved by the SWRCB, Office of Administrative Law and in some cases, the  
28    USEPA.

29    **6.2.2.1.1    California 303(d)/305(b) Integrated Reports**

30    The California 303(d)/305(b) Integrated Report is updated biennially for inclusion  
31    in the USEPA's national Water Quality Inventory Report to Congress. The report  
32    is composed of the current California 303(d) list, and all current listing decisions  
33    for contaminants in impaired water bodies. The statewide report is the  
34    compilation of 303(d)/305(b) Integrated Reports submitted by each RWQCB.  
35    The final California 303(d) list must be submitted to and approved by the USEPA  
36    before it becomes effective.

37    The most recent statewide report is the 2010 California 305(b)/303(d) Integrated  
38    Report, accompanied by the 2010 Staff Report, which outlines the process by  
39    which water bodies were assessed for impairment and by which listing decisions  
40    were made. Each successive 303(d) list updates the previous approved 303(d)  
41    list, in this case the 2006 Section 303(d) list. The updates are made by each  
42    RWQCB in accordance with the Water Quality Control Policy for Developing  
43    California's CWA Section 303(d) list ("Listing Policy").

1 For the 2010 Integrated Report, the data assessed included the 2006 California  
2 CWA Section 303(d) list and its supporting data and information, applicable  
3 Surface Water Ambient Monitoring Program (SWAMP) data from 2000 to 2007,  
4 data from several local monitoring programs, and data provided during public  
5 solicitation. Data incorporated into the assessment were existing and readily  
6 available to RWQCB staff.

7 Data were assessed to identify the beneficial uses for each water body, and  
8 whether water quality criteria were being met. The core beneficial uses most  
9 commonly evaluated were aquatic life, drinking water supply, fish consumption,  
10 non-contact recreation, shell fishing, and swimming. The water quality criteria  
11 considered included water quality objectives set forth by RWQCB Basin Plans,  
12 criteria included in Statewide Basin Plans, the CTR, and maximum contaminant  
13 level MCLs. Narrative “Evaluation Guidelines” were designated for pollutants  
14 without numeric Basin Plan Objectives, MCLs or CTR criteria, as described in the  
15 Listing Policy.

16 The data and assessment results were summarized in LOEs for water body  
17 segment-contaminant combinations. The LOEs include specific information used  
18 to determine whether water quality standards are being met for the water body  
19 segment, including: affected beneficial uses; relevant pollutant; relevant water  
20 quality criteria; and detailed information regarding data samples and quality  
21 assurance information. Fact sheets were prepared that summarize the LOEs and  
22 the reasoning for inclusion or exclusion of the water body-pollutant combination  
23 from the 303(d) list. The fact sheets are stored in the Water Boards’ California  
24 Water Quality Assessment (CalWQA) database.

25 Water body segment-contaminant combinations were categorized into one of  
26 three Beneficial Use Support Ratings: fully supporting (supporting), not  
27 supporting, and insufficient information. These Beneficial Use Support Ratings  
28 were used as the basis for categorizing the water bodies into Integrated Report  
29 categories.

30 For water bodies that are in need of a TMDL, the Listing Policy provides  
31 instruction for scheduling TMDL development, based on, among other factors,  
32 the significance of the water segment, the degree that water quality objectives are  
33 not met or that beneficial uses are threatened, and the potential threat to human  
34 health and the environment.

35 The 2010 California 305(b)/303(d) Integrated Report results in a significant  
36 increase in proposed 303(d) listings in comparison to previous years. This is  
37 likely the result of a large volume of water quality data available for the 2010  
38 assessment, which was not available for the 2006 assessment. There are also  
39 more protective water quality standards for some water bodies, requiring their  
40 addition to the 303(d) list.

#### 41 **6.2.2.2 Central Valley Salinity Alternatives for Long-term Sustainability** 42 **(CV-SALTS)**

43 In 2006, the CVRWQCB, the SWRCB, and stakeholders began a joint effort to  
44 address salinity and nitrate problems in California's Central Valley and adopt

1 long-term solutions that will lead to enhanced water quality and economic  
2 sustainability. This effort is referred to as the CV-SALTS Initiative. The goal of  
3 CV-SALTS is to develop a comprehensive region-wide Salt and Nitrate  
4 Management Plan (SNMP) describing a water quality protection strategy that will  
5 be implemented through a mix of voluntary and regulatory efforts. The SNMP  
6 may include recommendations for numeric water quality objectives, beneficial  
7 use designation refinements, and/or other refinements, enhancements, or basin  
8 plan revisions. The SNMP will serve as the basis for amendments to the three  
9 water quality control plans that cover the Central Valley Region (Sacramento  
10 River and San Joaquin River Basin Plan, the Tulare Lake Basin Plan and the  
11 Sacramento/San Joaquin Rivers Bay-Delta Plan) and the San Francisco Bay Area  
12 Region Basin Plan. The Basin Plan Amendments (BPAs) will likely establish a  
13 comprehensive implementation plan to achieve water quality objectives for  
14 salinity (including nitrate) in the Region's surface waters and groundwater; and  
15 the SNMP may include recommendations for numeric water quality objectives,  
16 beneficial use designation refinements, and/or other refinements, enhancements,  
17 or Basin Plan revisions.

## 18 **6.3 Affected Environment**

19 This section describes surface water quality that could be potentially affected by  
20 the implementation of the alternatives considered in this EIS. Changes in water  
21 quality due to changes in CVP and SWP operations may occur in the Trinity  
22 River, Central Valley, San Francisco Bay Area, and Central Coast and Southern  
23 California regions. Changes to surface water bodies and water supplies are  
24 described in Chapter 5, Surface Water Resources and Water Supplies.

25 This chapter focuses on constituents of concerns that could be affected by changes  
26 in CVP and SWP water operations. The constituents of concern have been  
27 identified in the Final California 2010 Integrated Report (303(d) List/305(b)  
28 Report) as well as other water quality reports. This section provides descriptions  
29 of sources of constituents, water quality effects, water quality objectives and/or  
30 guidelines, and plans to improve water quality.

### 31 **6.3.1 Beneficial Uses of Surface Waters in the Study Area**

32 Water quality conditions throughout the study area are assessed and described by  
33 the RWQCB Basin Plans and Integrated Reports. Each region has specific  
34 beneficial uses, as summarized in Table 6.2 and water quality constituents of  
35 concern; however, several pollutants are prevalent throughout the study area. The  
36 origins and prevalence of these pollutants are discussed below.

1 **Table 6.2 Designated Beneficial Uses within Project Study Area**

Surface Water Body	Municipal and Domestic Supply (MUN)	Agricultural Supply (AGR)	Industrial Service Supply (IND)	Industrial Process Supply (PRO)	Groundwater Recharge (GWR)	Fresh water Replenishment (FRSH)	Navigation (NAV)	Hydropower Generation (POW)	Water Contact Recreation (REC-1)	Non-Contact Water Recreation (REC-2)	Commercial and Sport Fishing (COMM)	Warm Fresh water Habitat (WARM)	Cold Fresh water Habitat (COLD)	Wildlife Habitat (WILD)	Rare, Threatened, or Endangered Species (RARE)	Marine Habitat (MAR)	Migration of Aquatic Organisms (MIGR)	Spawning, Reproduction, and/or Early Development (SPWN)	Shellfish Harvesting (SHELL)	Estuarine Habitat (EST)	Aquaculture (AQUA)	Native American Culture (CUL)	Flood Peak Attenuation/ Flood Water Storage (FLD)	Wetland Habitat (WET)	Water Quality Enhancement (WQE)
<b>Trinity and Lower Klamath Rivers</b>																									
Lower Klamath River and Klamath Glen Hydrologic Subarea	E	E	P	P	E	E	E	P	E	E	E	E	E	E	E	E	E	E	E	E	P	E	-	-	-
Trinity Lake	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	-	P	E	-	-	P	-	-	-	-
Lewiston Reservoir	E	E	P	P	E	E	E	E	E	E	E	P	E	E	E	-	P	E	-	-	E	-	-	-	-
Middle Trinity River and Surrounding Hydrologic Area	E	E	E	P	E	E	E	P	E	E	E	-	E	E	E	-	E	E	-	-	E&P	-	-	-	-
Lower Trinity River and Surrounding Hydrologic Area <sup>1</sup>	E&P	E&P	E	E&P	E	E	E	E&P	E	E	E	-	E	E	E	-	E	E	P	-	E&P	E <sup>2</sup>	-	-	-
<b>Sacramento River Basin</b>																									

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Surface Water Body	Municipal and Domestic Supply (MUN)	Agricultural Supply (AGR)	Industrial Service Supply (IND)	Industrial Process Supply (PRO)	Groundwater Recharge (GWR)	Fresh water Replenishment (FRSH)	Navigation (NAV)	Hydropower Generation (POW)	Water Contact Recreation (REC-1)	Non-Contact Water Recreation (REC-2)	Commercial and Sport Fishing (COMM)	Warm Fresh water Habitat (WARM)	Cold Fresh water Habitat (COLD)	Wildlife Habitat (WILD)	Rare, Threatened, or Endangered Species (RARE)	Marine Habitat (MAR)	Migration of Aquatic Organisms (MIGR)	Spawning, Reproduction, and/or Early Development (SPWN)	Shellfish Harvesting (SHELL)	Estuarine Habitat (EST)	Aquaculture (AQUA)	Native American Culture (CUL)	Flood Peak Attenuation/ Flood Water Storage (FLD)	Wetland Habitat (WET)	Water Quality Enhancement (WQE)
Shasta Lake	E	E	-	-	-	-	-	E	E	E	-	E <sup>4</sup>	E <sup>4</sup>	E	-	-	-	E <sup>5,6</sup>	-	-	-	-	-	-	-
Sacramento River: Shasta Dam to Colusa Basin Drain	E	E	E	-	-	-	E	E	E <sup>3</sup>	E	-	E <sup>4</sup>	E <sup>4</sup>	E	-	-	E <sup>5,6</sup>	E <sup>5,6</sup>	-	-	-	-	-	-	-
Colusa Basin Drain	-	E	-	-	-	-	-	-	E <sup>3</sup>	-	-	E <sup>4</sup>	E <sup>4</sup>	E	-	-	E <sup>6</sup>	E <sup>6</sup>	-	-	-	-	-	-	-
Sacramento River: Colusa Basin Drain to Eye ("I") Street Bridge	E	E	-	-	-	-	E	-	E <sup>3</sup>	E	-	E <sup>4</sup>	E <sup>4</sup>	E	-	-	E <sup>5,6</sup>	E <sup>5,6</sup>	-	-	-	-	-	-	-
Whiskeytown Lake	E	E	-	-	-	-	-	E	E	E	-	E <sup>4</sup>	E <sup>4</sup>	E	-	-	-	E <sup>6</sup>	-	-	-	-	-	-	-
Clear Creek below Whiskeytown Lake	E	E	-	-	-	-	-	-	E <sup>3</sup>	E	-	E <sup>4</sup>	E <sup>4</sup>	E	-	-	E <sup>5</sup>	E <sup>5,6</sup>	-	-	-	-	-	-	-



Surface Water Body	Municipal and Domestic Supply (MUN)	Agricultural Supply (AGR)	Industrial Service Supply (IND)	Industrial Process Supply (PRO)	Groundwater Recharge (GWR)	Fresh water Replenishment (FRSH)	Navigation (NAV)	Hydropower Generation (POW)	Water Contact Recreation (REC-1)	Non-Contact Water Recreation (REC-2)	Commercial and Sport Fishing (COMM)	Warm Fresh water Habitat (WARM)	Cold Fresh water Habitat (COLD)	Wildlife Habitat (WILD)	Rare, Threatened, or Endangered Species (RARE)	Marine Habitat (MAR)	Migration of Aquatic Organisms (MIGR)	Spawning, Reproduction, and/or Early Development (SPWN)	Shellfish Harvesting (SHELL)	Estuarine Habitat (EST)	Aquaculture (AQUA)	Native American Culture (CUL)	Flood Peak Attenuation/ Flood Water Storage (FLD)	Wetland Habitat (WET)	Water Quality Enhancement (WQE)
Feather River below Lake Oroville (Fish Barrier Dam to Sacramento River)	E	E	-	-	-	-	-	-	E <sup>3</sup>	E	-	E <sup>4</sup>	E <sup>4</sup>	E	-	-	E <sup>5,6</sup>	E <sup>5,6</sup>	-	-	-	-	-	-	-
American River below Lake Natoma (Folsom Dam to Sacramento River)	E	E	E	-	-	-	-	E	E <sup>3</sup>	E	-	E <sup>4</sup>	E <sup>4</sup>	E	-	-	E <sup>5,6</sup>	E <sup>5,6</sup>	-	-	-	-	-	-	-
Yolo Bypass <sup>7</sup>	-	E	-	-	-	-	-	-	E	E	-	E <sup>4</sup>	P <sup>4</sup>	E	-	-	E <sup>5,6</sup>	E <sup>6</sup>	-	-	-	-	-	-	-
<b>Sacramento-San Joaquin River Delta</b>																									
Sacramento-San Joaquin River Delta <sup>7,8,9</sup>	E	E	E	E	E	-	E	-	E	E	E	E <sup>4</sup>	E <sup>4</sup>	E	E	-	E <sup>5,6</sup>	E <sup>6</sup>	E	E	-	-	-	-	-
<b>San Joaquin River and Tulare Basin</b>																									
San Joaquin River: Friant Dam to Mendota Pool	E	E	-	E	-	-			E <sup>3</sup>	E	-	E <sup>4</sup>	E <sup>4</sup>	E	-	-	E <sup>5,6</sup>	E <sup>6</sup> , P <sup>5</sup>	-						

Chapter 6: Surface Water Quality

Surface Water Body	Municipal and Domestic Supply (MUN)	Agricultural Supply (AGR)	Industrial Service Supply (IND)	Industrial Process Supply (PRO)	Groundwater Recharge (GWR)	Fresh water Replenishment (FRSH)	Navigation (NAV)	Hydropower Generation (POW)	Water Contact Recreation (REC-1)	Non-Contact Water Recreation (REC-2)	Commercial and Sport Fishing (COMM)	Warm Fresh water Habitat (WARM)	Cold Fresh water Habitat (COLD)	Wildlife Habitat (WILD)	Rare, Threatened, or Endangered Species (RARE)	Marine Habitat (MAR)	Migration of Aquatic Organisms (MIGR)	Spawning, Reproduction, and/or Early Development (SPWN)	Shellfish Harvesting (SHELL)	Estuarine Habitat (EST)	Aquaculture (AQUA)	Native American Culture (CUL)	Flood Peak Attenuation/ Flood Water Storage (FLD)	Wetland Habitat (WET)	Water Quality Enhancement (WQE)
San Joaquin River: Mendota Dam to the Mouth of Merced River	P	E	-	E	-	-			E <sup>3</sup>	E	-	E <sup>4</sup>	-	E	-		E <sup>5,6</sup>	E <sup>5,6</sup>	-						
San Joaquin River: Mouth of Merced River to Vernalis	P	E	-	E	-				E <sup>3</sup>	E	-	E <sup>4</sup>	-	E	-		E <sup>5,6</sup>	E <sup>6</sup>	-	-	-	-	-	-	-
New Melones Reservoir	E	E	-	-	-	-	-	E	E	E	-	-	E <sup>4</sup>	E	-	-	-	-	-	-	-	-	-	-	-
Tulloch Reservoir	P	E	-	-	-	-	-	E	E	E	-	E <sup>4</sup>	-	E	-	-	-	-	-	-	-	-	-	-	-
Stanislaus River: Goodwin Dam to San Joaquin River	P	E	E	E	-	-	-	E	E <sup>3</sup>	E	-	E <sup>4</sup>	E <sup>4</sup>	E	-	-	E <sup>5</sup>	E <sup>5,6</sup>	-	-	-	-	-	-	-
San Luis Reservoir	E	E	E	-	-	-	-	E	E	E	-	E <sup>4</sup>	-	E	-	-	-	-	-	-	-	-	-	-	-
O'Neill Reservoir	E	E	-	-	-	-	-	-	E	E	-	E <sup>4</sup>	-	-	-	-	-	-	-	-	-	-	-	-	-

Surface Water Body	Municipal and Domestic Supply (MUN)	Agricultural Supply (AGR)	Industrial Service Supply (IND)	Industrial Process Supply (PRO)	Groundwater Recharge (GWR)	Fresh water Replenishment (FRSH)	Navigation (NAV)	Hydropower Generation (POW)	Water Contact Recreation (REC-1)	Non-Contact Water Recreation (REC-2)	Commercial and Sport Fishing (COMM)	Warm Fresh water Habitat (WARM)	Cold Fresh water Habitat (COLD)	Wildlife Habitat (WILD)	Rare, Threatened, or Endangered Species (RARE)	Marine Habitat (MAR)	Migration of Aquatic Organisms (MIGR)	Spawning, Reproduction, and/or Early Development (SPWN)	Shellfish Harvesting (SHELL)	Estuarine Habitat (EST)	Aquaculture (AQUA)	Native American Culture (CUL)	Flood Peak Attenuation/ Flood Water Storage (FLD)	Wetland Habitat (WET)	Water Quality Enhancement (WQE)
California Aqueduct	E	E	E	E	-	-	-	E	E	E	-	-	-	E	-	-	-	-	-	-	-	-	-	-	-
Delta-Mendota Canal	E	E	-	-	-	-	-	-	E	E	-	E <sup>4</sup>	-	E	-	-	-	-	-	-	-	-	-	-	-

1 Sources: Central Valley RWQCB 2004, SWRCB 2006a, Hoopa Valley TEPA 2008, Central Valley RWQCB 2011, North Coast RWQCB 2011,

2 Notes:

3 E: Existing Beneficial Use; P: Potential Beneficial Use

4 1 Includes beneficial uses for the Trinity River within the Hoopa Valley Indian Reservation as designated by the Hoopa Valley Indian Reservation  
 5 Water Quality Control Plan, which, in addition to beneficial uses shown, also designates the Lower Trinity River as a Wild and Scenic waterway,  
 6 providing for scenic, fisheries, wildlife and recreational purposes.

7 2 Not all beneficial uses are present uniformly throughout this water body. They have been summarized to reflect beneficial uses present in  
 8 multiple segments of the water body.

9 3 Canoeing and rafting included in REC-1 designation.

## Chapter 6: Surface Water Quality

- 1 4 Resident does not include anadromous. Any Segments with both COLD and WARM beneficial use designations will be considered COLD water  
2 bodies for the application of water quality objectives.
- 3 5 Cold water protection for salmon and steelhead.
- 4 6 Warm water protection for striped bass, sturgeon, and shad.
- 5 7 Beneficial uses vary throughout the Delta and will be evaluated on a case-by-case basis. COMM is a designated beneficial use for the  
6 Sacramento San Joaquin Delta and Yolo Bypass waterways listed in Appendix 43 of the Basin Plan for the Sacramento River and San Joaquin  
7 River Basins and not any tributaries to the listed waterways or portions of the listed waterways outside of the legal Delta boundary unless  
8 specifically designated.
- 9 8 Delta beneficial uses are shown as designated by the Water Quality Control Plan for the Sacramento River Basin and the San Joaquin River  
10 Basin, and the Water Quality Control Plan for the San Francisco Bay/Sacramento San Joaquin Delta Estuary.
- 11 9 Per State Water Board Resolution No. 90-28, Marsh Creek and Marsh Creek Reservoir in Contra Costa County are assigned the following  
12 beneficial uses: REC-1 and REC-2 (potential uses), WARM, WILD and RARE. COMM is a designated beneficial use for Marsh Creek and its  
13 tributaries listed in Appendix 43 of the Basin Plan for the Sacramento River and San Joaquin River Basins within the legal Delta boundary.

### 1 **6.3.1.1 Water Temperature**

2 Water temperature is a concern in regions throughout California including the  
 3 lower Klamath River, Trinity Lake, Sacramento River, and the San Joaquin River.  
 4 These regions support warm and cold fresh water habitat and other aquatic  
 5 beneficial uses. Water bodies in these areas must maintain water temperatures  
 6 supportive of resident and seasonal fish species habitats, particularly for  
 7 endangered species. Common narrative and numeric water quality objectives for  
 8 water temperature in water bodies within the study area are specified in each of  
 9 the basin plans for the North Coast, Central Valley, Tulare Lake and the San  
 10 Francisco Bay regions (NCRWQCB 2011; CVRWQCB 2004, and 2011; SFB  
 11 RWQCB 2013):

- 12 • The natural receiving water temperature of intrastate waters shall not be  
 13 altered unless it can be demonstrated to the satisfaction of the Regional Water  
 14 Board that such alteration in temperature does not adversely affect beneficial  
 15 uses.
- 16 • At no time or place shall the temperature of cold or warm-intrastate waters be  
 17 increased by more than 5° F above natural receiving water temperature.

18 Water quality objectives for water temperature within the project study area are  
 19 also specified in the SWRCB *Water Quality Control Plan for Control of*  
 20 *Temperature in the Coastal and Interstate Waters and Enclosed Bays and*  
 21 *Estuaries of California (Statewide Temperature Plan).*

22 Further information on the measurement and enforcement of water quality  
 23 objectives for temperature is included in the Statewide Temperature Plan  
 24 (SWRCB 1998).

### 25 **6.3.1.2 Salinity**

26 Salinity, a measure of dissolved salts in water, is a concern in the tidally-  
 27 influenced Delta as it can cause impacts on domestic supply, agriculture, industry,  
 28 and wildlife (CALFED 2007). The impacts of salinity on the domestic supply of  
 29 water in the Delta include aesthetic (skin or tooth discoloration), or cosmetic  
 30 (taste, odor, or color) effects, and increasing the need to reduce salinity for M&I  
 31 uses by blending which can lead to a reduction in the quantity of usable water.  
 32 Salts, such as bromide, in drinking water can increase the formation of harmful  
 33 byproducts (see the Bromide, Organics, and Pathogens section). Salinity in the  
 34 Delta impacts agriculture by reducing crop yields and salinity in the soil can cause  
 35 plant stress. Another salt ion, chloride, in high concentrations in municipal and  
 36 industrial supply has been known to cause corrosion in canned goods because of  
 37 residual salts in paper boxes or linerboard.

38 Some fish and wildlife are also affected by salinity concentrations in the Delta  
 39 because certain levels of salinity are required during different life stages to  
 40 survive. One measure of salinity in the western Delta is “X2.” X2 refers to the  
 41 horizontal distance from the Golden Gate Bridge up the axis of the Delta estuary  
 42 to where tidally averaged near-bottom salinity concentration of 2 parts of salt in  
 43 1,000 parts of water occurs. The X2 standard was established to improve shallow

1 water estuarine habitat in the months of February through June and relates to the  
2 extent of salinity movement into the Delta (DWR, Reclamation, USFWS and  
3 NMFS 2013). The location of X2 is important to both aquatic life and water  
4 supply beneficial uses.

5 The CVP and SWP are operated to achieve salinity objectives in the Delta, as  
6 described in detail in Appendix 3A, No Action Alternative: Central Valley Project  
7 and State Water Project Operations.

8 The SWRCB D-1641 includes “spring X2” criteria that require operations of the  
9 CVP and SWP to include upstream reservoir releases from February through June  
10 to maintain freshwater and estuarine conditions in the western Delta to protect  
11 aquatic life. In addition, the 2008 U.S. Fish and Wildlife Service (USFWS)  
12 Biological Opinion (BO) also includes an additional Delta salinity requirement in  
13 September and October in wet and above normal water years (Fall X2), as  
14 described in Chapter 5, Surface Water Resources and Water Supplies.

### 15 **6.3.1.3 Mercury**

16 Mercury is a constituent of concern throughout California, both as total mercury  
17 and as biologically-formed methylmercury, which is more available for food  
18 chain exposure and toxicity. Mercury present in the Delta, its tributaries, Suisun  
19 Marsh, and San Francisco Bay is derived both from current processes and as a  
20 result of historical deposition. Most of the mercury present in these locations is  
21 the result of historical mining of mercury ore in the Coast Ranges (via Putah and  
22 Cache creeks to the Yolo Bypass) and the extensive use of elemental mercury to  
23 aid gold extraction processes in the Sierra Nevada (via Sacramento, San Joaquin,  
24 Cosumnes, and Mokelumne rivers) (Alpers et al. 2008; Wiener et al. 2003).  
25 Elemental mercury from historical gold mining processes appears to be more  
26 bioavailable than that from mercury ore tailings because mercury used in gold  
27 mining processes was purified before use (CVRWQCB 2010a). Additional  
28 sources of mercury include atmospheric deposition from both local and distant  
29 sources, and discharges from wastewater treatment plants (SWRCB 2014a).

30 Methylation of mercury is an important step in the entrance of mercury into food  
31 chain (USEPA 2001a). This transformation can occur in both sediment and the  
32 water column. Methylmercury is absorbed more quickly by aquatic organisms  
33 than inorganic mercury, and it biomagnifies (i.e., increases the concentration of  
34 methylmercury in predatory fish from eating smaller contaminated fish and  
35 invertebrates). The pH of water, the length of the aquatic food chain, water  
36 temperature, and dissolved organic material and sulfate are all factors that can  
37 contribute to the bioaccumulation of methylmercury in aquatic organisms. The  
38 proportion of an area that is wetlands, the soil type, and erosion can also  
39 contribute to the amount of mercury that is transported from soils to water bodies.  
40 These effects can be seen in the variability in bioaccumulated mercury in the  
41 Sacramento-San Joaquin River Delta.

42 Consumption of contaminated fish is the major pathway for human exposure to  
43 methylmercury (USEPA 2001a). Once consumed, methylmercury is almost  
44 completely absorbed into the blood and transported to all tissues, and is also

1 transmitted to the fetus through the placenta. Neurotoxicity from methylmercury  
 2 can result in mental retardation, cerebral palsy, deafness, blindness, and dysarthria  
 3 in utero, and in sensory and motor impairments in adults. Cardiovascular and  
 4 immunological effects from low-dose methylmercury exposure have also been  
 5 reported.

6 In an effort to protect aquatic and human health, USEPA recommended maximum  
 7 concentrations “without yielding unacceptable effects” in 2001 for acute  
 8 exposure, identified as the criteria maximum concentration (CMC), and for  
 9 chronic exposure, identified as the criterion continuous concentration (CCC)  
 10 (USEPA 2001a and USEPA 2014a). Current state-wide water quality criteria for  
 11 mercury were established in the CTR in 2000 (USEPA 2000a). Under these  
 12 requirements, total recoverable mercury for the protection of human health was  
 13 set as limits for consumption of water and organisms as well as consumption of  
 14 organisms only, as summarized in Table 6.3. Mercury objectives are also  
 15 included in some California RWQCB basin plans, as discussed in subsequent  
 16 sections of this chapter. Where both a CTR criterion and a Basin Plan objective  
 17 exist, the more stringent value applies (SWRCB 2006a).

18 **Table 6.3 Water Quality Criteria for Mercury and Methylmercury (as Total Mercury)**

NRWQC	For the protection of freshwater species		CMC = 1.4 µg/l
			CCC = 0.77 µg/l
	For the protection of saltwater species		CMC = 1.8 µg/l
			CCC = 0.94 µg/l
For the protection of human health <sup>1</sup>		0.3 mg/kg <sup>2</sup>	
CTR	For the protection of human health	Consumption of water + organism	0.050 µg/l
		Consumption of organism only	0.051 µg/l

19 Source: NRWQC (National Recommended Water Quality Criteria) - USEPA 2014a; CTR  
 20 (California Toxic Rule) - USEPA 2000a, USEPA 2001b

21 Notes:

22 1 For the consumption of organisms only and based on a total consumption 0.0175 kg  
 23 fish and shellfish per day.

24 2 Methylmercury in fish tissue (wet weight)

25 A review of the mercury human health criteria by USEPA in 2001 concluded that  
 26 a fish tissue (including shellfish) residue water quality criterion for  
 27 methylmercury is more appropriate than a water-column-based water quality  
 28 criterion (USEPA 2001a). A fish tissue criterion directly addresses the dominant  
 29 human exposure route for methylmercury, and thus is more closely tied to the  
 30 CWA goal of protecting public health. The USEPA also strongly encourages  
 31 States and authorized Tribes to develop local or regional water quality criteria if  
 32 they will be more appropriate for the target population.

1 The SWRCB is considering adopting statewide objectives for methylmercury  
2 based on the USEPA criteria, which would apply to inland waters, enclosed bays,  
3 and estuaries (SWRCB 2006a). These objectives would be applicable to waters  
4 that are not listed as impaired or that do not require a TMDL. Potential elements  
5 include a methylmercury fish tissue objective, a total mercury water quality  
6 objective, a methylmercury water quality objective, or some combination of these.  
7 Implementation procedures related to the NPDES permitting process also may be  
8 included.

9 The CTR criterion may be implemented as a fish tissue-based objective (FTO), or  
10 it may be converted into an ambient methylmercury water quality objective  
11 (AWQO), the latter reflecting the USEPA's fish consumption rate of 0.0175 kg  
12 fish/day, or site-specific consumption rates that more accurately reflect local  
13 consumption patterns (SWRCB 2006a). A USFWS evaluation of the USEPA  
14 criterion for methylmercury concluded that the FTO of 0.3 mg methylmercury/kg  
15 fish would be insufficient to protect three species that may occur in the study area  
16 including California Least Tern, California Clapper Rail, and Bald Eagle  
17 evaluated in the study.

#### 18 **6.3.1.4 Selenium**

19 Selenium is a constituent of concern in the project area because of its potential  
20 effects on water quality and on aquatic and terrestrial resources primarily in the  
21 San Joaquin Valley and the San Francisco Bay, as well as some locations in  
22 Southern California (SWRCB 2011a). Elevated concentrations of selenium in  
23 soil and waterways within the San Joaquin Valley, and to some extent in the San  
24 Francisco Bay, are due primarily to erosion of uplifted selenium-enriched  
25 Cretaceous and Tertiary marine sedimentary rock located at the base of the east-  
26 facing side of the Coastal Range (Presser and Piper 1998; Presser 1994). The  
27 selenium-enriched soil derived from the eroded rock has been transported to the  
28 western San Joaquin Valley through natural processes; selenium is mobilized  
29 from the soil by irrigation practices and transported to waterways receiving  
30 agricultural drainage (Presser and Ohlendorf 1987). Other sources of selenium to  
31 the western Delta and San Francisco Bay include several oil refineries located in  
32 the vicinity of Carquinez Strait and San Pablo Bay (Presser and Luoma 2013;  
33 SWRCB 2011a). The specific water bodies within these areas that may be  
34 affected by the project and are impaired by selenium, as specified on the  
35 California CWA Section 303(d) list, include the Panoche Creek (from Silver  
36 Creek to Belmont Avenue), Mendota Pool, Grasslands Marshes, San Joaquin  
37 River (from Mud Slough to Merced River), Sacramento-San Joaquin Delta, and  
38 Suisun Bay (SWRCB 2011a).

39 Adverse effects of selenium may occur as a result of either a selenium deficiency  
40 or excess in the diet (ATSDR 2003; Ohlendorf 2003); the latter is the primary  
41 concern in the case of the impaired water bodies on the 303(d) list. Because of  
42 the known effects of selenium bioaccumulation from water to aquatic organisms  
43 and to higher trophic levels in the food chain, the fresh water, estuarine and  
44 wildlife habitat; spawning, reproduction, and/or early development; and rare,  
45 threatened, or endangered species beneficial uses of the water bodies are the most



1 sensitive receptors to selenium exposure. Thus, excessive exposure can lead to  
2 selenium toxicity or selenosis and result in death or deformities of fish embryos,  
3 fry, or larvae (Ohlendorf 2003, Janz et al. 2010). Consequently, regulatory  
4 agencies have established exposure criteria to protect the beneficial uses of the  
5 water bodies.

6 Agencies such as the Agency for Toxic Substances and Disease Registry  
7 (ATSDR), California Office of Environmental Health Hazard Assessment  
8 (OEHHA), USEPA, SWRCB, and RWQCBs have determined acceptable  
9 selenium exposure levels for humans and water bodies in California. The  
10 ATSDR has stated the minimum risk levels (MRLs) for selenium to be ingested  
11 over a one-year period is 0.005 mg/kg/day, with an uncertainty factor of 3  
12 (ATSDR 2013a). The 0.005 mg/kg/day value is also used by OEHHA to develop  
13 guidelines for consuming fish (OEHHA 2008). USEPA has set 50 µg/l as the  
14 maximum MCL for selenium in drinking water and OEHHA has set a more  
15 stringent draft public health goal (PHG) of 30 µg/l for selenium in drinking water  
16 (USEPA 2009a; OEHHA 2010). USEPA has also specified through the  
17 California Toxics Rule that the water quality criteria for aquatic life in all of  
18 California's fresh water bodies except for the San Joaquin River from Merced  
19 River to Vernalis are 20 µg/l for short-term (1-hour average) and 5 µg/l for long-  
20 term (4-day average) exposure (USEPA 2000a). For the San Joaquin River from  
21 Merced River to Vernalis, the short-term exposure is 12 µg/l and long-term limit  
22 is 5 µg/l, as stated in the Sacramento-San Joaquin River Basin Plan (CVRWQCB  
23 2011). The water quality criteria for aquatic life in all of California's water  
24 bodies is 5 µg/l (4-day average exposure) and 20 µg/l (1-hour exposure) (USEPA  
25 2014a).

26 The USEPA, Reclamation, the SWRCB, and the RWQCBs have created plans to  
27 reduce the toxic levels of selenium in California's impaired water bodies. The  
28 USEPA's Action Plan consists of recommendations to restore water quality and to  
29 protect aquatic species in the San Francisco Bay and Sacramento-San Joaquin  
30 Delta, which include strengthening selenium water quality criteria to reduce long-  
31 term exposure of sensitive aquatic and terrestrial species to selenium (USEPA  
32 2012a). Grasslands Marshes, located in the San Joaquin Valley, include an area  
33 contaminated with selenium from agricultural irrigation and drainage practices  
34 when the marshes were irrigated with a blend of subsurface agricultural drainage  
35 water and higher-quality water. Reclamation's Grasslands Bypass Project  
36 reroutes the discharge of selenium-laden subsurface agriculture water from  
37 upstream agricultural dischargers that formerly passed through the Grassland  
38 Water District and nearby wildlife refuges and wetlands to Mud Slough by  
39 conveying it through a portion of the San Luis Drain. The project began in 1996  
40 and has since reduced the selenium load discharged from the Grassland Drainage  
41 Area from 9,600 lbs to 2,200 lbs in 2011 (GBPOC 2013). Both the USEPA  
42 Action Plan and the Grasslands Bypass Project reduce selenium levels in  
43 waterways to meet the water quality objective targeted for December 2019. The  
44 CVRWQCB released a draft waste discharge requirement in May 2014 that  
45 suggests a performance goal of 15 µg/l (monthly mean) and water quality  
46 objective of 5 µg/l (4-day average) for Mud Slough (north) and the San Joaquin

1 River (CVRWQCB 2014a). This water quality objective for a 4-day average  
 2 selenium concentration is consistent with the TMDL for the lower San Joaquin  
 3 River (CVRWQCB 2001). The USEPA also released draft water quality criteria  
 4 for the protection of freshwater aquatic life from toxic effects of selenium, shown  
 5 in Table 6.4 (USEPA 2014b).

6 **Table 6.4 Draft Water Quality Criteria for Selenium**

Media Type	Fish Tissue	–	Water Column <sup>3</sup>	–
Criterion Element	Egg/Ovary <sup>1</sup>	Fish Whole-Body or Muscle <sup>2</sup>	Monthly Average Exposure	Intermittent Exposure <sup>4</sup>
Magnitude	15.2 mg/kg	8.1 mg/kg whole body or 11.8 mg/kg muscle (skinless, boneless filet)	1.3 µg/l in lentic aquatic systems 4.8 µg/l in lotic aquatic systems	$WQC_{int} = \frac{WQC_{30-day} - C_{bkgrnd}(1 - f_{int})}{f_{int}}$
Duration	Instantaneous measurements <sup>5</sup>	Instantaneous measurements <sup>5</sup>	30 days	Number of days/month with an elevated concentration

7 Source: USEPA 2014b

8 1 Overrides any whole-body, muscle, or water column elements when fish egg/vary  
 9 concentrations are measured.

10 2 Overrides any water column element when both fish tissue and water concentrations  
 11 are measured,

12 3 Water column values are based on dissolved total selenium in water

13 4 Where  $WQC_{30-day}$  is the water column monthly element, for either a lentic or lotic  
 14 system, as appropriate.  $C_{bkgrnd}$  is the average background selenium concentration, and  
 15  $f_{int}$  is the fraction of any 30-day period during which elevated selenium concentrations  
 16 occur, with  $f_{int}$  assigned a value  $\geq 0.033$  (corresponding to 1 day).

17 5 Instantaneous measurement. Fish tissue data provide point measurements that reflect  
 18 integrative accumulation of selenium over time and space in the fish at a given site.  
 19 Selenium concentrations in fish tissue are expected to change only gradually over time in  
 20 response to environmental fluctuations.

21 **6.3.1.5 Nutrients**

22 Nutrients are a constituent of concern in the lower Klamath River hydrologic area  
 23 (Klamath Glen HSA) and the Suisun Marsh Wetlands (SWRCB 2011a) (Klamath  
 24 Glen HSA; SWRCB 2011a). Nutrients, such as nitrogen and phosphorus, come  
 25 from natural sources such as weathering of rocks and soil, and from the ocean  
 26 when nutrients are mixed in the water current, as well as animal manure,  
 27 atmospheric deposition, and nutrient recycling in sediment (NOAA 2014; USEPA

1 1998). Anthropogenic sources include fertilizers, detergents, sewage treatment  
 2 plants, septic systems, combined sewer overflows, and sediment mobilization  
 3 (USEPA 1998).

4 Nutrients are essential to maintaining a healthy water system. However, over  
 5 enrichment of nitrogen and phosphorus can contribute to a process known as  
 6 eutrophication where there is an excessive growth of macrophytes, phytoplankton,  
 7 or potentially toxic algal blooms. Eutrophication may also lead to a decrease of  
 8 dissolved oxygen, typically at night, when plants stop producing oxygen through  
 9 photosynthesis but continue to use oxygen. Low dissolved oxygen levels can kill  
 10 fish, cause an imbalance of prey and predator species, and result in a decline in  
 11 aquatic resources (USEPA 1998). Severely low dissolved oxygen conditions are  
 12 referred to as anoxic and may enhance methylmercury production (SFB RWQCB  
 13 2012a). Over enrichment can also contribute to cloudy or murky water clarity by  
 14 increasing the amount of materials (i.e., algae) suspended in the water.

#### 15 **6.3.1.6 Dissolved Oxygen**

16 Dissolved oxygen is a constituent of concern in the project area primarily in the  
 17 lower Klamath River, Sacramento-San Joaquin River Delta, and Suisun Marsh  
 18 Wetlands (SWRCB 2011a). Oxygen in water comes primarily from the  
 19 atmosphere through diffusion at the water surface, as well as from groundwater  
 20 discharge into streams and when plants undergo photosynthesis releasing oxygen  
 21 in exchange for carbon dioxide (USGS 2014; NOAA 2008a). Levels of dissolved  
 22 oxygen vary with several factors including season, time of day, water  
 23 temperature, salinity, and organic matter. The season and time of day dictate  
 24 photosynthesis processes, which require sunlight. Increases in water temperature  
 25 and salinity reduce the solubility of oxygen (NOAA 2008b). Fungus and the  
 26 bacteria use oxygen when decomposing organic matter in water bodies. So, the  
 27 more organic matter present in a water body, the more potential for dissolved  
 28 oxygen levels to decline.

29 Adverse effects of low dissolved oxygen are a concern for water quality and  
 30 aquatic organisms. Low dissolved oxygen impairs growth, immunity,  
 31 reproduction, and causes asphyxiation and death (NCRWQCB 2011).

32 To protect aquatic life, USEPA has established water quality standards for  
 33 dissolved oxygen (USEPA 1986a). However, to protect the beneficial uses of  
 34 California's water bodies (Table 6.2), including warm and cold freshwater  
 35 habitats in both tidal and non-tidal waters, site-specific water quality objectives  
 36 were established.

37 Future plans to maintain a healthy level of dissolved oxygen in water bodies are  
 38 also site-specific, such as plans for the San Joaquin River and the Stockton Deep  
 39 Water Ship Channel (CVRWQCB 2011).

#### 40 **6.3.1.7 Pesticides**

41 Pesticides are constituents of concern throughout the study area and particularly  
 42 in the Central Valley. Major pesticides of concern include organophosphate (OP)  
 43 pesticides – primarily diazinon and chlorpyrifos, and organochlorine (OC)

1 pesticides – mainly Dichloro-Diphenyl-Trichloroethane (DDT) and Group A  
2 compounds. The toxicity and fates of these pesticides are described in the  
3 following sections.

#### 4 **6.3.1.7.1 Organophosphate Pesticides**

5 The two most prevalent OP pesticides in the study area are man-made pesticides,  
6 diazinon and chlorpyrifos, which have been used extensively in agricultural and  
7 residential applications. Former and current uses of diazinon and chlorpyrifos  
8 have resulted in the contamination of water bodies throughout the Central Valley,  
9 as identified on the 303(d) list (SWRCB 2011a). The CVRWQCB has also  
10 identified hot spots of contamination, particularly in the Delta and in urban areas  
11 of Stockton and Sacramento (CVRWQCB 2003).

12 Pesticides are primarily transported into streams and rivers in runoff from  
13 agriculture (CVRWQCB 2011) but also occur or have occurred in urban non-  
14 point runoff and stormwater discharges. Treated municipal wastewater can also  
15 be a point source. However, OP pesticides, diazinon and chlorpyrifos, have been  
16 banned from non-agricultural uses since December 31st, 2004 and December,  
17 2001, respectively. Reported non-agricultural pesticide use of diazinon and  
18 chlorpyrifos declined substantially in some counties between 2000 and 2009  
19 (CVRWQCB 2014b). However, the reduction of OP pesticide use has resulted in  
20 the increasing use of pyrethroids and carbamates as alternative pesticides in urban  
21 and agricultural areas.

22 Diazinon was one of the most common insecticides in the U.S. for household  
23 lawn and garden pest control, indoor residential crack and crevice treatments and  
24 pet collars until all residential uses of diazinon were phased out, between 2002  
25 and 2004 (USEPA 2004). Diazinon usage was then prohibited for several  
26 agricultural uses in 2007, with only a few remaining agricultural uses permitted,  
27 including uses on some fruit, vegetable, nut and field crops, and as an ear-tag on  
28 non-lactating cattle (USEPA 2007). The highest continued use of diazinon is on  
29 almonds and stone fruits (USEPA 2004).

#### 30 **6.3.1.7.2 Organochlorine Pesticides**

31 Organochlorine (OC) pesticides are mainly comprised of Dichloro-Diphenyl-  
32 Trichloroethane (DDT) and Group A Pesticides (CVRWQCB 2010b). DDT is a  
33 persistent chemical that binds tightly to soil and sediment, and breaks down  
34 slowly in the environment. It degrades to the isomers o,p'- and p,p'- DDT; o,p'-  
35 and p,p'-Dichloro-Diphenyl-Dichloroethylene (DDE) and o,p'- and p,p'-  
36 Dichloro-Diphenyl-Dichloroethane (DDD). Group A Pesticides are made up of  
37 the total concentration of the OC pesticides: aldrin, dieldrin, endrin, heptachlor,  
38 heptachlor epoxide, chlordane (total), hexachlorocyclohexane (total) including  
39 Lindane (gamma-BHC), alpha-BHC, endosulfan (total), and toxaphene. These  
40 pesticides have similar chemical properties to DDT and are also persistent in the  
41 environment.

42 Transport of OC pesticides into streams and rivers is primarily from agriculture  
43 runoff (CVRWQCB 2011). Other potential point sources of OC pesticides

1 include storm sewer discharges and historic spills. Non-point sources can include  
 2 areas of previous residential applications, open space and channel erosion, and  
 3 some background sources through wet and dry atmospheric deposition. Most OC  
 4 pesticides were previously deposited on terrestrial soils, thus erosion and transport  
 5 of contaminated sediments continue to contribute to detectable levels in stream  
 6 bed sediment (CVRWQCB 2010b).

7 OC pesticides have historically been used as insecticides, fungicides and  
 8 antimicrobial chemicals in residential and agricultural pest control (CVRWQCB  
 9 2010b). Most were banned in the mid-1970s, and fish tissue concentrations  
 10 declined rapidly since the ban through the mid-1980s (Greenfield et al., 2004);  
 11 however, they continue to be detected in fish tissue, the water column, and  
 12 sediment in the Central Valley.

### 13 **6.3.1.7.3 Pyrethroid Pesticides**

14 Pyrethroids (e.g., bifenthrin, permethrin, cypermethrin) are synthetic insecticides  
 15 used in agriculture and households. The Surface Water Ambient Monitoring  
 16 Program (SWAMP) studies indicate that the replacement of organophosphate  
 17 pesticides by pyrethroids has resulted in an increased contribution of pyrethroids  
 18 to ambient water and sediment toxicity (Anderson et al. 2011) In the water  
 19 column, toxicity to the water flea *Ceriodaphnia dubia* (*C. dubia*) is caused by  
 20 organophosphate and pyrethroid pesticides. Pyrethroids are also the major  
 21 chemical class of concern in urban storm water, as indicated by the highly  
 22 sensitive amphipod *Hyalella azteca* (*H. azteca*) which is highly sensitive to  
 23 pyrethroids (Weston and Lydy 2010). Non-polar organic compounds, especially  
 24 herbicides, and the herbicide Diuron have been identified as causes of algal  
 25 toxicity in the Central Valley. Of the pyrethroid pesticides, bifenthrin is of major  
 26 concern (Markiewicz et al. 2012).

27 Sediment criteria are also under development for pyrethroids that may inform  
 28 waterbody impairment evaluations (SWRCB 2014b). With regard to sediment, as  
 29 indicated by *H. azteca*, the majority of toxicity has been attributed to pyrethroids,  
 30 particularly in urban areas (Markiewicz et al. 2012).

### 31 **6.3.1.7.4 Other Pesticides**

32 Diuron (3-(3,4-dichlorophenyl)-1,1-dimethylurea or DCMU) was introduced in  
 33 1954 and is currently is one of the most-used herbicides in California  
 34 (CVRWQCB 2012b). It is an herbicide that inhibits photosynthesis and is  
 35 targeted on controlling annual broadleaf and grassy weeds. EPA has not  
 36 developed a WQC specific to Diuron but a TMDL in development will include  
 37 the development of WQO for Diuron in the Central Valley.

### 38 **6.3.1.7.5 General Pesticide Regulations**

39 In addition to the existing water quality objectives and FCGs for pesticides in the  
 40 study area, a Basin Plan Amendment for the Sacramento and San Joaquin River  
 41 watersheds and the Delta is in progress to address those pesticides which currently  
 42 impact or could potentially impact aquatic life uses in surface waters. The Basin

1 Plan Amendment will include the establishment of numeric water quality  
2 objectives for these selected pesticides. By addressing a greater grouping of  
3 pesticides than those included in the current Section 303(d) impaired water body  
4 list, the Basin Plan Amendment will help prevent the increased use of those  
5 pesticides not included on the 303(d) list (CVRWQCB 2006a).

6 **6.3.1.8 Polychlorinated Biphenyls (PCBs)**

7 Polychlorinated biphenyls, a group of synthetic organic chemicals, is a constituent  
8 of concern throughout California including the Sacramento River region  
9 (Sacramento River, Feather River, and American River), the Sacramento-San  
10 Joaquin River Delta, Suisun Bay, Carquinez Strait, and San Pablo Bay (SWRCB  
11 2011a). PCBs cause harmful environmental effects and also pose a risk to human  
12 health (ATSDR 2000).

13 PCBs are mixtures of a variety of individual chlorinated biphenyl components,  
14 known as congeners. In the United States, many of these mixtures were sold  
15 under the trade name Aroclor, manufactured from 1930 to 1977 primarily for use  
16 as coolants and lubricants in transformers, capacitors, and other electrical  
17 equipment. Although manufacture was banned in 1979, PCBs continue to cause  
18 environmental degradation because they are environmentally persistent, easily  
19 redistributed between air, water and soil, and tend to accumulate and biomagnify  
20 in the food chain (ATSDR 2000, OEHHA 2008).

21 The “weathering” of PCBs is a process by which the composition of Aroclor  
22 mixtures undergo differential partitioning, degradation, and biotransformation.  
23 This results in differential environmental persistence and bioaccumulation of the  
24 mixtures, where these increase with the degree of chlorination of new mixtures.  
25 (OEHHA 2008). The biphenyls with more chlorine atoms tend to be heavier and  
26 remain close to the source of contamination, whereas those with fewer chlorine  
27 atoms are easily transported in the atmosphere. Atmospheric deposition is the  
28 primary source of PCBs to surface waters, although redissolution of sediment-  
29 bound PCBs also contributes to surface water contamination. PCBs leave the  
30 water column through sorption to suspended solids, volatilization from water  
31 surfaces, and concentration in plants and animals (ATSDR 2000).

32 PCBs cannot be distinctly assessed for health effects, as their toxicity is  
33 determined by the interactions of individual congeners and by the interactions of  
34 PCBs with other structurally related chemicals, including those combined with or  
35 used in the production of PCBs. However, several general health effects of PCB  
36 exposure have been identified. When PCBs are absorbed, they are distributed  
37 throughout the body and accumulate in lipid-rich tissues, including the liver, skin  
38 tissue, and breast milk. They can also be transferred across the placenta to the  
39 fetus. Studies have linked oral exposure to cancer and to adverse neurological,  
40 reproductive, and developmental effects. The International Agency for Research  
41 on Cancer has thus listed PCBs as probable human carcinogens, and OEHHA has  
42 administratively listed PCBs on the Proposition 65 list of chemicals known to the  
43 State of California to cause cancer (OEHHA 2008).

### 1 **6.3.2 Trinity River Region**

2 The Trinity River Region includes the area in Trinity County along the Trinity  
3 River from Trinity Lake to the confluence with the Klamath River; and in  
4 Humboldt and Del Norte counties along the Klamath River from the confluence  
5 with the Trinity River to the Pacific Ocean.

6 This water quality analysis includes Trinity Lake, Lewiston Lake, Trinity River  
7 downstream of Lewiston Dam, and the Klamath River from its confluence with  
8 the Trinity River to the Pacific Ocean. The analysis does not include Trinity  
9 River upstream of Trinity Lake, the South Fork of the Trinity River, or the  
10 Klamath River upstream of Trinity River, because these areas are not affected by  
11 changes in CVP operations.

12 Several water quality requirements affect the Klamath River and Trinity River  
13 basins. Beneficial uses and water quality objectives provided by the NCRWQCB  
14 and the Hoopa Valley Tribal Environmental Protection Agency (Hoopa Valley  
15 TEPA) are described below, as well as relevant TMDLs. The Yurok Tribe Basin  
16 Plan for the Yurok Indian Reservation and the Resighini Rancheria Tribal Water  
17 Quality Ordinance also regulate portions of the Trinity and Klamath Rivers that  
18 flow into and through the reservations; however, because they have not yet been  
19 approved by the USEPA, their objectives are not described in detail here. Oregon  
20 water quality requirements also affect the water quality of the Klamath River  
21 which originates in Oregon. However, this chapter only discusses the  
22 requirements within the Trinity and lower Klamath River Basins.

#### 23 **6.3.2.1 Beneficial Uses**

24 Beneficial uses for all water bodies in the study area are determined by the  
25 NCRWQCB and the Hoopa Valley TEPA (Table 6.2). In addition to the  
26 beneficial uses listed in the Trinity and Klamath River basins, the North Coast  
27 Basin Plan notes that recreational use (i.e., water contact recreation [REC-1] and  
28 non-contact water recreation [REC-2]) occurs in all hydrologic units of the  
29 Klamath River Basin, with Trinity River being one of the rivers receiving the  
30 largest levels of recreational use (NCRWQCB 2011). Fish and wildlife reside in  
31 virtually all of the surface waters within the North Coast Region (NCRWQCB  
32 2011). These species include several that are designated as rare, threatened and  
33 endangered. Trinity Dam also provides the beneficial use of hydroelectric power  
34 (i.e., POW).

#### 35 **6.3.2.2 Constituents of Concern**

36 The constituents of concern that are currently not in compliance with existing  
37 water quality standards and for which TMDLs are adopted or are in development  
38 are summarized in Table 6.1 and discussed below.

##### 39 **6.3.2.2.1 Water Temperature**

40 The majority of the Trinity and Klamath Rivers are not listed on the 303(d) list  
41 approved by the USEPA in 2010 as impaired by water temperature. However, the  
42 hydrologic area of the South Fork Trinity River and the lower hydrologic area of

1 the Klamath River (Klamath Glen HSA) are listed for elevated water temperatures  
 2 adversely affecting the cold freshwater habitat (SWRCB 2011c-h).

3 The Trinity River and lower Klamath River watersheds must maintain water  
 4 temperatures to protect and support resident and seasonal fish species habitats.  
 5 The North Coast Basin Plan designates narrative and numeric water temperature  
 6 objectives applicable to surface waters in the Trinity River and the lower Klamath  
 7 River basins. Other objectives and criteria specific to each region are specified  
 8 below.

9 *Trinity River*

10 The South Fork Trinity River flows from its headwaters to the confluence with  
 11 the mainstem of the Trinity River. It then flows into the lower Klamath River and  
 12 out to the Pacific Ocean. Elevated water temperatures in the South Fork Trinity  
 13 River can be attributed to the loss of shade trees due to habitat modification, range  
 14 grazing, removal of riparian vegetation, streambank modification and  
 15 destabilization, and water diversions (SWRCB 2011d). This reach supports  
 16 steelhead, Chinook Salmon, and Coho Salmon (below Grouse Creek) (USDAFS  
 17 2014). The mainstem of the Trinity River also supports steelhead, Coho Salmon,  
 18 and Chinook Salmon.

19 Water temperature objectives, summarized in Table 6.5, were set forth in the  
 20 North Coast Basin Plan specifically applicable to the Trinity River, from  
 21 Lewiston Dam to Douglas City and to the confluence with the North Fork Trinity  
 22 River. These criteria are reach dependent, and vary seasonally. They were  
 23 specifically developed to enhance the productivity of Trinity River Fish Hatchery,  
 24 specifically for salmon and steelhead trout populations (NCRWQCB 2011).

25 **Table 6.5 Water Quality Objectives for Temperature in the Trinity River**

Period	Daily Average Temperature Not to Exceed	Trinity River Reach
July 1 – September 14	60° F	Lewiston Dam to Douglas City Bridge
September 15 – October 1	56° F	Lewiston Dam to Douglas City Bridge
October 1 – December 31	56° F	Lewiston Dam to confluence of North Fork Trinity River

26 Source: NCRWQCB 2011

27 *Hoopa Valley Indian Reservation*

28 Natural causes of temperature exceedances, such as unusually excessive ambient  
 29 air temperatures coupled with flows, intended to protect aquatic habitat specified  
 30 in the Trinity River Flow Evaluation report (TRFE), will not be considered to  
 31 violate the water quality objectives stated in the Hoopa Valley Indian Reservation  
 32 Basin Plan.

33 Temperature objectives for the Trinity River as it passes through the Hoopa  
 34 Valley Reservation vary seasonally and are precipitation dependent (Table 6.6).



1 The water quality objectives are based on temperature-flow relationships that  
 2 maintain TRFE flow regimes and protect adult salmonids holding and spawning.  
 3 The objectives are also consistent with the temperature standards specified in the  
 4 NCRWQCB Basin Plan (Hoopa Valley TEPA 2008).

5 **Table 6.6 Trinity River Temperature Criteria for the Hoopa Valley Indian**  
 6 **Reservation**

Dates	Running 7-Day Average Temperature not to Exceed <sup>1,2</sup>	
	Extremely Wet, Wet and Normal Water Years	Dry and Critically Dry Water Years
May 23 – June 4	59° F	62.6° F
June 5 – July 9	62.6° F	68° F
July 10 – September 14	72.0° F	74.0° F <sup>3</sup>
September 15 – October 31	66.0° F	66.0° F
November 1 – May 22	55.4° F	59.0° F

7 Source: Adapted from Hoopa Valley TEPA 2008

8 1 Temperature standards will be monitored at the Weitchpec temperature monitoring  
 9 station operated and maintained by Reclamation.

10 2 Temperature standard violations will be determined if more than ten percent of seven-  
 11 day running averages exceed the standard, to be determined by the number of days  
 12 exceeded for that seasonal period (i.e., for June 16 – September 14, a 91 day period, ten  
 13 percent exceedance will equate to nine days).

14 3 For the seasonal period of June 16 – September 14, temperatures on the mainstem  
 15 Trinity River at the Weitchpec gauging station were used to determine running seven-day  
 16 averages.

17 The Hoopa Valley TEPA established a goal of attaining a temperature of 21° C  
 18 (69.8° F) during the July 10 – September 14 period within five years of the  
 19 adoption of these standards (Hoopa Valley TEPA 2008). If monitoring reveals  
 20 that temperatures continue to increase, the Hoopa Valley TEPA will employ  
 21 adaptive management strategies until temperatures begin to decrease

22 In addition to the seasonal water temperature criteria, the Hoopa Valley TEPA has  
 23 established varying criteria for each life stage of salmonids (Table 6.7).

1 **Table 6.7 Tributary Temperature Criteria for the Hoopa Valley Indian Reservation**

Dates	Maximum Weekly Average Temperature (MWAT) <sup>1,2</sup>		Applicable Salmonid Life Stage(s) <sup>3</sup>
	Extremely Wet, Wet and Normal Water Years	Dry and Critically Dry Water Years	
May 23 – June 4	55.4° F	57.2° F	Adult holding; coho incubation and emergence; spawning; smoltification
June 5 – Jul 9	60.8° F	62.6° F	Adult holding; peak temperatures timeframe according to Hoopa Tribal data
July 10 – September 14	64.4° F	68.0° F	Adult holding
September 15 – October 31	57.2° F	60.8° F	Adult holding; spawning
November 1 – May 22	50.0° F	53.6° F	Adult incubation and emergence (including coho); smoltification; spawning

2 Source: Adapted from Hoopa Valley TEPA 2008

3 1 The MWAT is defined as the highest 7-day moving average of equally spaced water  
 4 temperature measurements for a given time period. In this application, the time period is  
 5 the duration of the existing salmonids life stage. For the MWAT objective, temperatures  
 6 may not exceed the numeric objective for every 7-day period during the given life stage.

7 2 Applicable where a given species and life stage time period exist, and when and where  
 8 the species and life stage time period existed historically, and have the potential to exist  
 9 again.

10 3 Adult migration and juvenile rearing are considered all year life stages.

11 Water temperature data for Trinity River between 2001 and 2012 show seasonal  
 12 trends and the warming effect of ambient conditions at the downstream location  
 13 (Table 6.8 and Figure 6.1). Compliance locations for water quality monitoring  
 14 along the Trinity River are shown in Figure 6.2.

1  
2

**Table 6.8 Monthly Average of Water Temperatures Recorded at Trinity River Compliance Locations**

WY	WYT	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Douglas City</b>													
2001	D	51.9	46.6	44.2	42.0	43.2	47.5	50.7	54.4	55.5	58.5	57.0	54.2
2002	D	51.0	47.7	42.7	43.1	43.8	46.6	52.5	49.4	56.1	58.9	56.2	54.4
2003	AN	49.8	46.5	44.6	44.9	44.8	48.0	48.8	50.4	52.8	57.0	56.6	52.7
2004	BN	51.2	46.6	43.7	41.5	43.7	47.5	51.4	50.3	51.4	54.7	56.4	53.0
2005	AN	50.9	47.4	42.9	42.8	45.3	48.2	50.8	49.9	52.2	57.9	59.5	54.7
2006	W	51.5	47.4	43.9	45.5	44.4	44.2	47.5	48.4	49.3	54.9	NA	NA
2007	D	NA	NA	43.0	39.8	43.1	48.4	52.5	47.9	55.8	58.7	57.2	54.1
2008	C	50.3	46.9	41.8	39.8	41.2	46.4	50.0	48.6	50.8	53.4	58.0	55.3
2009	D	51.4	49.3	43.5	43.0	43.4	46.8	51.7	50.9	56.6	60.5	58.1	55.9
2010	BN	51.2	47.5	42.2	44.3	45.2	46.8	48.4	48.4	52.3	57.3	58.5	55.1
2011	W	51.4	46.7	44.4	42.3	42.6	45.2	48.8	47.7	50.4	54.4	57.6	53.9
2012	BN	50.5	45.5	41.2	40.2	43.5	45.2	48.9	49.3	50.9	55.2	55.6	52.4
WY	WYT	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>North Fork Trinity near Helena</b>													
2001	D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2002	D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2003	AN	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2004	BN	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2005	AN	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	64.5	58.2
2006	W	53.4	47.8	44.0	45.7	44.8	44.9	48.3	49.6	51.4	59.0	NA	NA
2007	D	NA	NA	42.5	39.6	43.5	48.9	53.2	49.3	59.8	65.4	63.0	58.3
2008	C	52.5	48.3	42.0	40.6	42.3	46.6	50.1	50.1	53.2	56.7	62.8	59.2
2009	D	53.3	49.6	43.0	42.5	43.4	47.0	51.8	52.6	59.7	66.0	62.9	60.0
2010	BN	53.4	47.7	41.9	44.8	45.9	47.1	48.4	49.4	53.7	60.9	63.3	59.0
2011	W	53.9	47.1	45.1	43.1	43.0	45.2	45.5	NA	NA	NA	NA	NA
2012	BN	52.8	46.4	40.9	39.9	43.8	45.1	49.1	50.6	53.3	59.3	60.3	55.9
WY	WYT	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Weitchpec</b>													
2001	D	57.9	48.2	44.8	41.9	43.5	48.8	52.1	60.9	65.8	73.8	72.1	67.0
2002	D	59.3	51.2	46.0	44.7	45.8	47.4	53.9	55.9	66.1	73.6	71.1	67.2
2003	AN	57.5	49.1	46.7	49.3	50.8	54.2	54.8	58.6	69.5	70.2	71.3	64.6
2004	BN	59.7	50.4	46.3	45.3	46.8	53.5	58.7	56.6	62.3	70.4	72.1	64.4
2005	AN	58.6	49.9	45.0	44.3	46.7	50.0	51.5	54.6	59.5	69.8	73.0	64.9
2006	W	58.8	50.6	46.4	48.8	47.5	47.8	50.2	53.8	57.1	65.2	NA	NA
2007	D	NA	NA	47.9	44.9	48.3	52	56.2	56.3	66.6	73.2	72.6	NA
2008	C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2009	D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

WY	WYT	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2010	BN	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2011	W	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2012	BN	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

1 Source: DWR 2014a,b,c

2 Temperatures in the Trinity River within the Reservation boundary will be  
 3 monitored based on water-year type as established by the TRFE and determined  
 4 by the Bureau of Reclamation.

5 Activities that increase water temperatures must comply with Tribal and Federal  
 6 anti-degradation policies. The responsible party must not increase water  
 7 temperatures, even if caused by their actions coupled with natural factors (Hoopa  
 8 Valley TEPA 2008). In some streams, the numeric objectives may not be  
 9 attainable due to site specific limitations. If this is the case, and provided that the  
 10 stream has been restored to its full site potential; and the salmonid population is at  
 11 a level consistent with the National Marine Fisheries Service (NMFS) concept of  
 12 a ‘Viable Salmonid Population’(McElhany et al. 2000), then the Hoopa Valley  
 13 TEPA may not be applicable.

14 **6.3.2.2.2 Mercury**

15 Trinity Lake and the upper hydrologic area of the East Fork Trinity River are two  
 16 water bodies in the North Coast that were placed on the Section 303(d) list,  
 17 approved by USEPA in 2010 (SWRCB 2011a), as impaired due to mercury.  
 18 Mercury in Trinity Lake can be attributed to atmospheric deposition, natural  
 19 sources, resource extractions, and other unknown sources (SWRCB 2011b).  
 20 Significant mercury contamination is likely due to historical gold and mercury  
 21 mining activities along the East Fork Trinity River at the inactive Altoona  
 22 Mercury Mine (May et al. 2004).

23 The commercial or recreational collection of fish, shellfish, or organisms was  
 24 deemed impaired since fish tissue exceeded USEPA’s recommended Fish Tissue  
 25 Residue Criteria for human health of 0.3 mg of methylmercury (wet weight) per  
 26 kg of fish tissue (SWRCB 2011b-g). This criterion is based on the consumption-  
 27 weighted rate of 0.0175 kg of total fish and shellfish per day. Fourteen out of  
 28 fifty seven fish tissue samples from fish in the North and the East Fork of the lake  
 29 in September 2001 and 2002 exceeded this fish tissue criterion. Composite fish  
 30 tissue samples that exceeded the criterion were from White Catfish, Smallmouth  
 31 Bass, and Chinook Salmon.

32 For the protection of marine aquatic life, water quality objectives for mercury  
 33 were set for discharges within the area specified in the North Coast Region Water  
 34 Quality Control Board Basin Plan as follows (NCRWQCB 2011).

- 35 • Six-Month Median: 0.04 µg/l
- 36 • Daily Maximum: 0.16 µg/l
- 37 • Instantaneous Maximum: 0.4 µg/l (conservative estimate for chronic toxicity)

1 In an effort to meet the water quality standards in Trinity Lake and the East Fork  
 2 of Trinity River, a TMDL is expected to be completed by 2019. An approach for  
 3 calculating effluent limitations was established in the NCRWQCB Basin Plan  
 4 (NCRWQCB 2011).

5 **6.3.2.2.3 Nutrients**

6 The lower Klamath River was placed on the 303(d) list approved by the USEPA  
 7 in 2010 for being impaired by nutrients (SWRCB 2011a). Nutrient levels in the  
 8 Klamath Estuary may cease to be a limiting factor and can promote levels of algal  
 9 growth that cause a nuisance or adversely affect beneficial uses when excess  
 10 growth is not consumed by animals or exported by flows (DOI and DFG 2012).

11 The Klamath River receives the greatest nutrient loading from the Upper Klamath  
 12 basin, comprising approximately 40 percent of its total contaminant load  
 13 (NCRWQCB 2010). Tributaries to the Klamath River are the greatest  
 14 contributors of the remaining nutrient loads, with the Trinity River contributing  
 15 the most.

16 The Hoopa Valley TEPA also designates water quality objectives to address  
 17 contamination by nutrients (Table 6.9).

18 **Table 6.9 Specific Use Water Quality Criteria for Waters of the Hoopa Valley Indian**  
 19 **Reservation**

Contaminant	Trinity River	Klamath River
Maximum Annual Periphyton Biomass	–	150 mg chlorophyll a/m <sup>2</sup> of streambed area
pH	MUN-designated waters: 5.0 – 9.0 All other designated uses: 7.0 – 8.5	7.0 – 8.5
Total Nitrogen <sup>1</sup>	–	0.2 mg/l
Total Phosphorus <sup>1</sup>		0.035 mg/l
Microcystis aeruginosa cell density	–	< 5,000 cells/mL for drinking water < 40,000 cells/mL for recreational water
Microcystin toxin concentration		< 1 µg/l total microcystins for drinking water < 8 µg/l total microcystins for recreational water
Total potentially toxigenic blue-green algal species <sup>2</sup>		< 100,000 cells/mL for recreational water

Contaminant	Trinity River	Klamath River
Cyanobacterial scums		There shall be no presence of cyanobacterial scums

1 Source: Hoopa Valley TEPA 2008

2 1 There should be at least two samples per 30-day period. If total nitrogen and total  
 3 phosphorus standards are not achievable due to natural conditions, then the standards  
 4 shall instead be the natural conditions for total nitrogen and total phosphorus. Through  
 5 consultation, the ongoing TMDL process for the Klamath River is expected to further  
 6 define these natural conditions.

7 2 Includes: Anabaena, Microcystis, Planktothrix, Nostoc, Coelsphaerium, Anabaenopsis,  
 8 Aphanizomenon, Gloeotrichia, and Oscillatoria.

9 In addition to the water quality criteria established by the Hoopa Valley TEPA  
 10 (2008), the 2010 *Klamath River TMDLs Addressing Temperature, Dissolved*  
 11 *Oxygen, Nutrient, and Microcystin Impairments in California* provides TMDLs  
 12 for nutrients which address elevated pH levels (DOI and DFG 2012). Nutrient  
 13 targets include numeric targets for total phosphorus (TP), total nitrogen (TN)  
 14 (NCRWQCB 2010).

15 The Klamath River nutrient TMDLs are in the process of being implemented by  
 16 the NCRWQCB and other affiliated agencies, including the SWRCB, the USEPA,  
 17 Reclamation, the USFWS, the Oregon Department of Environmental Quality,  
 18 responsible for implementation of the Klamath TMDLs in Oregon, and other  
 19 state, federal, and private agencies with operations that affect the Klamath River  
 20 (NCRWQCB 2010).

21 **6.3.2.2.4 Organic Matter**

22 The lower Klamath River was placed on the 303(d) list approved by the USEPA  
 23 in 2010 for impairment due to organic enrichment (SWRCB 2011a).

24 The Klamath River has several natural sources of organic matter. The river  
 25 originates from the Upper Klamath Lake, which is a naturally shallow, eutrophic  
 26 lake, with high levels of organic matter (algae), including nitrogen fixing blue-  
 27 green algae (NCRWQCB 2010). Other sources of organic matter include runoff  
 28 from agricultural lands (i.e., irrigation tailwater, storm runoff, subsurface  
 29 drainage, and animal waste), flow regulations/modification, industrial point  
 30 sources, and municipal point sources (SWRCB 2011).

31 To protect the beneficial uses of the lower Klamath River, including cold  
 32 freshwater habitat, a TMDL was established in 2010 for organic matter and other  
 33 constituents. The TMDL equals 143,019 pounds of Carbonaceous Biochemical  
 34 Oxygen Demand (CBOD) per day from the Klamath River (NCRWQCB 2011h).  
 35 The average organic matter (measured as CBOD) loads from all other Klamath  
 36 River tributaries are sufficient to meet other related objectives, including  
 37 dissolved oxygen and biostimulatory substances objectives, in the Klamath River  
 38 (NCRWQCB 2010). The dissolved oxygen objectives are the primary targets  
 39 associated with organic matter as well as nutrients. Organic matter allocations

1 were also established for the Klamath River below Salmon River, and the major  
 2 tributaries to the Klamath, including Trinity River.  
 3 Implementation actions and other objectives were established to ensure the  
 4 TMDL is met to protect the beneficial uses of the Klamath River and other water  
 5 bodies downstream. The North Coast Basin Plan states that a water quality study  
 6 will be completed to identify actions for monitoring, evaluating, and  
 7 implementing any necessary actions to address organic matter loading so that the  
 8 TMDL will be met (NCRWQCB 2011).

9 **6.3.2.2.5 Dissolved Oxygen**

10 The lower Klamath River was placed on the 303(d) list approved by the USEPA  
 11 in 2010 for low dissolved oxygen (SWRCB 2011a).

12 Sources that contribute to low dissolved oxygen include sources of organic  
 13 enrichment, specified in the previous section; water temperature; and salinity,  
 14 explained further in Section 6.3.2.6. Other sources that contribute to low  
 15 dissolved oxygen are runoff from roads and agriculture that can transport  
 16 nutrients into water bodies and lower dissolved oxygen through biostimulatory  
 17 effects (NCRWQCB 2010). Over-enrichment and growth of algae and aquatic  
 18 plants can produce oxygen during the day through photosynthesis but those same  
 19 plants can deplete dissolved oxygen at night.

20 To protect the beneficial uses of the lower Klamath River, including the cold  
 21 freshwater habitat, water quality objectives were established in the North Coast  
 22 Basin Plan (2010) and the Hoopa Valley TEPA (2008) for dissolved oxygen in  
 23 the Klamath River and its major tributary, the Trinity River (Table 6.10 and  
 24 Table 6.11) (NCRWQCB 2011). Site Specific Objectives (SSOs) for dissolved  
 25 oxygen were calculated as part of TMDLs developed by the NCRWQCB (2011),  
 26 and have been incorporated into the North Coast Basin Plan (2011) (Table 6.12).  
 27 For those waters without location-specific dissolved oxygen criteria, dissolved  
 28 oxygen shall not be reduced below minimum levels, shown in Table 6.13, at any  
 29 time to protect beneficial uses.

30 **Table 6.10 Water Quality Objectives for Dissolved Oxygen in Trinity and Lower**  
 31 **Klamath**

Water body	Dissolved Oxygen (mg/l)	
	Minimum	50% Lower Limit <sup>1</sup>
Trinity Lake and Lewiston Reservoir	7.0	10.0
Lower Trinity River	8.0	10.0
Lower Trinity Area Streams	9.0	10.0
Lower Klamath River Area Streams	8.0	10.0

32 Source: NCRWQCB 2011

1 1: 50 percent lower limit represents the 50 percentile values of the monthly means for a  
 2 calendar year. 50 percent or more of the monthly means must be greater than or equal  
 3 to the lower limit.

4 **Table 6.11 Specific Use Water Quality Criteria for Waters of the Hoopa Valley Indian**  
 5 **Reservation**

Contaminant	Trinity River	Klamath River
Minimum Water Column Dissolved Oxygen Concentration	11.0 mg/l	SPWN-designated waters <sup>1</sup> : 11.0 mg/l <sup>2</sup> COLD-designated waters: 8.0 mg/l <sup>2</sup>
Minimum Inter-gravel Dissolved Oxygen Concentration	8.0 mg/l	SPWN-designated waters <sup>1</sup> : 8.0 mg/l <sup>2</sup>

6 Source: Hoopa Valley TEPA 2008

7 1 Whenever spawning occurs, has occurred in the past or has potential to occur.

8 2 7-day moving average of the daily minimum DO. If dissolved oxygen standards are not  
 9 achievable due to natural conditions, the COLD and SPWN standard shall instead be  
 10 dissolved oxygen concentrations equivalent to 90 percent saturation under natural  
 11 receiving water temperatures.

12 **Table 6.12 Site Specific Objectives for Dissolved Oxygen in the Klamath River<sup>1</sup>**

Location <sup>2</sup>	Percent Dissolved Oxygen Saturation Based On Natural Receiving Water Temperatures <sup>3</sup>	Time Period
Downstream of Hoopa-California Boundary to Turwar	85	June 1 through August 31
	90	September 1 through May 31
Upper and Middle Estuary	80	August 1 through August 31
	85	September 1 through October 31 and June 1 through July 31
	90	November 1 through May 31
Lower Estuary	For the protection of estuarine habitat (EST), the dissolved oxygen content of the Lower Klamath estuary shall not be depressed to levels adversely affecting beneficial uses as a result of controllable water quality factors.	

13 Source: NCRWQCB 2011



1 1 States may establish site specific objectives equal to natural background (USEPA  
 2 1986a. Ambient Water Quality Criteria for Dissolved Oxygen, EPA 440/5-86-033; USEPA  
 3 Memo from Tudor T. Davies, Director of Office of Science and Technology, USEPA  
 4 Washington, D.C. dated November 5, 1997). For aquatic life uses, where the natural  
 5 background condition for a specific parameter is documented, by definition that condition  
 6 is sufficient to support the level of aquatic life expected to occur naturally at the site  
 7 absent any interference by humans (Davies 1997). These dissolved oxygen objectives  
 8 are derived from the T1BSR run of the Klamath TMDL model and described in Tetra  
 9 Tech, December 23, 2009 Modeling Scenarios: Klamath River Model for TMDL  
 10 Development (Tetra Tech and WR and TMDL Center 2009). They represent natural  
 11 dissolved oxygen background conditions due only to non-anthropogenic sources and a  
 12 natural flow regime.

13 2 These objectives apply to the maximum extent allowed by law. To the extent that the  
 14 State lacks jurisdiction, the Site Specific Dissolved Oxygen Objectives for the Mainstem  
 15 Klamath River are extended as a recommendation to the applicable regulatory authority.

16 3 Corresponding dissolved oxygen concentrations are calculated as daily minima, based  
 17 on site-specific barometric pressure, site-specific salinity, and natural receiving water  
 18 temperatures as estimated by the T1BSR run of the Klamath TMDL model and described  
 19 in Tetra Tech, December 23, 2009 (Tetra Tech and WR and TMDL Center 2009).  
 20 Modeling Scenarios: Klamath River Model for TMDL Development. The estimates of  
 21 natural receiving water temperatures used in these calculations may be updated as new  
 22 data or method(s) become available. After opportunity for public comment, any update or  
 23 improvements to the estimate of natural receiving water temperature must be reviewed  
 24 and approved by Executive Officer before being used for this purpose.

25 **Table 6.13 Water Quality Objectives for Dissolved Oxygen for Specified Beneficial**  
 26 **Uses**

Beneficial Use Designation	Minimum Dissolved Oxygen Limit (mg/l)
WARM, MAR, or SAL	5.0
COLD	6.0
SPWN	7.0
SPWN – during critical spawning and egg incubation periods	9.0
Klamath River Water Column <sup>1</sup> SPWN-designated waters <sup>2</sup> : COLD-designated waters:	11.0 mg/l <sup>3</sup> 8.0 mg/l <sup>3</sup>
Klamath River Inter Gravel <sup>1</sup> SPWN-designated waters <sup>2</sup> :	8.0 mg/l <sup>3</sup>

27 Source: NCRWQCB 2011

28 1 Hoopa Valley TEPA (2008)

29 2 Whenever spawning occurs, has occurred in the past or has potential to occur.

30 3 7-day moving average of the daily minimum DO. If dissolved oxygen standards are not  
 31 achievable due to natural conditions, the COLD and SPWN standard shall instead be

1 dissolved oxygen concentrations equivalent to 90 percent saturation under natural  
2 receiving water temperatures.

3 The 2010 *Klamath River TMDLs Addressing Temperature, Dissolved Oxygen,*  
4 *Nutrient, and Microcystin Impairments in California* provide numerical targets for  
5 dissolved oxygen and other constituents (NCRWQCB 2010). Site specific  
6 objectives for dissolved oxygen were proposed in this TMDL and adopted into the  
7 North Coast Basin Plan (Table 6.29). The dissolved oxygen objectives are the  
8 primary targets associated with nutrient and organic matter, with additional  
9 dissolved oxygen-related TMDLs prescribed for total phosphorus (TP), total  
10 nitrogen (TN) and organic matter (CBOD) loading, and numerical targets  
11 provided for benthic algae biomass, suspended algae chlorophyll-a, *microcystis*  
12 *aeruginosa*, and microcystin toxin discussed in their corresponding sections.

13 Plans to monitor dissolved oxygen and other constituents in the Klamath River  
14 below Trinity River, near Turwar, and the Klamath River Estuary were  
15 established in Chapter 7 of the Klamath River TMDLs to further protect the  
16 beneficial uses of the Trinity and lower Klamath Rivers (NCRWQCB 2010). The  
17 TMDL also includes a proposal to revise SSOs for dissolved oxygen in the  
18 Klamath River.

#### 19 **6.3.2.2.6 Sedimentation and Siltation**

20 Sedimentation and siltation are not caused by operation of the CVP. However,  
21 the lower Klamath River and Trinity River were placed on the 303(d) list  
22 approved in 2010 as impaired by sedimentation and siltation (SWRCB 2011a).

##### 23 *Trinity River*

24 Disturbance of sediment and silt is a natural part of stream ecosystems, which can  
25 contribute to fluctuating salmonid populations in response to fine sediment  
26 embedded in spawning gravels. However, human activities have resulted in an  
27 increased severity and frequency of habitat disturbance (TRRP and NCRWQCB  
28 2009). In the Mainstem Trinity River, sediment loading can be attributed to  
29 runoff from areas of active or past mining, timber harvest, and road-related  
30 activities. Natural sources, such as landsliding, bank erosion, and soil creep,  
31 contribute the greatest sediment loads each year (NCRWQCB 2008). Future  
32 point sources of sedimentation into the Trinity River Basin, including CalTrans  
33 facilities and construction sites larger than five acres have to meet discharge  
34 requirements pursuant to California's NPDES general permit for construction site  
35 runoff (USEPA 2001f).

36 The primary adverse impacts of excess sedimentation are those affecting the  
37 spawning habitat for anadromous salmonids (TRRP and NCRWQCB 2009). The  
38 main affected beneficial uses include commercial or sport fishing, cold fresh  
39 water habitat, migration of aquatic organisms, spawning, reproduction, and/or  
40 early development; and rare, threatened and endangered species. Recreation in  
41 the Trinity River Basin, such as boating, fishing, camping, swimming,  
42 sightseeing, and hiking, is also potentially affected because sedimentation can  
43 affect the water clarity and water quality (USEPA 2001f). Water quality

1 objectives for sedimentation and siltation were established in the North Coast  
2 Basin Plan.

3 Turbidity criteria for all waters within the Hoopa Valley Indian Reservation are  
4 also under development (Hoopa Valley TEPA 2008).

5 In addition to these water quality objectives, the North Coast Basin Plan also  
6 prohibits the discharge of soil, silt, bark, sawdust, or other organic and earthen  
7 material from any logging, construction, or associated activity into any stream or  
8 watercourse in quantities harmful to beneficial uses, and the placing or disposal of  
9 such materials in locations where they can pass into any stream or watercourse in  
10 quantities harmful to beneficial uses (NCRWQCB 2011).

11 Sediment loading in the mainstem Trinity River exceeds applicable water quality  
12 standards, and is being addressed by the Trinity River TMDL for sediment,  
13 approved by the USEPA in December 2001 (SWRCB 2011b-g, USEPA 2001f).  
14 Assimilation capacity for sediment loading was determined for this TMDL and  
15 the percent reduction of managed sediment discharge required to meet the TMDL  
16 is provided for each subarea. These allocations are adequate to protect aquatic  
17 habitat, and are expected to be evaluated on a ten year rolling basis (USEPA  
18 2001f).

19 *Lower Klamath River*

20 The Klamath River downstream of Weitchpec has also been included on the  
21 303(d) list for contamination from sedimentation and siltation, due to exceedances  
22 of the sediment water quality criteria, and long-term sedimentation and siltation  
23 influxes (SWRCB 2011h).

24 Major sources of sediment discharge in the lower Klamath River are from  
25 ongoing logging and runoff from major storm events. According to reports cited  
26 by the SWRCB, water quality in runoff from timber harvest in all lower Klamath  
27 watersheds exceed cumulative effect thresholds (SWRCB 2011h).

28 *The Long Range Plan for the Klamath River Basin Fishery Conservation Area*  
29 *Restoration Program* (1986 to 2006) emphasizes sedimentation in the lower  
30 Klamath Basin, and notes that the sediment is creating problems with fish passage  
31 and stream bed stability (Klamath River Basin Fisheries Task Force 1991). The  
32 near extinction of the eulachon indicated problems with sediment supply, size and  
33 bed load movement, and that aggradations in salmon spawning reaches are  
34 expected to persist for decades (SWRCB 2011h). Increased sediment loads also  
35 result from the widening of stream channels, through processes like bank erosion,  
36 and with the related reduction of riparian shade can contribute to elevated stream  
37 temperatures (NCRWQCB 2010). The North Coast Basin Plan includes the  
38 TMDLs for the region, which include those that address sedimentation and  
39 siltation (NCRWQCB 2011).

1     **6.3.3     Central Valley Region**

2     **6.3.3.1     Sacramento Valley**

3     Major watersheds within the Sacramento Valley that could be affected by CVP  
4     and SWP operations include the Sacramento River, Feather River, and the lower  
5     American River watersheds.

6     This water quality analysis section focuses on Shasta Lake, Keswick Reservoir,  
7     Whiskeytown Lake, Spring Creek and Clear Creek; the Sacramento River from  
8     Shasta Lake to the Delta (near Freeport); the Feather River below Lake Oroville;  
9     American River below Lake Natoma; and Yolo Bypass.

10    Beneficial uses for the Sacramento Valley, as defined in the Central Valley Basin  
11    Plan, are summarized in Table 6.2. The constituents of concern that are currently  
12    not in compliance with existing water quality standards and for which TMDLs are  
13    adopted or are in development in this region are summarized in Table 6.1.

14    **6.3.3.1.1    Sacramento River from Shasta Lake to Verona**

15    Water quality in the upper Sacramento River is influenced by releases from  
16    Shasta Lake and diversions from Trinity Lake. Annual and seasonal flows in the  
17    Sacramento River watershed are highly variable from year to year, as described in  
18    Chapter 5, Surface Water Resources and Water Supplies. These variations in  
19    flow are a source of variability in water quality in the Sacramento drainage.

20    The water quality constituents that are currently not in compliance with existing  
21    water quality standards and for which TMDLs are adopted or are in development  
22    in this region are: mercury, PCBs, unknown toxicity and multiple pesticides.  
23    Chlorpyrifos and diazinon have been addressed by changes to the Basin Plan,  
24    cadmium, copper, zinc have been addressed by a TMDL, and temperature is also  
25    closely monitored.

26    *Water Temperature*

27    The Sacramento River was not placed on the 303(d) list approved by the USEPA  
28    in 2010 as impaired by water temperature (SWRCB 2011a). However, water  
29    bodies in the Upper Sacramento River watershed support the beneficial uses of  
30    both warm and cold fresh water habitat, which require that the water bodies  
31    maintain water temperatures suitable for multiple fish species (CVRWQCB  
32    2011). Water quality objectives have been established by the SWRCB for  
33    Sacramento River, as summarized in Table 6.14 and Appendix 3A, No Action  
34    Alternative: Central Valley Project and State Water Project Operations.  
35    Compliance locations in the upper Sacramento River basin are shown in  
36    Figure 6.2. Performance measures to meet temperature requirements are included  
37    in the 2009 NMFS BO, as described in Appendix 3A, No Action Alternative:  
38    Central Valley Project and State Water Project Operations.

1 **Table 6.14 Water Quality Objectives for Temperature in the Sacramento River**

Applicable Water Bodies	Objective
Sacramento River from Keswick Dam to Hamilton City	> 56° F
Sacramento River from Hamilton City to the I Street Bridge (during periods when temperature increases will be detrimental to the fishery)	> 68° F

2 Source: CVRWQCB 2011

3 Table 6.15 and Figure 6.3 depict monthly water temperature data at selected  
 4 compliance locations in the Sacramento River between 2001 and 2012.

5 **Table 6.15 Monthly Average of Water Temperatures Recorded at Sacramento River**  
 6 **Compliance Locations in °F**

WY	WYT	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Balls Ferry</b>													
2001	D	55.0	53.2	51.4	47.9	47.0	51.5	52.5	52.9	53.6	54.5	54.3	55.3
2002	D	56.1	54.3	50.0	49.4	48.8	50.5	53.9	53.7	53.7	54.4	54.4	54.0
2003	AN	54.4	54.2	50.0	49.6	49.3	51.7	53.2	53.3	53.5	53.6	54.9	55.4
2004	BN	54.7	52.6	50.2	48.3	47.6	50.9	52.5	53.0	53.7	54.5	54.6	56.7
2005	AN	56.5	54.9	50.6	48.8	50.0	52.1	54.1	54.2	53.5	54.0	55.4	55.6
2006	W	56.2	54.5	50.5	ND	47.8	47.7	49.7	52.7	52.8	53.6	53.8	53.5
2007	D	53.4	52.4	49.7	47.7	48.4	52.0	54.0	52.9	53.8	55.2	55.1	55.7
2008	C	55.9	55.3	50.1	45.7	46.8	49.8	50.9	52.9	55.6	56.0	56.4	57.0
2009	D	58.1	55.8	50.1	47.5	47.8	50.6	51.6	53.8	55.0	56.0	56.0	56.5
2010	BN	56.5	55.1	49.4	48.3	49.6	50.9	52.5	54.0	53.5	53.9	54.2	54.2
2011	W	54.0	51.3	51.2	49.2	48.0	48.8	51.8	54.1	53.6	53.6	54.3	54.0
2012	BN	53.1	51.2	49.6	48.4	48.6	49.6	53.6	54.5	53.4	53.6	54.0	54.1
<b>Jelly's Ferry</b>													
2001	D	55.5	52.9	51.1	47.5	47.0	52.3	53.6	54.5	54.7	55.6	55.6	56.3
2002	D	56.7	54.4	49.1	47.9	48.6	51.0	55.4	55.1	55.1	55.6	55.5	55.1
2003	AN	54.9	54.1	50.3	50.0	49.0	52.4	53.4	54.5	55.4	55.0	56.0	56.6
2004	BN	55.3	52.5	50.0	47.9	48.1	52.0	54.0	54.7	55.1	55.5	55.8	57.5
2005	AN	56.8	54.6	50.2	48.4	50.3	52.8	55.3	55.6	55.3	55.6	56.7	56.5
2006	W	56.5	54.3	49.9	49.1	48.3	47.9	50.7	54.6	54.8	55.1	55.0	54.6
2007	D	54.2	52.6	49.0	47.1	48.7	52.8	55.0	54.2	54.9	56.0	56.0	56.6
2008	C	56.3	55.4	49.6	45.4	47.0	50.5	52.2	54.5	56.6	56.9	57.3	58.0
2009	D	58.0	55.8	49.8	47.4	47.9	51.2	53.3	55.7	56.4	57.1	57.0	57.8
2010	BN	57.1	54.9	48.9	48.0	49.7	51.7	53.3	55.2	55.4	55.6	55.3	55.2
2011	W	54.6	51.3	50.9	48.9	47.8	48.7	52.2	55.3	55.2	55.0	55.4	55.2
2012	BN	53.7	51.2	49.1	48.1	48.8	49.9	54.4	56.0	54.8	54.6	55.1	55.3

WY	WYT	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
WY	WYT	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Bend Bridge</b>													
2001	D	55.7	52.8	50.8	47.3	47.0	52.6	54.1	55.0	55.1	56.0	56.0	56.8
2002	D	56.9	54.4	49.0	48.1	48.9	51.2	55.8	55.6	55.6	56.0	56.2	55.6
2003	AN	55.1	53.9	50.2	50.0	49.0	52.6	53.8	54.7	55.9	55.4	56.7	57.0
2004	BN	55.5	52.3	49.4	48.0	48.2	52.2	54.2	55.5	55.6	56.1	56.2	57.9
2005	AN	57.0	54.4	50.0	48.3	50.4	53.1	55.7	55.9	55.5	56.0	57.2	56.9
2006	W	56.6	54.2	50.0	49.2	48.4	48.0	50.7	54.9	55.1	55.6	55.4	54.9
2007	D	54.4	52.3	49.1	46.9	48.8	52.9	55.1	54.9	55.5	56.6	56.6	57.0
2008	C	56.4	55.1	49.3	45.6	47.1	51.0	52.6	55.0	57.4	57.5	57.9	58.5
2009	D	57.4	55.8	49.4	47.3	48.1	52.0	53.6	56.1	56.9	57.7	57.2	58.0
2010	BN	57.0	54.8	48.6	47.9	49.6	51.6	53.3	55.4	55.5	56.2	56.2	55.8
2011	W	54.4	51.0	50.7	49.0	48.0	49.0	52.5	55.7	55.6	55.8	56.2	55.6
2012	BN	53.9	51.3	48.8	47.9	48.9	49.9	54.8	56.5	55.4	55.1	55.5	55.8

1 Source: Reclamation 2013b

2 *Mercury*

3 The USEPA approved a new decision to place Shasta Lake, Whiskeytown Lake,  
 4 Clear Creek, and the Sacramento River from Cottonwood Creek to Red Bluff, on  
 5 the Section 303(d) list in 2010 for mercury contamination (SWRCB 2011a). The  
 6 Sacramento River from Red Bluff to Knights Landing has been on the 303(d) list  
 7 for mercury prior to the final decision in 2010. Mercury is not a constituent of  
 8 concern for the Sacramento River between Shasta Dam and the Cottonwood  
 9 Creek.

10 Mercury in the Sacramento River Basin can be attributed to resource extraction as  
 11 described in Section 6.3.2 (SWRCB 2011i-l). Significant gold mining activity  
 12 took place within the Whiskeytown watershed, lands inundated by Whiskeytown  
 13 Reservoir, in the Clear Creek watershed between Whiskeytown Reservoir, the  
 14 confluence with the Sacramento River, and within the Sacramento River  
 15 watershed.

16 A 2008 CALFED report tabulates methylmercury concentrations in the  
 17 Sacramento River from Redding (0.3ng/l) to Freeport (0.11 ng/l) from 2003 to  
 18 2006 (Foe et al. 2008). For the 2010 listing, composite fish tissue samples were  
 19 collected from Shasta Lake, Whiskeytown Lake, Clear Creek, and the Sacramento  
 20 River from Cottonwood Creek to Knights Landing. The commercial or  
 21 recreational collection of fish, shellfish, or organisms were deemed impaired since  
 22 fish tissue exceeded USEPA’s recommended Fish Tissue Residue Criteria for  
 23 human health of 0.3 mg of methylmercury (wet weight) per kg of fish tissue  
 24 (SWRCB 2011i-l).

25 In an effort to protect the beneficial uses of these water bodies, including the  
 26 protection of aquatic and human health, USEPA has recommended maximum

1 exposure concentrations. In addition, a TMDL is expected to be completed in  
2 2021 to meet the water quality standards in these water bodies (SWRCB 2011i-l).

### 3 *Cadmium, Copper, and Zinc*

4 Shasta Lake where West Squaw Creek enters the lake, Spring Creek (from Iron  
5 Mountain Mine to Keswick Reservoir), and Keswick Reservoir downstream of  
6 Spring Creek were placed on the 303(d) list approved by the USEPA in 2010 for  
7 impairment by cadmium, copper, and zinc (SWRCB 2011a). The Upper  
8 Sacramento River from Keswick Dam to Cottonwood Creek was previously listed  
9 on the 303(d) list for impairment by cadmium, copper, and zinc but was delisted  
10 after a TMDL was completed in 2002 and the SWRCB determined the water  
11 quality standard was met. The elevated levels were primarily the result of acid  
12 mine drainage discharged from inactive mines in the upper Sacramento River  
13 watershed, located upstream of Shasta and Keswick dams (CVRWQCB 2002a).  
14 There are projects underway to clean up many inactive mine sites that discharge  
15 high concentrations of metals (CVRWQCB 2011).

16 Cadmium, copper and zinc contamination in the Sacramento River have been  
17 addressed by the *2002 Upper Sacramento River TMDL for Cadmium, Copper and*  
18 *Zinc*, and by water quality objectives in the Basin Plan (CVRWQCB 2002a).  
19 Although cadmium, copper, and zinc are generally found as mixtures in surface  
20 water, the mixtures tend to be antagonistic – less toxic than when found as  
21 individual components – thus the water quality objectives focus on individual  
22 parameters. Levels of water hardness affect the toxicity of these metals, where  
23 increased hardness decreases toxicity. Thus the water quality objectives at certain  
24 locations are determined using specific levels of water hardness (CVRWQCB  
25 2002a). The TMDL for cadmium, copper, and zinc in Shasta Lake, Spring Creek,  
26 and Keswick Reservoir is expected to be completed in 2020 (SWRCB 2011i,m,n).

### 27 *Pesticides*

28 The Sacramento River from Red Bluff to Knights Landing was placed on the  
29 303(d) list approved by the USEPA in 2010 as impaired by DDT and the Group A  
30 pesticide dieldrin. The Sacramento River from Knights Landing to the Delta was  
31 also placed on the 303(d) list as impaired by chlordane, DDT, and dieldrin  
32 (SWRCB 2011a). Chlordane, DDT, and dieldrin are legacy pesticides and were  
33 discontinued from the early 1970s to the late 1980s.

34 Although these pesticides have been discontinued since the late 1980's, the  
35 narrative water quality objective for toxicity, which applies to single or the  
36 interactive effect of multiple pesticides or substances, and states that “All waters  
37 shall be maintained free of toxic substances in concentrations that produce  
38 detrimental physiological responses in human, plant, animal, or aquatic life” has  
39 not been met. Fish concentrations of DDT collected in 2005 exceeded the Total  
40 DDT OEHHA screening value of 21 µg/kg by up to five times, which was used as  
41 a criterion to evaluate the narrative water quality objective by up to five times.  
42 Concentrations of dieldrin were also found to exceed the OEHHA Evaluation  
43 Guideline of 0.46 µg/kg (SWRCB 2011o).

1 To protect the beneficial uses of the Sacramento River and other water bodies  
2 downstream, including the impaired commercial or recreational collection of fish,  
3 shellfish, or organisms, TMDLs for DDT and dieldrin in the Sacramento River  
4 from Red Bluff to Knights Landing are expected to be completed in 2021  
5 (SWRCB 2011o). For the Sacramento River from Knights Landing to the Delta,  
6 TMDLs are expected to be completed in 2021 for DDT and chlordane, and in  
7 2022 for dieldrin.

8 Although the Sacramento River was not placed on the 303(d) list approved by the  
9 USEPA in 2010 for chlorpyrifos and diazinon contamination, these pesticides  
10 have also been of concern in the Sacramento River (SWRCB 2011o, CVRWQCB  
11 2007a). Water quality sampling from 1999 to 2006 revealed concentrations of  
12 both pesticides at levels of concern in the Sacramento and Feather Rivers. In  
13 addition to runoff of applied pesticides into irrigation and storm water runoff into  
14 the Sacramento and Feather Rivers, atmospheric transport of diazinon from the  
15 Central Valley to the Sierra Nevada Mountains has been noted to occur. Of  
16 particular concern were the beneficial uses of Warm and Cold Fresh water  
17 Habitat.

#### 18 *PCBs*

19 The reach of the Sacramento River from Red Bluff to Knights Landing was  
20 placed on the 303(d) list approved by the USEPA in 2010 as impaired by PCBs  
21 (SWRCB 2011a). According to the *Final California 2010 Integrated Report*  
22 (303(d)/305(b) Report) Supporting Information, sources of PCBs in Sacramento  
23 River are unknown (SWRCB 2011o). PCBs, a group of synthetic organic  
24 chemicals, were manufactured from 1930 to 1977 and were banned in 1979.  
25 However, these organic pollutants persistent in the environment (ATSDR 2000).

26 The OEHHA Fish Contaminant Goal of total PCBs in fish is 3.6 ppb (or 3.6 ng/g)  
27 (SWRCB 2011o). Fish tissue samples collected in August and October 2005  
28 exhibited significant exceedances. Six composite samples were analyzed for 48  
29 individual PCB congeners and four Aroclor mixtures, with the four exceedances  
30 reported as 102.499 ng/g in channel catfish at Colusa, 9.151 ng/g in channel  
31 catfish at Grimes, 6.504 ng/g in Sacramento sucker at Colusa, and 5.767 ng/g in  
32 Sacramento sucker at Woodson Bridge.

33 To protect the beneficial uses of the Sacramento River, including the impaired  
34 beneficial use of commercial and sport fishing, a TMDL is expected to be  
35 completed in 2021 (SWRCB 2011o).

#### 36 *Unknown Toxicity*

37 The Sacramento River from Keswick Reservoir to Knights Landing was placed  
38 on the 303(d) list as impaired for unknown toxicity (SWRCB 2011a).

39 Results of survival, growth, and reproductive toxicity tests performed from 1998  
40 to 2007 showed an increase in mortality and a reduction in growth and  
41 reproduction in *C. dubia*, the Fathead Minnow *Pimephales promelas* (*P.*  
42 *promelas*) and the alga *Pseudokirchneriella subcapitata* (*P. subcapitata*, formerly  
43 known as *Selenastrum capricornutum*) (SWRCB 2011, o-q). Observations



1 violated the narrative toxicity objective found in the Sacramento – San Joaquin  
 2 River Basin Plan, which states that all waters shall be maintained free of toxic  
 3 substances in concentrations that produce detrimental physiological responses in  
 4 human, plant, or aquatic life (CVRWQCB 2011). This objective applies  
 5 regardless of whether the toxicity is caused by a single substance or the  
 6 interactive effect of multiple substances. Further research is being conducted on  
 7 the causes of toxicity in the Sacramento River. The TMDL for unknown toxicity  
 8 in the Upper Sacramento River is expected to be completed in 2019 (SWRCB  
 9 2011i,o-q).

10 A 2012 SWAMP report summarized the occurrences and causes of toxicity in the  
 11 Central Valley (Markiewicz et al.2012). The SWRCB’s Surface Water Ambient  
 12 Monitoring Program (SWAMP) defines toxicity as a statistically significant  
 13 adverse impact on standard aquatic test organisms in laboratory exposures. In  
 14 order to assess the causes of toxicity in California waterways, SWAMP testing  
 15 uses laboratory test organisms as surrogates for aquatic species in the  
 16 environment (Anderson et al.2011).

17 Sediment toxicity was noted to be higher in urban areas including Sacramento,  
 18 Yuba City, Redding, and Antioch, while sediments from agricultural areas were  
 19 generally non-toxic (Markiewicz et al.2012). Moderate water toxicity was  
 20 observed throughout the agricultural and urban-agricultural areas in the upper  
 21 Sacramento watershed, including in the Colusa Basin, in the vicinity of the Sutter  
 22 Buttes, and along the eastern valley floor between Chico and Lincoln.

23 SWAMP studies indicate that the replacement of organophosphate pesticides by  
 24 pyrethroids has resulted in an increased contribution of pyrethroids to ambient  
 25 water and sediment toxicity (Anderson et al. 2011). With regard to sediment, as  
 26 indicated by *H. azteca*, the majority of toxicity has been attributed to pyrethroids,  
 27 particularly in urban areas (Markiewicz et al. 2012). Of the pyrethroid pesticides,  
 28 bifenthrin is of major concern.

#### 29 **6.3.3.1.2 Sacramento River from Verona to Freeport**

30 The water quality of the lower Sacramento River is influenced by the upstream  
 31 sources discussed above as well as by inflows from the American River and from  
 32 surrounding urban and agricultural runoff. The major water quality constituents  
 33 of concern are described below. Water temperature is not a major concern in this  
 34 lower reach of the Sacramento River because the vitality of aquatic species in this  
 35 reach are not dependent on temperature.

##### 36 *Mercury*

37 The Sacramento River from Verona to Freeport is on the 303(d) list approved by  
 38 USEPA in 2010 for mercury contamination (SWRCB 2011a).

39 Mercury in this reach of the river can be attributed to waterborne inputs from the  
 40 upper Sacramento River, Feather River, Yuba River, and American River  
 41 (SWRCB 2011q). These major tributaries are also listed as impaired due to  
 42 mercury. As in the Klamath and Trinity River basins, historic mining has resulted  
 43 in significant mercury contamination in the Sacramento River Basin.

1 Flows from the Yuba River are an important source of mercury loading to the  
2 lower Sacramento River. Tailings discharged from gold mines in the Sierra  
3 Nevada mountains during the nineteenth century contained significant amounts of  
4 mercury-laden sediment, due to the use of mercury to extract gold. These  
5 discharges caused the formation of anthropogenic alluvial fans at the base of the  
6 Sierra Nevada, most notably the Yuba Fan. Singer et al. (2013) predicted that  
7 mercury-laden sediment from the original fan deposit will continue to be  
8 transported to the Sacramento River for the next 10,000 years.

9 The Sacramento River is a key source of mercury contamination into the  
10 Sacramento – San Joaquin River Delta. Over 80 percent of total mercury flux to  
11 the Delta can be attributed to the Sacramento River Basin (CVRWQCB 2010a).  
12 The CVRWQCB (2010a) compiled data from 2000 to 2003 and reported an  
13 average of 0.10 ng/l in the Sacramento River at Freeport. Similarly, CALFED  
14 reported that the Sacramento River at Freeport contributed an average of 0.11 ng/l  
15 of methylmercury to the Delta from 2003 to 2006 (Foe et al. 2008).

16 Water samples were collected from the lower Sacramento River and its tributaries  
17 from March 2003 to June 2006 (Foe et al. 2008). For comparison, concentrations  
18 in samples from the upper Sacramento River from Redding to Colusa were lower,  
19 ranging from 0.03 to 0.10 ng/l. Major tributaries to the lower Sacramento River,  
20 including the Feather River (0.05 ng/l), American River (0.06 ng/l), Colusa Basin  
21 Drain (0.21 ng/l), and Yuba River (0.05 ng/l), contributed to the mean  
22 methylmercury concentration of 0.11 ng/l at Freeport in the Sacramento River.

23 The commercial or recreational collection of fish, shellfish, or organisms were  
24 deemed impaired prior to the current 303(d) list approved in 2010 (SWRCB  
25 2011q). However, no new data were available to be assessed for this updated  
26 listing.

27 Table 6.16 presents streambed sediment mercury concentrations from the  
28 Sacramento River and Delta regions in 1995, sampled as part of the National  
29 Water Quality Assessment (NWQA) Program for the Sacramento River Basin  
30 (MacCoy and Domagalski 1999). Limited data for mercury in sediment exist;  
31 however, these data exhibit levels of mercury greatly exceeding the average  
32 amount of mercury found on the earth's surface, of about 0.05 µg/g. The highest  
33 streambed sediment concentrations of mercury were measured downstream from  
34 the Sierra Nevada and Coast Ranges. Within the Sacramento River, sites  
35 downstream of the Feather River had higher concentrations of mercury than  
36 sampled locations upstream of this confluence. The highest reported mercury  
37 concentrations were from the Yuba River, Bear River, Sacramento River at  
38 Verona, and the Feather River which exceeded the threshold effect concentration  
39 (0.18 µg/g), but not the probable effect concentration (1.06 µg/g) reported by  
40 MacDonald et al. (2000).

1 **Table 6.15 Streambed sediment concentrations of mercury in the Sacramento River**  
 2 **and Delta regions**

Water body/Site	Concentration
<b>Feather River sites</b>	
Feather River	0.21 µg/g
Yuba River	0.37 µg/g
Bear River	0.37 µg/g
Feather & Sacramento Rivers Downstream of the confluence at Verona	0.24 µg/g
<b>Sacramento River sites</b>	
Bend Bridge	0.16 µg/g
Freeport	0.14 µg/g
Cache Creek	0.15 µg/g
Arcade Creek	0.13 µg/g
American River	0.16 µg/g

3 Source: MacCoy and Domagalski 1999

4 Reported in bottom material <63 micron fraction dry weight.

5 \* Concentration exceeds the MacDonald et al. (2000) threshold effect concentration (0.18  
 6 µg/g dry weight) but not the probable effect concentration (1.06 µg/g dry weight).

7 In an effort to protect the beneficial uses of the Sacramento River, including the  
 8 impaired commercial and recreational collection of fish, shellfish, or organisms,  
 9 the CVRWQCB (2011) made recommendations for the future reduction of  
 10 mercury contamination. Additionally, the Delta Mercury Control Program  
 11 (MERP 2012) provides potential load allocations for mercury pertaining to the  
 12 Sacramento River and the Yolo Bypass, while the Cache Creek Watershed  
 13 Mercury Program provides load allocations for Cache Creek, Bear Creek, Sulphur  
 14 Creek, and Harley Gulch.

15 *Pesticides*

16 The Sacramento River was placed on the 303(d) list approved by the USEPA in  
 17 2010 as impaired by the pesticides chlordane, DDT, and dieldrin from Knights  
 18 Landing to the Delta. These three pesticides listings were based on the evaluation  
 19 of fish contaminant data from 2005. Chlordane, DDT, and dieldrin are legacy  
 20 pesticides that were discontinued from the early 1970s to the late 1980s.  
 21 However, samples collected in the Sacramento River at the Veterans Bridge in  
 22 September 2005 revealed elevated pesticide concentrations (SWRCB 2011q).

23 A composite sample of carp and a composite sample of channel catfish had total  
 24 chlordane concentrations of 6.72 µg/kg and 10.20 µg/kg, respectively, both  
 25 exceeding OEHHAs (2008) FCG of 5.6 µg/kg for total chlordane in fish tissue  
 26 (SWRCB 2011q).

1 Composite samples of carp and Channel Catfish contained total DDT  
2 concentrations of 59. µg/kg and 109. µg/kg, respectively. These concentrations  
3 exceeded the OEHHAs (2008) FCG of 21 µg/kg (SWRCB 2011q).

4 Composite samples of carp and Channel Catfish contained total dieldrin  
5 concentrations of 0.98 µg/kg and 1.49 µg/kg, respectively, These concentrations  
6 both exceeded the OEHHAs (2008) FCG of 0.46 µg/kg (SWRCB 2011q).

#### 7 *PCBs*

8 The Sacramento River from Knights Landing to the Delta was placed on the  
9 303(d) list approved by the USEPA in 2010 as impaired by PCBs (SWRCB  
10 2011a).

11 According to the Final California 2010 Integrated Report (303(d)/305(b) Report)  
12 Supporting Information, sources of PCBs in this reach of the Sacramento River  
13 are unknown (SWRCB 2011q).

14 The Sacramento River from Knights Landing to the Delta has also been newly  
15 listed as contaminated by PCBs. Three of three composite samples analyzed for  
16 total PCBs in September 2005 exceeded the OEHHA Fish Contaminant Goal for  
17 total PCBs of 3.6 ppb (or 3.6 ng/g), wet weight. The exceeding concentrations  
18 were recorded at 53 ng/g in channel catfish, 6.0 ng/g in Sacramento sucker, and  
19 26 in carp (SWRCB 2011q).

20 A TMDL for PCBs in the Sacramento River from Knights Landing to the Delta is  
21 expected to be completed in 2021 to protect the beneficial uses of the Sacramento  
22 River and downstream waterbodies (SWRCB 2011q).

#### 23 *Dissolved Oxygen*

24 The Sacramento River was not placed on the 303(d) list approved by the USEPA  
25 in 2010 for low dissolved oxygen (SWRCB 2011a).

#### 26 *Salinity, Electrical Conductivity, and Total Dissolved Solids*

27 The Sacramento River was not placed on the 303(d) list approved by the USEPA  
28 in 2010 as impaired by salinity (SWRCB 2011a).

#### 29 *Selenium*

30 Water bodies in the Sacramento River Basin were not listed on the 303(d) list as  
31 impaired by selenium. Waterborne selenium concentrations in the Sacramento  
32 River near Verona are relatively low compared to concentrations in the San  
33 Joaquin River Basin. However, the much larger flow that the Sacramento River  
34 contributes to the Delta, in comparison to the San Joaquin River, results in a  
35 substantial contribution to the mass loading of selenium to the Delta from the  
36 Sacramento River (Cutter and Cutter 2004; SWRCB 2008a). Loads to the Delta  
37 from the Sacramento River were projected to be about half of what the Grasslands  
38 basin was projected to contribute to the San Joaquin River, with subsequent  
39 loading to the Delta from the San Joaquin River dependent on flow (Presser and  
40 Luoma 2006).

41 Data for selenium in fish from the Sacramento River are limited, but Largemouth  
42 Bass were sampled in 1999, 2000, 2005, and 2007 from the lower Sacramento

1 River, San Joaquin River, and Delta by the CVRWQCB. The fillet data and  
 2 whole-body selenium concentrations, estimated using an equation from Saiki et  
 3 al. (1991), were used to evaluate potential human and wildlife health risks (Foe  
 4 2010). Selenium concentrations in fillets and whole bodies of the bass from the  
 5 Sacramento River at Veterans Bridge were well below the draft criteria released  
 6 in May 2014 (11.8 mg/kg for fillets and 8.1 mg/kg for whole body) (USEPA  
 7 2014b).

#### 8 *Unknown Toxicity*

9 The Sacramento River from Knights Landing to the Delta is listed as impaired by  
 10 toxicity due to the results of survival, growth and reproductive toxicity tests  
 11 performed in 2006 and 2007. Observations of increased mortality and reduction  
 12 in growth and reproduction in *C. dubia* and *P. promelas* compared to laboratory  
 13 controls violated the narrative toxicity objective of the Basin Plan. The TMDL  
 14 for toxicity in this reach of the river is expected to be completed in 2019  
 15 (SWRCB 2011q).

#### 16 **6.3.3.1.3 Colusa Basin Drain**

17 The Colusa Basin Drain receives inflow from local creeks and discharge and  
 18 runoff from the Colusa agricultural basin. Under conditions of low water levels,  
 19 it drains by gravity into the Sacramento River at Knights Landing; however, when  
 20 the water levels at Knights Landing are too high for this gravity flow to occur,  
 21 discharge from the Colusa Basin Drain is routed directly to the Yolo Bypass  
 22 through the Ridge Cut canal (USGS 2002). During the non-storm season, flows  
 23 from the Colusa Basin Drain can contribute over ten percent of Sacramento River  
 24 flows at Verona when there are floods in the Colusa Basin, high irrigation  
 25 discharges, and/or low Sacramento River flows (Colusa Basin Drain Steering  
 26 Committee 2005).

27 Beneficial uses designated for the Colusa Basin Drain include agricultural  
 28 irrigation and stock watering, water contact recreation, and warm and cold water  
 29 habitat, migration and spawning for aquatic biota (CVRWQCB 2011). In spite of  
 30 the many uses of the waterway, the Colusa Basin Drain is listed as impaired for  
 31 numerous contaminants. Water quality constituents of concern impact both local  
 32 beneficial uses and the water quality of receiving waterways, including the  
 33 Sacramento River and the Yolo Bypass. Suspended solids, agricultural  
 34 chemicals, heavy metals and organic matter are often present in concentrations  
 35 that exceed those in the Sacramento, Feather, and American Rivers (Colusa Basin  
 36 Drain Steering Committee 2005, SWRCB 2011r, USGS 2002)

#### 37 *Mercury*

38 The Colusa Basin Drain is listed on the 303(d) list for contamination by mercury  
 39 due to multiple exceedances of the USEPA Fish Tissue Residue Criterion for  
 40 methylmercury in fish of 0.3 mg/kg (or 0.3 ppm) for the protection of human  
 41 health (SWRCB 2011r). Samples exceeding the criterion included two of seven  
 42 samples collected at the County Road 99E bridge crossing between 1997 and  
 43 2002 (one carp composite sample with a concentration of 0.41 ppm and one white  
 44 catfish composite sample with concentration of 0.30 ppm) and one of ten samples

1 collected in the Colusa Basin Drain at Abel Road between 1980 and 1988 (one  
2 brown bullhead composite sample with concentration of 0.58 ppm).

3 The Delta mercury TMDL study reported an average concentrations of  
4 methylmercury in the Colusa Basin Drain was reported to be 0.214 ng/l between  
5 2000 and 2003. The Colusa Basin Drain contributed 3.3 percent of total mercury  
6 inputs to the Sacramento Basin between 1984 and 2003 (CVRWQCB 2010a). A  
7 TMDL for the Colusa Basin Drain is expected to be completed in 2021 (SWRCB  
8 2011r).

### 9 *Pesticides*

10 The Colusa Basin Drain is listed as contaminated by the organophosphate  
11 pesticides azinphos-methyl (Guthion), diazinon, DDT and malathion. Azinphos-  
12 methyl and malathion have been included on the 303(d) list since 2006; thus,  
13 supporting information for their listing is not readily available. However,  
14 diazinon has been listed due to samples collected between 1996 and 2000 and  
15 again in 2004 exceeding the CDFW acute criterion of 0.16 µg/l one hour average.  
16 Samples collected in 2004 also exceeded the four day average criterion of 0.10  
17 µg/l. Diazinon was addressed by a 2008 basin plan amendment but has not been  
18 removed from the 303(d) list (SWRCB 2011r).

19 Two of two samples assessed for DDT in the Colusa Basin Drain in 2005 greatly  
20 exceeded the OEHHA 2008 FCG for DDT, of 21 µg/kg of total DDT in fish  
21 tissue. Concentrations of 44.009 µg/kg and 65.903 µg/kg were recorded in  
22 composite samples of white catfish and carp, respectively. The TMDL for DDT  
23 is expected to be completed in 2021 (SWRCB 2011r).

24 The organochlorine pesticide dieldrin, and the Group A pesticides generally, are  
25 included on the 303(d) list for the Colusa Basin Drain (SWRCB 2011r). The  
26 Group A pesticides have been listed since 2006, thus supporting information is  
27 not readily available. Dieldrin is listed due to two of two samples collected in  
28 August 2005 exceeding the OEHHA FCGs for dieldrin of 0.46 µg/kg dieldrin in  
29 fish tissue. One composite sample of white catfish recorded a concentration of  
30 0.7 µg/kg and one composite sample of carp recorded a value of 1.14 µg/kg.  
31 Contamination by organochlorine pesticides in the Colusa Basin Drain will be  
32 addressed by the Central Valley Organochlorine Pesticide TMDL and Basin Plan  
33 Amendment.

34 The carbamate pesticide carbofuran is also included on the 303(d) list for the  
35 Colusa Basin Drain. It has been listed since 2006; thus, supporting information is  
36 not readily available. A TMDL is expected by 2021 (SWRCB 2011r).

### 37 *Dissolved Oxygen*

38 The Colusa Basin Drain was placed on the 303(d) list approved by the USEPA in  
39 2010 for low dissolved oxygen (SWRCB 2011a). According to the Final  
40 California 2010 Integrated Report (303(d)/305(b) Report) Supporting  
41 Information, sources of contributing to the dissolved oxygen impairment in the  
42 Colusa Basin Drain are unknown (SWRCB 2011r).

1 Samples collected from the Colusa Basin Drain (at Maxwell Road, above Knights  
 2 Landing, at Highway 162, and at “Colusa Basin Drain #5”) between September  
 3 2004 and October 2006 and were tested for dissolved oxygen (SWRCB 2011r).  
 4 Thirty of the 73 samples exceeded the general number water quality objectives for  
 5 COLD and SPWN beneficial uses. Five of the samples exceeded the water  
 6 quality objective for WARM beneficial uses.

#### 7 *Other Constituents of Concern*

8 The Colusa Basin Drain is also listed as contaminated by *E. coli*, low dissolved  
 9 oxygen, and unknown toxicity (SWRCB 2011r). Knights Landing Ridge Cut is  
 10 listed as contaminated by boron, low dissolved oxygen, and salinity. A USGS  
 11 study of Yolo Bypass water quality in 2000 also reported that significant  
 12 concentrations of ammonium and dissolved organic carbon in the Yolo Bypass  
 13 were correlated with high concentrations in the Colusa Basin Drain, and that the  
 14 Colusa Basin Drain was a major discharger of sulfate to the Yolo Bypass (USGS  
 15 2002)

#### 16 **6.3.3.1.4 Feather River from Lake Oroville to the Confluence with the** 17 **Sacramento River**

18 Water quality constituents of concern in the Lower Feather River have the  
 19 potential to affect several supported beneficial uses, including municipal and  
 20 agricultural water supply, contact and non-contact water recreation, and fish  
 21 habitat and migration uses, for cold and warm water. The 303(d) listed  
 22 contaminants in this reach of the Feather River.

#### 23 *Water Temperature*

24 The Lower Feather River (downstream of Lake Oroville) is not listed on the  
 25 303(d) list as impaired by water temperature (SWRCB 2011a). However, water  
 26 temperature in the lower Feather River is crucial to maintaining fresh water  
 27 habitat for both warm and cold fresh water fish species in downstream habitats  
 28 (DWR 2007). The SWP operates Lake Oroville and the Thermalito Reservoir  
 29 Complex to meet temperature objectives established through a 1983 agreement  
 30 with California Department of Fish and Wildlife and biological opinions issued  
 31 by NMFS, as described in Appendix 3A, No Action Alternative: Central Valley  
 32 Project and State Water Project Operations. Releases from Lake Oroville  
 33 determine initial river temperatures. Water is released at different depths through  
 34 shutters at the intake structures (DWR 2007). Although Lake Oroville releases  
 35 determine water temperatures initially, atmospheric conditions modify  
 36 downstream river temperatures. Water temperatures vary seasonally and spatially  
 37 between the low flow channel (LFC) and high flow channel (HFC) of the Lower  
 38 Feather River downstream of the fish barrier dam. The LFC is the reach of the  
 39 river between the Fish Barrier Dam and the confluence with the Thermalito  
 40 Afterbay Outlet and it is managed to protect cold water fish species. The HFC is  
 41 the downstream reach of the river, from the Thermalito Afterbay Outlet to the  
 42 confluence with the Sacramento River.

43 Warmer temperatures in the LFC start to appear in March, reaching maximum  
 44 temperatures in July and early August ranging from 61° F upstream of the Feather

1 River Fish Hatchery to 69° F upstream of the Thermalito Afterbay Outlet (DWR  
2 2007a). Cooling of the LFC begins in September, with a minimum temperature  
3 of approximately 45° F occurring in February. At the Feather River Fish  
4 Hatchery, water temperatures are generally compliant with the 1983 Agreement.  
5 Temperatures from 2002 to 2004 were in compliance 95 percent of the time,  
6 exceeding requirements for 23 days during an extended warm period in fall 2002,  
7 and dropping below requirements for 13 days during the warm summer months.  
8 Water temperatures at Robinson Riffle are almost always met when the fish  
9 hatchery temperatures are met. Agricultural temperature requests cannot always  
10 be satisfied due to the requirements of the fish species and the fluctuating  
11 meteorological conditions.

12 Temperatures in the HFC are influenced by releases from the Thermalito Afterbay  
13 and flow contributions from Honcut Creek, the Yuba River, and the Bear River  
14 from April through October (DWR 2007). Except for during high flows from the  
15 Thermalito Afterbay (occurring frequently in July and August), releases in the  
16 warm season generally raise the water temperature. Honcut and Bear River  
17 inflows tend to increase downstream temperatures as well, while flows from the  
18 Yuba River tend to cool downstream temperatures during the warmer months.

19 Warming water temperatures appear in the HFC starting in March, with maximum  
20 temperatures occurring in July and August, ranging from 71 to 77° F (DWR  
21 2007). In late August, the HFC begins to cool, reaching minimum temperatures of  
22 44 to 45° F by January or February.

23 In addition to effects on fish species, agriculture is potentially affected by changes  
24 in water temperature, because the temperatures of irrigation water can affect crop  
25 growth (DWR 2007). In the Feather River Basin, this is particularly an issue for  
26 rice production. Water contact recreation can also be affected by water  
27 temperatures, as flows in the LFC are managed for cold water species and thus  
28 may be too cold for some water-contact recreation.

### 29 *Mercury*

30 The Lower Feather River is included on the 303(d) list for mercury contamination  
31 (SWRCB 2011a). The listing was made before the 2006 Integrated Report; thus,  
32 the evidence of water quality exceedance is not readily available. It has been  
33 noted, however, that the Feather River has relatively large mercury loadings and  
34 high mercury concentrations in suspended sediment, contributing significantly to  
35 mercury loading to the Delta. The Feather River transports much of the mercury  
36 to the Sacramento River that was released in the Sierra Nevada Mountains during  
37 gold mining operations (CVRWQCB 2010a).

38 FERC relicensing studies indicate that mercury consistently exceeds USEPA  
39 guidelines in most fish species and locations, and that biomagnification appears to  
40 have caused elevated mercury levels in fish (DWR 2007). A beneficial effect of  
41 Lake Oroville is the capture of contaminated sediments, preventing their further  
42 transport downstream.

43 In the Sacramento – San Joaquin Delta Estuary TMDL for methylmercury, the  
44 CVRWQCB (2010a) recommends that the Feather River be targeted for mercury



1 reduction during initial efforts focusing on the watersheds that export the largest  
2 volumes of highly mercury-contaminated sediment to the Delta.

### 3 *Pesticides*

4 The Feather River below Lake Oroville is listed as contaminated for chlorpyrifos.  
5 Samples collected during storm events at the Feather River near Nicolaus in 2004  
6 exceeded the California DFG Hazard Assessment Criteria of 25 ng/l over a one  
7 hour average. The TMDL for chlorpyrifos in the Feather River is expected to be  
8 completed in 2019 (SWRCB 2011t).

9 Group A Pesticides have also been detected in exceedance of water quality  
10 criteria (SWRCB 2011t). Data collected for organochlorine pesticide  
11 contamination in the Feather River between 2000 and 2009 as part of the NPDES  
12 permit program did not indicate exceedances of CTR criteria, but did show  
13 detections in all samples in the water column. Channel catfish tissue samples  
14 from the Feather River at Highway 99 between 1978 and 2008 exhibited high  
15 concentrations of DDT and dieldrin. These water quality and fish tissue data were  
16 presented as part of supplemental documents in the process to develop a basin  
17 plan amendment to address organochlorine pesticides in Central Valley water  
18 bodies. This basin plan amendment is currently in development and will include  
19 organochlorine pesticides in the Feather River (CVRWQCB 2010c).

### 20 *PCBs*

21 The Lower Feather River was placed on the 303(d) list approved by the USEPA  
22 in 2010 as impaired by PCBs (SWRCB 2011a).

23 According to the *Final California 2010 Integrated Report (303(d)/305(b) Report)*  
24 *Supporting Information*, sources of PCBs in the Feather River are unknown  
25 (SWRCB 2011t). However, The Draft Environmental Impact Report for the  
26 FERC relicensing notes that PCBs have been detected in all fish and crayfish  
27 species from all sampled water bodies. Aroclors were also detected in at least  
28 some fish in all water bodies, as well as in crayfish in the Feather River  
29 downstream from the State Route 70 bridge (DWR 2007). PCBs have been  
30 released into the Feather River watershed from several activities. Two events in  
31 the 1980s resulted in PCB contamination in the watershed: oil containing PCBs  
32 was applied to a dirt road and entered the Ponderosa Reservoir in surface runoff,  
33 and PCBs contaminated soil and water at Belden Forebay due to a landslide  
34 which damaged powerhouses. Some remediation was performed in response to  
35 these events.

36 The same narrative water quality objective and evaluation criteria of 3.6 ng/g that  
37 was used as guidance to place the Sacramento River on the 303(d) list was also  
38 used to evaluate the Feather River. Composite samples of Largemouth Bass and  
39 crayfish collected in 2002 and 2003 showed high exceedances of the FCG.  
40 Upstream of the Thermalito Afterbay Outlet, a composite sample of Largemouth  
41 Bass had a concentration of 15.6 ng/g total PCBs, wet weight. Downstream of the  
42 outlet, the concentration of total PCBs in two composite samples of Largemouth  
43 Bass were 11.2 and 15.0 ng/g. Downstream of the Highway 70 Bridge, the

1 concentration of total PCBs in a composite sample of crayfish was 56 ng/g  
2 (SWRCB 2011t)

3 An additional study performed in 2003 and 2004 also revealed high exceedances  
4 of the OEHHA FCG for PCBs. Concentrations of total PCBs in composite  
5 samples of hardhead and pikeminnow were 26 ng/g and 31 ng/g wet weight,  
6 respectively. All samples were analyzed for 48 individual PCB congeners and  
7 two Aroclor mixtures (SWRCB 2011t)

8 A TMDL for PCBs in the Lower Feather River is expected to be completed in  
9 2021 to protect the beneficial uses of the Feather River and other water bodies  
10 downstream (SWRCB 2011t).

#### 11 *Other Constituents of Concern*

12 The Lower Feather River is listed as impaired by unknown toxicity due to  
13 significant exceedances of the toxicity criteria outlined by the CVRWQCB  
14 (SWRCB 2011t, CVRWQCB 2011). Water samples were tested with *C. dubia*,  
15 *P. promelas*, and *P. subcapitata* for survival, growth and/or reproductive toxicity  
16 between 1998 and 2007. Of 212 samples tested with *C. dubia* for survival and/or  
17 reproductive toxicity, 85 exceeded the narrative toxicity objective. Of 34 samples  
18 tested with *P. promelas* for survival and/or growth toxicity, seven exceeded the  
19 objective. Of 23 samples tested with *P. subcapitata*, none exceeded the objective.  
20 Samples in violation of the toxicity objective were collected in the Feather River  
21 at Nicolaus; in the Thermalito Diversion Pool; downstream from the Feather  
22 River Hatchery; upstream and downstream from the Thermalito Afterbay Outlet;  
23 downstream from the Sewage Commission Oroville Region (SCOR) Outlet; and  
24 downstream from the FERC Project 2100 project boundary.

#### 25 **6.3.3.1.5 American River below Lake Natoma**

26 The lower American River flows for 23 miles from Nimbus Dam to its confluence  
27 with the Sacramento River. Water quality in this reach of the river is influenced  
28 by releases from upstream reservoirs, including Lake Natoma and Folsom Lake.  
29 In general, the runoff that flows into Folsom Reservoir and Lake Natoma,  
30 upstream of the lower American River, is of high quality (Wallace, Roberts, and  
31 Todd et al. 2003). Water quality parameters measured in Folsom Reservoir,  
32 upstream of the lower American River, include pH, turbidity, dissolved oxygen  
33 (DO), total organic carbon (TOC), nutrients (nitrogen and phosphorus), electrical  
34 conductivity, total dissolved solids (TDS), and fecal coliform.

#### 35 *Water Temperature*

36 The lower American River is not listed on the 303(d) list as impaired by water  
37 temperature (SWRCB 2011a). The lower American River supports warm and  
38 cold fresh water habitat beneficial uses, as well as migration and spawning uses.  
39 In particular, in-stream rearing of juvenile steelhead requires certain water  
40 temperatures which are targeted through water temperature objectives  
41 (CVRWQCB 2011, NMFS 2009).

1 The CVP operates Folsom Lake to meet temperature objectives, as described in  
 2 Appendix 3A, No Action Alternative: Central Valley Project and State Water  
 3 Project Operations.

#### 4 *Mercury*

5 The American River from Nimbus Dam to the confluence with the Sacramento  
 6 River was listed on the 303(d) list for mercury contamination in 2010, due to  
 7 exceedances of OEHHA's guidance tissue levels for mercury (SWRCB 2011u).  
 8 The major source of mercury to the lower American River is mercury lost during  
 9 historic mining activities that is now distributed downstream.

10 The American River contributes mercury to the Sacramento River, and thus the  
 11 Delta, due to its relatively large mercury loadings and high mercury  
 12 concentrations in suspended sediment (CVRWQCB 2010a). Like the Feather  
 13 River, the lower American River is recommended for initial mercury reduction  
 14 efforts as part of the Sacramento – San Joaquin Delta Estuary TMDL for  
 15 Methylmercury. In addition to load allocations recommended as part of the Delta  
 16 TMDL for methylmercury, mercury contamination in the American River and its  
 17 reservoirs will be addressed as part of the statewide water quality control program  
 18 for mercury (SWRCB 2014a).

#### 19 *PCBs*

20 The lower American River was placed on the 303(d) list approved by the USEPA  
 21 in 2010 as impaired by PCBs (SWRCB 2011a).

22 Composite samples of white catfish and Sacramento sucker collected in the  
 23 American River at Discovery Park were analyzed for 48 individual PCB  
 24 congeners and three Aroclor mixtures (SWRCB 2011u). The total PCBs recorded  
 25 in the White Catfish and Sacramento Sucker were 3.934 ng/g and 44.094 ng/g,  
 26 respectively. An additional Sacramento Sucker composite sample collected at  
 27 Nimbus Dam did not exceed the OEHHA goal.

28 A TMDL for PCBs in the lower American River is expected to be completed in  
 29 2021 to protect the beneficial uses of the American River and other water bodies  
 30 downstream (SWRCB 2011u).

#### 31 *Unknown Toxicity*

32 The lower American River is listed as impaired by unknown toxicity. Toxicity  
 33 has been indicated for vertebrates and invertebrates from samples collected at  
 34 Discovery Park, using survival, growth, and reproduction toxicity tests with *C.*  
 35 *dubia* and *P. promelas*. These tests, conducted between 1998 and 2007, exhibited  
 36 significant increases in mortality and reductions in growth and reproduction in the  
 37 test organisms (SWRCB 2011u). The TMDL is expected to be completed in 2021  
 38 (SWRCB 2011u).

#### 39 **6.3.3.1.6 Yolo Bypass**

40 The Yolo Bypass supports a variety of beneficial uses, including agricultural  
 41 supply, recreational uses, and spawning, migration and habitat use. The Yolo  
 42 Bypass is used for agriculture in times of low flow, and discharges to the San

1 Francisco Bay-Delta contribute to drinking water supplies. The Yolo Bypass also  
2 supports seasonal fish and bird populations when it is inundated, and resident fish  
3 species in its perennial channel. Water quality in the Yolo Bypass is of great  
4 importance because of the in-Bypass water uses and its effects on receiving  
5 waters downstream (CVRWQCB 2011, Sommer et al. 2001)

6 *Mercury*

7 The Yolo Bypass contributes a significant amount of methylmercury and total  
8 mercury to the Delta. While the Sacramento River is the primary tributary source  
9 of mercury to the Delta in dry years, mercury loading from the Yolo Bypass  
10 increases in wet years and is comparable to that of the Sacramento River.

11 Although only two thirds of the Yolo Bypass floodplain lie within the legal Delta,  
12 the entire floodplain was evaluated as part of the Sacramento – San Joaquin Delta  
13 Estuary TMDL for Methylmercury (Delta Methylmercury TMDL) (CVRWQCB  
14 2010a). Compounding the issue of mercury contamination in the Yolo Bypass,  
15 the USGS study noted that the Bypass has conditions conducive to the production  
16 of methylmercury, including stagnant waters and marshes with an abundance of  
17 sulfate and organic carbon (USGS 2002).

18 A major source of mercury to the Yolo Bypass is Cache Creek. Mercury mine  
19 wastes have contributed relatively large mercury loading and high mercury  
20 concentrations in suspended sediment, making this area a priority for mercury  
21 reduction as part of the Delta Methylmercury TMDL (CVRWQCB 2010a).  
22 Elevated methylmercury concentrations in the Colusa Basin Drain are also a  
23 concern (USGS 2002).

24 The Cache Creek Settling Basin (CCSB) captures sediment and mercury  
25 transported by Cache Creek; however, any sediment that is not captured is  
26 transported to the Yolo Bypass (approximately half of the sediment transported by  
27 Cache Creek). The CTR mercury criterion of 0.050 µg/l for drinking water is  
28 exceeded in outflow from the CCSB (and possibly in other tributaries to Yolo  
29 Bypass), thus it is anticipated that when the Yolo Bypass is dominated by flows  
30 from Cache Creek, it also exceeds the CTR criterion (CVRWQCB 2010a).

31 The Delta Methylmercury TMDL recommends reducing mercury loads entering  
32 the CCSB, and regularly excavating the sediment accumulating in the CCSB, in  
33 order to increase its effectiveness and prevent its filling and thus cessation of  
34 sediment and mercury deposition. Additional reductions in mercury loading to  
35 Cache Creek will be achieved through the existing mercury TMDL in the  
36 watershed, which includes measures for mine remediation, erosion control in  
37 mercury-enriched areas, and the removal of floodplain sediments containing  
38 mercury (CVRWQCB 2010a).

39 In addition to efforts targeting mercury loading reductions in Cache Creek, the  
40 TMDL includes methylmercury and total mercury load and waste load allocations  
41 for agricultural drainage, tributary inputs and NDPES facilities in the Yolo  
42 Bypass to enable reductions in mercury contamination in water and fish  
43 (CVRWQCB 2010a).

1 *Agricultural Runoff*

2 The City of Woodland developed a water quality management plan for the Yolo  
3 Bypass which included water quality testing to identify pollutants of concern.  
4 Water quality was monitored within the Yolo Bypass and in its major tributaries,  
5 at the locations where they enter the Bypass. The study indicated that the highest  
6 concentrations of several contaminants were found in tributaries receiving  
7 predominantly agricultural discharge: the Willow Slough Bypass; Knights  
8 Landing Ridge Cut, which drains the Colusa Basin Drain; and for some  
9 contaminants, the Z Drain (City of Woodland 2005). Although the Yolo Basin is  
10 not included as a water body on the 303(d) list, the Tule Canal is listed as  
11 contaminated by several of these agricultural by-products, including boron,  
12 salinity, E. coli and fecal coliform. These contaminants will be addressed by  
13 TMDLs expected to be completed in 2021 (SWRCB 2011w).

14 Pesticides are of major concern in the agricultural drains tributary to the Yolo  
15 Bypass. DDE, a degradation product of the organochlorine pesticide DDT, was  
16 detected in the water column in agricultural drains and in Putah Creek sediment.  
17 The organophosphate pesticide chlorpyrifos was detected in excess of the  
18 concurrent DFG criterion of 0.009 µg/l in four samples, while diazinon was not  
19 reported in excess of its criterion. The carbamate pesticides diuron and methomyl  
20 were detected, but did not exceed their applicable criteria. Pyrethroids were not  
21 monitored, but were noted to be of increasing concern in the Yolo Bypass as in  
22 the rest of the Central Valley (City of Woodland 2005).

23 **6.3.3.2 San Joaquin Valley**

24 Water quality conditions in the San Joaquin River are described for locations that  
25 would be influenced by implementation of Alternatives 1 through 5, including  
26 Stanislaus River near Caswell Park in the vicinity of the confluence with the San  
27 Joaquin River; San Joaquin River near Vernalis, and San Joaquin River near  
28 Buckley Cove and Stockton

29 **6.3.3.2.1 San Joaquin River**

30 Water quality concerns in the San Joaquin River near Vernalis are primarily  
31 salinity, boron, and selenium which are influenced by low flows due to upstream  
32 diversions and water use and agricultural return flows.

33 *Water Temperature*

34 The reach of the San Joaquin River from Merced River to Stanislaus River was  
35 placed on the Section 303(d) list per the partial approval by USEPA in 2010 and  
36 the final approval in 2011 (SWRCB 2011a).

37 According to the *Final California 2010 Integrated Report* (303(d) list/305(b)  
38 Report) Supporting Information, water temperature concerns in San Joaquin River  
39 from Merced River to Stanislaus River are attributed to unknown sources  
40 (SWRCB 2011x,y). However, declines in fish populations, particularly salmon  
41 and steelhead trout, have been linked to increases in water temperatures and  
42 suggestions have been made that the population declines may be a result of

1 watershed changes from the construction of dams, water diversions, mining, and  
2 harvest (NMFS 2009).

3 USEPA (2011) evaluated salmonid migration and spawning temperatures to  
4 assess the water quality of the San Joaquin River. Recommended water  
5 temperature criteria for salmon and steelhead trout life stages are presented in  
6 Table 6.16. San Joaquin River temperatures from the Merced River to the  
7 Stanislaus River in 1996-2007 exceeded USEPA’s recommendations, thus  
8 impairing the cold freshwater habitat.

9 **Table 6.16 San Joaquin River Maximum Temperature Criteria and Recommended**  
10 **Uses for Summer**

Applicable to:	Criteria:
Chinook Salmon Adult Migration	64 °F
Chinook Salmon Spawning	55 °F
Chinook Salmon Smoltification and Juvenile Rearing	61 °F
Steelhead Trout Summer Rearing	64 °F

11 Source: SWRCB 2011x,y; USEPA 2003

12 TMDLs for the lower reaches in the San Joaquin River (Merced to Tuolumne and  
13 Tuolumne to Stanislaus) are expected to be completed in 2021 in an effort to  
14 further protect the beneficial uses of this water body (SWRCB 2011).

15 *Selenium*

16 San Joaquin River from Mud Slough to Merced River was placed on the Section  
17 303(d) list in 2010 for selenium contamination per the list approved by USEPA  
18 (SWRCB 2011a). Other water bodies that drain to the San Joaquin River  
19 upstream of this reach and are listed as impaired by selenium contamination on  
20 the 303(d) list include Mendota Pool, Panoche Creek from Silver Creek to  
21 Belmont Avenue, Agatha Canal, Grasslands Marshes, Mud Slough (North,  
22 downstream of San Luis Drain), and Salt Slough (upstream from confluence with  
23 San Joaquin River).

24 TMDLs for selenium were approved by the USEPA for the San Joaquin River  
25 (Mud Slough to Merced River) (in 2002), Grasslands Marshes (in 2000), Agatha  
26 Canal (in 2000), and Mud Slough (north, downstream of San Luis Drain) (in  
27 2002) (SWRCB 2011z-ac). A TMDL is expected to be completed for Panoche  
28 Creek in 2019 and another for Mendota Pool in 2021. Water quality objectives  
29 defined in the Basin Plan for the Sacramento River basin and the San Joaquin  
30 River basin are shown in Table 6.17 (CVRWQCB 2011).

1 **Table 6.17 Water Quality Objectives for Selenium in the San Joaquin River**  
 2 **Region, mg/l**

Objective	Applies to:
0.012 (maximum concentration)	San Joaquin River, mouth of the Merced River to Vernalis
0.005 (4-day average)	
0.020 (maximum concentration)	Mud Slough (north), and the San Joaquin River from Sack Dam to the mouth of Merced River
0.005 (4-day average)	
0.020 (maximum concentration)	Salt Slough and constructed and re-constructed water supply channels in the Grassland watershed*
0.002 (monthly mean)	

3 Source: CVRWQCB 2011

4 \*Applies to channels identified in Appendix 40 of the CVRWQCB (2011) Basin Plan

5 The drainage area for the Grasslands Bypass Project is a major but decreasing  
 6 source of selenium to the San Joaquin River. Selenium from subsurface  
 7 agricultural drainage waters originating in the Drainage Area was historically  
 8 transported through the Grassland Marshes through tributaries such as Mud  
 9 Slough and Salt Slough (CVRWQCB 2001). Efforts to decrease the selenium  
 10 loading to the San Joaquin River include the Grassland Bypass Project, discussed  
 11 in more detail below, which has decreased selenium loading by an average of  
 12 55 percent from the Grasslands Drainage Area in comparison to pre-Grassland  
 13 Bypass Project conditions (1986-1996 to 1997-2011) (GBPOC 2013). In the San  
 14 Joaquin River below the Merced River, selenium concentrations decreased from  
 15 an average of 4.1 µg/l during pre-project conditions (1986 to 1996) to 2 µg/l  
 16 (1997 to 2011). The continued operation of the Grassland Bypass Project is  
 17 expected to achieve the CVRWQCB Basin Plan objectives for the San Joaquin  
 18 Valley (Reclamation & SLDMWA 2009).

19 Largemouth Bass were sampled during 1999, 2000, 2005, and 2007 from the San  
 20 Joaquin River, lower Sacramento River, and Delta by the CVRWQCB (Foe  
 21 2010). The samples were analyzed as fillets to evaluate potential human health  
 22 risks, and whole-body selenium concentrations were estimated using an equation  
 23 from Saiki et al. (1991) to evaluate risks to wildlife. The data do not exceed the  
 24 draft water quality criteria released by the USEPA in May 2014.

25 The draft discharge requirements released by the CVRWQCB in 2014 were  
 26 created in an effort to meet the water quality objective for the San Joaquin River.  
 27 In 2010, the CVRWQCB and SWRCB approved amendments (Resolution 2010-  
 28 0046) to the Basin Plan for the Sacramento River and San Joaquin River Basins to  
 29 address selenium control in the San Joaquin River basin as related to the  
 30 Grassland Bypass Project (which is described below) (CVRWQCB 2010g,  
 31 SWRCB 2010b).

1 Other relevant requirements/actions to meet the water quality objectives for the  
2 San Joaquin River, in addition to release of the draft waste discharge requirements  
3 by the CVRWQCB (2010g), include the following:

4 • The Basin Plan amendments (CVRWQCB 2010g, SWRCB 2010b) modify the  
5 compliance time schedule for discharges regulated under waste discharge  
6 requirements to meet the selenium objective or comply with a prohibition of  
7 discharge of agricultural subsurface drainage to Mud Slough (north), a  
8 tributary to the San Joaquin River, in Merced County. For Mud Slough  
9 (north) and the San Joaquin River from the Mud Slough confluence to the  
10 mouth of the Merced River:

11 – The interim performance goal is 15 µg/l (monthly mean) by  
12 December 31, 2015 (adds to Table 6.46), and

13 – The water quality objective to be achieved by December 31, 2019, is  
14 5 µg/l (4-day average).

15 An extensive water quality and biological monitoring program was implemented  
16 in conjunction with the Grassland Bypass Project, and reports are issued  
17 periodically through the San Francisco Estuary Institute (e.g., SFEI 2011).

#### 18 *Electrical Conductivity and Salinity*

19 Grasslands Marshes, North Mud Slough (downstream of San Luis Dam), Salt  
20 Slough (upstream from confluence with San Joaquin River), and San Joaquin  
21 River (Bear Creek to Vernalis) are water bodies in the Central Valley that were  
22 placed on the Section 303(d) list approved by the USEPA in 2010 as impaired by  
23 electrical conductivity (SWRCB 2011a). Salinity, which is linked to electrical  
24 conductivity, is a major concern for water quality in the San Joaquin Valley  
25 (CVRWQCB 2011). The RWQCB has adopted a TMDL for the San Joaquin  
26 River upstream of Vernalis for salt and boron.

27 Elevated electrical conductivity in Grasslands Marshes, North Mud Slough  
28 (downstream of San Luis Dam), Salt Slough (upstream from confluence with San  
29 Joaquin River), and San Joaquin River (Bear Creek to Vernalis) can be attributed  
30 to agriculture (SWRCB 2011x-aa,ac-af). Likewise, high salinity in the San  
31 Joaquin River near Vernalis has been linked to the discharge of water from  
32 agricultural practices (CALFED 2007). Saline water from agricultural return flow  
33 is added to the southern Delta by the San Joaquin River whereupon a portion is  
34 pumped by the export pumps back to the farms that eventually drain back to the  
35 river, exacerbating the problem of salinity control and salt buildup in the San  
36 Joaquin Valley.

37 To protect the beneficial uses of these water bodies, including agricultural supply,  
38 and municipal and domestic supply, particularly for San Joaquin River from Bear  
39 Creek to Mud Slough, water quality objectives were established in the SWRCB  
40 (2006a) Basin Plan for the San Francisco Bay/Sacramento-San Joaquin Delta  
41 Estuary (Table 6.18).



1 **Table 6.18 SWRCB Water quality objectives for electrical conductivity in the San**  
 2 **Joaquin River (Airport Way Bridge, Vernalis)**

Time Period	Water Quality Objective <sup>1</sup>
April 1 to August 31	0.7 mmhos (700 $\mu$ S/cm)
September 1 to March 31	1.0 mmhos (1000 $\mu$ S/cm)

3 Source: SWRCB 2006a

4 1 Maximum 30-day running average of mean daily

5 Several samples from San Joaquin River (Bear Creek to Vernalis) between  
 6 October 1995 and February 2007 exceeded the SWRCB Basin Plan's water  
 7 quality objective for electrical conductivity in the San Joaquin River (SWRCB  
 8 2011 x-aa,ac-af). Samples were collected from San Joaquin River at Lander  
 9 Avenue, Fremont Ford, Patterson Fishing Access, Hills Ferry Bridge, and Crows  
 10 Landing. Guidelines for evaluating Grasslands Marshes, North Mud Slough, and  
 11 Salt Slough are not available because the listing was made prior to 2006.

12 The record of monthly average electrical conductivity (EC) readings for recent  
 13 years for the San Joaquin River at Vernalis is shown in Figure 6.4. Salinity in the  
 14 lower San Joaquin River as observed at Vernalis often exceeds the water quality  
 15 objective for individual records during summer months. The highest salt  
 16 concentrations emanate from Mud and Salt sloughs, while less saline water  
 17 provides dilution from the Merced River (CALFED 2007). Note the marked  
 18 increase in salinity during dry months and dry years at Vernalis, ranging from  
 19 midwinter lows near 100  $\mu$ mhos/cm up to summer high values near 1000  
 20  $\mu$ mhos/cm.

21 A TMDL is expected to be completed in 2019, with the exception of San Joaquin  
 22 River from Tuolumne to Stanislaus River which is expected to be completed in  
 23 2021 (SWRCB 2011 x-aa,ac-af). In addition, the Board has implemented the  
 24 comprehensive salt management program, known as CV-SALTS (Central Valley  
 25 Salinity Alternatives for Long Term Sustainability), to develop salt control  
 26 strategies for the San Joaquin and the entire Central Valley watershed  
 27 (CVRWQCB 2011, 2010h). The San Joaquin River Water Quality Improvement  
 28 Program (SJRIP) was designed to address issues of chronically saline water,  
 29 reuse, treatment options, and the development of salt-tolerant crops for this area  
 30 of the valley, as part of the Grasslands Bypass Project.

### 31 *Mercury*

32 Mercury is a constituent of concern for the San Joaquin River from Bear Creek to  
 33 the Delta boundary, and was placed on the 303(d) list in 2010 (SWRCB 2011a).  
 34 San Joaquin River from Friant Dam to Bear Creek was not included on the 303(d)  
 35 list for mercury contamination.

36 Mercury in this reach of the San Joaquin can be attributed to resource extraction.  
 37 Significant gold mining took place along the major tributaries of the San Joaquin  
 38 River, including Merced River, Tuolumne River, Stanislaus River, and Cosumnes  
 39 River in the San Joaquin River basin (CVRWQCB 2010a).

1 Mercury and enhanced mercury methylation can affect the beneficial uses of the  
2 San Joaquin River and receiving waters downstream. At the Delta boundary in  
3 Vernalis, the waterborne methylmercury concentration in the San Joaquin River  
4 from 2003 to 2006 ranged from 0.10-0.75 ng/l with an average of 0.19 ng/l (Foe  
5 et al. 2008). The average fish tissue mercury concentration in Largemouth Bass  
6 from Vernalis in 2000 was 0.68 mg/kg (wet weight) (CVRWQCB 2010a). This  
7 fish tissue concentration exceeds the USEPA wet weight methylmercury fish  
8 tissue criterion (0.3 mg/kg) for the protection of human health.

9 To further protect the health of humans and wildlife, the Sacramento-San Joaquin  
10 Delta TMDL specified narrative and more stringent numeric water quality  
11 objectives for the more bioavailable and more toxic form of methylmercury  
12 (CVRWQCB 2011). The TMDL for the Sacramento-San Joaquin Delta  
13 (CVRWQCB 2010a), which is applicable to the Delta, Yolo Bypass, and their  
14 waterways, includes the reach of the San Joaquin River from Bear Creek to the  
15 Delta boundary.

### 16 *Pesticides*

17 The San Joaquin River (all segments from Mendota Pool to Vernalis), North Mud  
18 Slough (downstream of San Luis Drain), and Salt Slough (upstream from  
19 confluence with San Joaquin River) were placed on the Section 303(d) list  
20 approved by the USEPA in 2010 as impaired by pesticides (SWRCB 2011a).  
21 North Mud Slough is listed as impaired by “pesticides”; Salt Slough by  
22 chlorpyrifos and prometryn, and San Joaquin River by OP pesticides (chlorpyrifos  
23 and diazinon), OC pesticides (DDT, DDE, Group A Pesticides, including  
24 toxaphene), alpha.-BHC, and diuron. Impairment listings vary between reaches  
25 of the San Joaquin River. Several other small tributaries to the San Joaquin River  
26 from the west are also 303(d) listed as impaired by pesticides (i.e., Mud Slough  
27 North (upstream and downstream of San Luis drain).

28 Pesticides in North Mud Slough, Salt Slough, and the San Joaquin River can be  
29 attributed to runoff from agriculture, with the exception of the alpha-BHC in the  
30 San Joaquin River (from Merced to Tuolumne) and toxaphene in the San Joaquin  
31 River (from Stanislaus to the Vernalis) whose sources are unknown (SWRCB  
32 2011x-z,ac-ag).

### 33 *Boron*

34 The lower San Joaquin River upstream of Vernalis is listed as impaired due to  
35 elevated concentrations of boron (CVRWQCB 2002b, 2007c). A draft  
36 Amendment to the Basin Plan for the Sacramento River and San Joaquin River  
37 Basins for the control of Salt and Boron discharges into the lower San Joaquin  
38 River (resolution R5-2004-0108) (CVRWQCB 2007c) describes a pending  
39 TMDL and establishes Waste Load Allocations to meet boron water quality  
40 objectives near Vernalis (at the Airport Way Bridge).

41 Mean salinity in the lower San Joaquin River at Vernalis has doubled since the  
42 1940s while boron and other trace elements have also increased to concentrations  
43 that exceed the water quality criteria of 750 µg/l. These criteria were established  
44 to be protective of sensitive crops under long-term irrigation (USEPA 1986b).

1 Water quality improves in the San Joaquin River downstream of confluences with  
2 the Merced, Tuolumne, and Stanislaus rivers.

3 Most of the boron load to the Delta comes from the lower San Joaquin River as a  
4 result of surface and subsurface agricultural discharges (CVRWQCB 2007c) on  
5 soils overlying old marine deposits and from groundwater (Hoffman 2010h,  
6 CALFED 2000). Major boron contributions come from Salt and Mud sloughs to  
7 the lower river (CVRWQCB 2002b). Point sources contribute very little of the  
8 salt and boron loads to the San Joaquin River (CVRWQCB 2007c).

9 Boron concentrations in surface water from two surface water sources in the  
10 lower San Joaquin River are variable, and range from 100 to over 1000 µg/l  
11 (Hoffman 2010). Effluent from subsurface drains in the New Jerusalem Drainage  
12 District have also been reported up to 4200 µg/l (Hoffman 2010). These  
13 concentrations at times exceed the water quality criteria and thresholds for  
14 sensitive crops (i.e., bean tolerance threshold is 750 to 1000 µg/l).

15 The collaborative effort by stakeholders and regulators is developing  
16 comprehensive management programs that will lead to attainment of water-  
17 quality objectives for salinity and boron. This program, CV-SALTS, is scheduled  
18 to be completed by 2016 and may lead to a basin plan amendment that will  
19 support the protection of beneficial uses.

#### 20 *Arsenic*

21 The San Joaquin River from Bear Creek to Mud Slough was placed on the 303(d)  
22 list approved by the USEPA in 2010 for impairment by arsenic (SWRCB 2011a).  
23 Arsenic can cause adverse dermal, cardiovascular, respiratory, gastrointestinal,  
24 and neurological effects, and can cause cancer (ATSDR 2007). A TMDL  
25 addressing impairment due to arsenic is expected to be complete in 2021 to protect  
26 the beneficial uses of this reach of the San Joaquin River, including the municipal  
27 and domestic supply (SWRCB 2011ae).

#### 28 *Bacteria*

29 San Joaquin River (Bear Creek to Merced River; Stanislaus River to Delta  
30 Boundary) and Salt Slough (upstream from confluence with San Joaquin River) is  
31 a water body in the Central Valley that were placed on the Section 303(d) list  
32 approved by the USEPA in 2010 as impaired by *E. coli* (SWRCB 2011a).

#### 33 *Invasive Species*

34 San Joaquin River (Friant Dam to Mendota Pool) is a water body in the Central  
35 Valley that was placed on the Section 303(d) list approved by the USEPA in 2010  
36 as impaired by invasive species (SWRCB 2011a).

37 A TMDL for invasive species is expected to be completed in 2019 in an effort to  
38 meet the narrative water quality objective in San Joaquin River (Friant Dam to  
39 Mendota Pool).

1 **6.3.3.2.2 Stanislaus River**

2 *Water Temperature*

3 The lower Stanislaus River was placed on the 303(d) list per the partial approval  
4 by USEPA in 2010 and the final approval in 2011 (SWRCB 2011a). The  
5 Stanislaus River supports warm and cold fresh water habitat for aquatic species  
6 such as steelhead.

7 According to the *Final California 2010 Integrated Report* (303(d) list/305(b)  
8 Report) Supporting Information, water temperature concerns are attributed to  
9 unknown sources (SWRCB 2011). Future climate conditions that are warmer or  
10 drier or both will further restrict the extent of suitable habitat for steelhead  
11 (NMFS 2009).

12 USEPA recommended water temperature criteria for different salmon and  
13 steelhead trout life stages. Data from 1991 to 2007 exceeded USEPA's criteria  
14 and thus impairing the cold freshwater habitat. The 2009 NMFS BO also includes  
15 temperature objectives for the Stanislaus River, as described in Appendix 3A, No  
16 Action Alternative: Central Valley Project and State Water Project Operations.

17 *Mercury*

18 Lower Stanislaus River is a water body in the Central Valley that was placed on  
19 the Section 303(d) list approved by the USEPA in 2010 as impaired by mercury  
20 (SWRCB 2011a).

21 Mercury has impaired the beneficial use of the commercial or recreational  
22 collection of fish, shellfish, or organisms (SWRCB 2011aj-al). The lower  
23 Stanislaus River was evaluated prior to 2006, so the evidence for the list is not  
24 readily available. However, the total methylmercury concentration in the  
25 Stanislaus River at Caswell State Park from 2003 to 2006 was 0.12 ng/l (Foe et al.  
26 2008). Concentrations of methylmercury in Largemouth Bass, carp, Channel  
27 Catfish, and White Catfish tissue samples from the Stanislaus River between 1999  
28 and 2000 exceeded the USEPA methylmercury fish tissue criterion (0.3 mg/kg  
29 wet weight) for the protection of human health (Shilling 2003).

30 In an effort to protect the beneficial uses of these water bodies mentioned above,  
31 and including the commercial and recreational collection of fish, shellfish, or  
32 organisms beneficial use, TMDLs are expected to be completed between 2019 to  
33 2021 to meet the water quality standards in these water bodies (CVRWQCB  
34 2011).

35 *Pesticides*

36 Lower Stanislaus River was placed on the Section 303(d) list approved by the  
37 USEPA in 2010 as impaired by pesticides (chlorpyrifos, diazinon, Group A  
38 Pesticides) (SWRCB 2011a). OP pesticides (e.g., diazinon and chlorpyrifos) and  
39 OC pesticides (e.g., Group A Pesticides) are primarily transported to streams and  
40 rivers in runoff from agriculture (CVRWQCB 2011). Sources and descriptions of  
41 the listed pesticides are discussed further in Section 6.3.2.7.

1 *Other Constituents of Concern*

2 Lower Stanislaus River was placed on the Section 303(d) list approved by the  
3 USEPA in 2010 as impaired by unknown toxicity (SWRCB 2011a).

4 To protect the beneficial uses of Lower Stanislaus River, a narrative water quality  
5 objective, which addresses *E. coli*, was established in the CVRWQCB (2011)  
6 Basin Plan.

7 A TMDL is expected to be complete in 2021 in an effort to meet the water quality  
8 standards in the lower Stanislaus River.

9 **6.3.3.3 Sacramento-San Joaquin River Delta**

10 Water quality conditions in the Sacramento and San Joaquin River in the Delta  
11 are described in this subsection against criteria to protect the beneficial uses as  
12 summarized in Table 6.2. The constituents of concern that are currently not in  
13 compliance with existing water quality standards and for which TMDLs are  
14 adopted or are in development in this region are summarized in Table 6.1.

15 **6.3.3.3.1 Salinity**

16 Delta waterways were placed on the Section 303(d) List approved by the USEPA  
17 in 2010 as impaired by electrical conductivity (SWRCB 2011a). Electrical  
18 conductivity is linked to salinity and salinity is of particular concern in the tidally-  
19 influenced Delta (CVRWQCB 2011, CALFED 2007).

20 Electrical conductivity in Delta waterways (export area, northwestern portion,  
21 southern portion, western portion) can be attributed to runoff from agricultural  
22 practices (SWRCB 2011at-aw). Salinity in the Delta can vary significantly  
23 depending on several factors including hydrology, water operations, and Delta  
24 hydrodynamics (Jassby et al. 1995). Hydrology and upstream water operations  
25 influence the Delta inflows, which in turn influences the balance with the highly  
26 saline seawater intrusion. Various upstream watershed sources determine the  
27 quality of the Delta inflows, in addition to the in-Delta sources such as  
28 agricultural returns, natural leaching, municipal and industrial discharges that  
29 influence the Delta salinity conditions. Operation of various Delta gates and  
30 barriers, pumping rates of various diversions and volume of the open water bodies  
31 are the other key factors that influence the Delta hydrodynamics and salinity  
32 transport in the Delta.

33 The CVP and SWP are operated to achieve salinity objectives in the Delta, as  
34 described in detail in Appendix 3A, No Action Alternative: Central Valley Project  
35 and State Water Project Operations.

36 Water quality objectives for electrical conductivity were established in the  
37 SWRCB (2006a) Basin Plan to protect the beneficial uses of these Delta  
38 waterways, including agricultural supply. Objectives are specific to the western  
39 Delta, interior Delta, southern Delta and export area, as well as for inflows and  
40 outflows to the delta from other water bodies. Compliance locations in the Delta  
41 are shown in Figure 6.5.

1 The patterns of EC and salinity in the Delta over time and space follow  
2 predictable patterns, under the strong influence of higher saline water from the  
3 San Joaquin and less saline water from the Sacramento and Eastside streams in an  
4 ever-changing balance with tidal influence upstream from Suisun Bay and the  
5 losses from south Delta pumping. The record of monthly average EC readings for  
6 recent years at five sites throughout the Delta shows the pattern of increasing  
7 average EC in the western Delta, as shown in Figures 6.6 through 6.8. The  
8 highest salinity occurs in the late summer months when the flows from the  
9 Sacramento and San Joaquin rivers are the lowest, and sea water intrusion occurs.  
10 The lower Sacramento River at Collinsville experiences strong tidal influence  
11 during dry periods (EC above 8000  $\mu\text{mhos/cm}$ ) but is flushed with fresh water  
12 during winter flows. Historical salinity discharged from the CVP Jones Pumping  
13 Plant into the Delta Mendota Canal is summarized in Figure 6.9.  
14 Salinity objectives for the southern Delta are now under review by the SWRCB  
15 (SWRCB 2008b).

#### 16 **6.3.3.3.2 Mercury**

17 Mercury is a constituent of concern for the Sacramento-San Joaquin River Delta,  
18 which was placed on the 303(d) list in 2010 (SWRCB 2011a). In 2008, the San  
19 Francisco Bay Mercury TMDL was approved by the USEPA and the  
20 implementation plan is expected to attain the water quality standard 20 years after  
21 the approval (SFB RWQCB 2006). In 2010, the RWQCB approved amendments  
22 to the Basin Plan for the Sacramento River and San Joaquin River Basins to  
23 include the Sacramento-San Joaquin Delta Methylmercury TMDL (CVRWQCB  
24 2011). The TMDL was created to control methylmercury and total mercury in the  
25 Sacramento-San Joaquin River Delta Estuary, which is applicable to the Delta,  
26 Yolo Bypass, and their waterways (CVRWQCB 2010a). The waterways include  
27 the major tributaries to the Delta, the Sacramento River, eastside streams, and the  
28 San Joaquin River. Fish tissue and waterborne mercury concentration data for  
29 these water bodies are summarized in Tables 6.19 and 6.20.

1 **Table 6.19 Fish and Waterborne Methylmercury (as Total Mercury) Concentrations**  
 2 **by Delta Subarea**

	Delta Subarea <sup>1</sup>				
	Sacramento River	Mokelumne River	Central Delta	San Joaquin River	West Delta
<b>Fish (Sampled in September/October 2000) (mg/kg wet weight)</b>					
Standardized 350-mm Largemouth Bass <sup>2</sup>	0.72	1.04	0.19	0.68	0.31
<b>Water (Sampled between March and October 2000) (ng/l)</b>					
Average	0.120	0.140	0.055	0.147	0.087
Median	0.086	0.142	0.032	0.144	0.053
<b>Water (Sampled between March 2000 and April 2004) (ng/l)</b>					
Annual Average	0.108	0.166	0.060	0.160	0.083
Annual Median	0.101	0.161	0.051	0.165	0.061
Cool Season <sup>3</sup> Average	0.137	0.221	0.087	0.172	0.106
Cool Season <sup>3</sup> Median	0.138	0.246	0.077	0.175	0.095
Warm Season <sup>3</sup> Average	0.094	0.146	0.050	0.156	0.075
Warm Season <sup>3</sup> Median	0.089	0.146	0.040	0.162	0.055

3 Source: Adapted from CVRWQCB 2010a.

4 1 Location of each water and fish collection site provided on Figure 5.1 of the 2008 Draft  
 5 Staff Report for the Sacramento-San Joaquin Delta Estuary TMDL for Methylmercury  
 6 (CVRWQCB 2010a).

7 2 See CVRWQCB 2010a for the method used to calculate standard 350-mm Largemouth  
 8 Bass mercury concentrations.

9 3 For this analysis, “cool season” is defined as November through February and “warm  
 10 season” is defined as March through October.

1 **Table 6.20 Historical Methylmercury Concentrations in the Five Delta Source Waters for the Period 2000-2008**

Source Water	Sacramento River		San Joaquin River		San Francisco Bay		East Side Tributaries		Agriculture in the Delta	
	Total <sup>2</sup>	Dissolved <sup>3</sup>	Total <sup>2</sup>	Dissolved <sup>3</sup>	Total <sup>2</sup>	Dissolved <sup>3</sup>	Total <sup>2</sup>	Dissolved <sup>3</sup>	Total <sup>2</sup>	Dissolved <sup>3</sup>
Mean <sup>1</sup> (ng/L)	0.10	0.05	0.15	0.03	0.032	-	0.22	0.08	0.51	-
Minimum (ng/L)	0.06	0.02	0.09	0.01	-	-	0.02	0.02	0.02	-
Maximum (ng/L)	0.16	0.12	0.26	0.08	-	-	0.32	0.41	5.44	-
75 <sup>th</sup> Percentile (ng/L)	0.13	0.08	0.18	0.06	-	-	0.2	0.15	0.53	-
99 <sup>th</sup> Percentile (ng/L)	0.16	0.12	0.26	0.08	-	-	0.31	0.39	4.81	-
Data Source	CEDEN 2014 (Irrigated Lands Regulatory Program)		Central Valley Water Board 2010a		SFEI 2014b	-	Central Valley Water Board 2010a		Heim et al. 2009	-
Station(s)	Sacramento River at Freeport		San Joaquin River at Vernalis		Suisun Bay		Mokelumne and Calaveras Rivers		Delta locations	
Date Range	12/2006-08/2007		2000- 2001; 2003- 2004	2000- 2002	2008	-	2000- 2001; 2003- 2004	2000-2002	10/2005- 03/2008	-



Source Water	Sacramento River		San Joaquin River		San Francisco Bay		East Side Tributaries		Agriculture in the Delta	
	Total <sup>2</sup>	Dissolved <sup>3</sup>	Total <sup>2</sup>	Dissolved <sup>3</sup>	Total <sup>2</sup>	Dissolved <sup>3</sup>	Total <sup>2</sup>	Dissolved <sup>3</sup>	Total <sup>2</sup>	Dissolved <sup>3</sup>
ND Replaced with RL	No		Not Applicable	Yes	-		Yes		Not Applicable	
Data Omitted	No		None		-		None		None	
No. of Data Points	8	8	49	25	-	-	27	9	183	-

1 Source: Adapted from DWR, Reclamation, USFWS and NMFS 2013.

2 1 Geometric mean.

3 2 Total recoverable concentration of analyte.

4 3 Dissolved concentration of analyte.

1 For the protection of the beneficial uses of the Sacramento – San Joaquin Delta,  
 2 water quality objectives were specified in the San Francisco Bay Mercury TMDL  
 3 (Table 6.21) and the Sacramento-San Joaquin Delta Methylmercury TMDL  
 4 (Table 6.22).

5 **Table 6.21 Water Quality Objectives for Total Mercury in the Delta within the San**  
 6 **Francisco Bay Region<sup>1</sup>**

For the protection of human health	0.2 mg/kg wet weight mercury in fish tissue <sup>2</sup>
For the protection of aquatic organisms and wildlife	0.03 mg Hg/kg in fish <sup>3</sup>
1-hour average	2.1 µg/l, in water

7 Source: SFB RWQCB 2013

8 1 Water quality objectives are applicable to Sacramento/San Joaquin River Delta (within  
 9 the San Francisco Bay region as specified in the SFB RWQCB Basin Plan, 2013), Suisun  
 10 Bay, Carquinez Strait, and San Pablo Bay.

11 2 measured in the edible portion of trophic level 3 and trophic level 4 fish

12 3 measured in whole fish 3-5 cm in length

13 **Table 6.22 Water Quality Objectives for total mercury in the Delta within the Central**  
 14 **Valley**

Water body	Wet Weight Methylmercury Concentration of Fish Tissue (mg/kg wet weight)	
	Trophic Level 3 Fish	Trophic Level 4 Fish
Cache Creek, North Fork Cache Creek, and Bear Creek	0.12	0.23
Harley Gulch	0.05 <sup>1</sup>	–
Sacramento-San Joaquin Delta <sup>2</sup> and Yolo Bypass	0.08 <sup>3</sup> , 0.03 <sup>4</sup>	0.24 <sup>3</sup> , 0.03 <sup>4</sup>

15 Source: CVRWQCB 2011

16 1 Applies to whole fish of trophic levels 2 and 3.

17 2 Applies to the 146 Sacramento-San Joaquin Delta and Yolo Bypass waterways listed in  
 18 Appendix 43 of the Basin Plan for the Sacramento River and San Joaquin River Basins.

19 3 Applies to fish of total length 150-500 mm.

20 4 Applies to whole fish less than 50 mm in length.

21 Methylation processes in the Delta are enhanced by environmental characteristics  
 22 such as the source of inorganic mercury, nutrient enrichment, dissolved oxygen in  
 23 the water column, sediment organic content and grain size, water residence time  
 24 and sediment accumulation, periodic drying and wetting, and fish species and age

1 structure (Alpers et al. 2008). The mercury-laden sediment that accumulates in  
2 the Delta as a result of waterborne loading is subject to methylation (Heim et al.  
3 2007). Waterborne methylmercury in the Delta may be a more significant factor  
4 to bioaccumulation in fish than mercury-laden sediment that is subject to  
5 methylation (Melwani et al. 2009). Another factor affecting bioaccumulation in  
6 fish may be dissolved organic carbon (DOC). Laboratory studies have shown  
7 mercury uptake is much higher in water with lower DOC (as might be expected  
8 from the tributaries versus the interior Delta) (Pickhardt et al. 2006).

9 Mercury exposure and methylation can affect the beneficial uses of the  
10 Sacramento-San Joaquin Delta, and receiving waters downstream such as the  
11 Suisun Bay, Carquinez Strait, San Pablo Bay, and San Francisco Bay. To protect  
12 the beneficial uses of the water body a narrative water quality objective was  
13 specified, in addition to numeric water quality objectives, stating that surface  
14 waters are to "...be maintained free of toxic substances in concentrations that are  
15 toxic to or that produce detrimental physiological responses to human, plant,  
16 animal, and aquatic life" (CVRWQCB 2011).

17 In an effort to meet the water quality objectives, the CVRWQCB plans to  
18 continue monitoring metals in the Delta and control mass emissions from inactive  
19 or abandoned mines and other significant sources (CVRWQCB 2011). The  
20 ongoing interest in controlling mercury in fish in the Delta has spawned the  
21 Mercury Exposure Reduction Program (MERP), developed by the CVRWQCB,  
22 with the goal of pooling the resources of mercury dischargers to develop  
23 reduction programs and a better understanding of mercury bioaccumulation in  
24 Delta fish (MERP 2012). The MERP is designed to build on previous CALFED  
25 efforts. MERP was included as part of an amendment to the Sacramento River  
26 and San Joaquin River Basins Basin Plan in 2011 (CVRWQCB 2011), and is  
27 applicable to people eating one meal of trophic level 3 or 4 fish per week (32  
28 g/day) from the Delta and Yolo Bypass, as well as their waterways. The two-  
29 phase program was put into effect October 20, 2011 and will be completed in  
30 2030. Phase 1 consists of implementing programs to minimize pollution,  
31 implementing interim mass limits for point sources, and controlling potentially  
32 methylated sediment-bound mercury in the Delta and Yolo Bypass. Phase 1 also  
33 includes developing a program to control mercury in tributaries upstream. Plans  
34 for Phase 2 include implementing control programs and monitoring compliance.  
35 In addition to the Delta Control Mercury Program, the CVRWQCB designated  
36 load and waste load allocations for point sources within and to the Delta as  
37 specified in the Basin Plan.

#### 38 **6.3.3.3 Selenium**

39 Selenium is a constituent of concern for the Sacramento-San Joaquin River Delta  
40 and the Delta was placed on the 303(d) list in 2010 (SWRCB 2011a). Selenium  
41 criteria were promulgated for all San Francisco Bay and Delta waters in the NTR  
42 (SFB RWQCB 2011a). Although the entire San Francisco Bay is listed as  
43 impaired by selenium, the TMDL for the San Francisco Bay focuses on the North  
44 San Francisco Bay (North Bay, defined to include a portion of the Delta, Suisun  
45 Bay, Carquinez Strait, San Pablo Bay, and the Central Bay) because sources there

1 are substantially different from sources in the South San Francisco Bay (South  
 2 Bay) (Lucas and Stewart 2007). The NTR criteria specifically apply to San  
 3 Francisco Bay upstream to and including Suisun Bay and the Delta. The NTR  
 4 values are 5.0 µg/l (4-day average) and 20 µg/l (1-hour average).

5 Selenium concentrations in whole-body fish and in bird eggs are most useful for  
 6 evaluating risks to fish and bird wildlife receptors (Skorupa and Ohlendorf 1991;  
 7 DOI 1998; Ohlendorf 2003). Analyses of dietary items (such as benthic  
 8 [sediment-associated] or water-column invertebrates) can be used for evaluating  
 9 risks through dietary exposure, although with less certainty than when using  
 10 concentrations measured in fish or wildlife receptors. The USEPA (2014b)  
 11 released draft water quality criteria for public comment in May 2014 for selenium  
 12 in fish tissue; they include 15.2 mg/kg in egg/ovary, 8.1 mg/kg whole body, or  
 13 11.8 mg/kg muscle (skinless, boneless fillet).

14 A large number of fish tissue samples were collected from the Sacramento and  
 15 San Joaquin River watersheds and the Delta between 2000 and 2007 (Foe 2010).  
 16 As part of the Strategic Workplan for Activities in the San Francisco  
 17 Bay/Sacramento–San Joaquin Delta Estuary (SWRCB 2008a), archived  
 18 Largemouth Bass samples were analyzed for selenium to investigate possible  
 19 sources of selenium being bioaccumulated in bass in the Delta and whether  
 20 selenium concentrations in bass were above recommended criteria for the  
 21 protection of human and wildlife health (Foe 2010). Results of this study are the  
 22 most relevant biota data from the Delta, and they are summarized in Table 6.23 to  
 23 compare to tissue guidelines.

24 **Table 6.23 Selenium Concentrations in Largemouth Bass**

Site	Number of Samples	Selenium Concentrations in Fish Fillets (mg/kg, wet weight)			Selenium Concentrations in Whole-Body Fish (mg/kg, dry weight)			Years
		Min.	Max.	Mean	Min.	Max.	Mean	
Sacramento River at Veterans Bridge	3	0.40	0.81	0.56	1.7	2.9	2.2	2005
Sacramento River at River Mile 44 <sup>a</sup>	9	0.27	0.72	0.46	1.2	2.7	1.9	2000 2005 2007
Sacramento River near Ro Vista	9	0.30	0.80	0.44	1.3	3.2	1.9	2000 2005 2007
San Joaquin River at Frenot Ford	3	0.35	0.46	0.48	1.46	2.44	1.9	2005
San Joaquin River at Vernalis	8	0.15	0.63	0.40	0.77	2.5	1.7	2000 2005 2007
Old River near Tracy	3	0.45	0.69	0.55	2.0	2.9	2.4	2005
San Joaquin River at Potato Slough	9	0.22	0.89	0.38	1.1	3.5	1.6	2000 2005 2007
Mile River at Billings	6	0.37	0.58	0.47	1.6	2.3	2.0	2005 2007

Site	Number of Samples	Selenium Concentrations in Fish Fillets (mg/kg, wet weight)			Selenium Concentrations in Whole-Body Fish (mg/kg, dry weight)			Years
		Min.	Max.	Mean	Min.	Max.	Mean	
Franks Tract	8	0.15	0.70	0.37	0.79	3.0	1.7	2000 2005 2007
Big Break	9	0.15	0.82	0.38	0.81	3.1	1.6	2000 2005 2007
Discovery Bay	3	0.32	0.41	0.37	1.5	1.7	1.6	2005
Whiskey Slough	2	0.35	0.47	0.41	1.6	1.9	1.7	2005

1 Source: Foe 2010

2 Notes: Means are geometric means.

3 Max. = maximum, mg/kg = milligrams per kilogram, Min. = minimum.

4 a. Near Clarksburg.

5 Average selenium concentrations varied slightly in Largemouth Bass caught in  
6 the Sacramento River between Veterans Bridge and Rio Vista in 2005, as well as  
7 on the San Joaquin River between Fremont Ford and Vernalis (Foe 2010). These  
8 concentrations also varied slightly among years (2000, 2005, and 2007) in the  
9 Sacramento River at Rio Vista and in the San Joaquin River at Vernalis. The lack  
10 of a significant difference in bioavailable selenium between the two river systems  
11 was unexpected because the San Joaquin River is considered a significant source  
12 of selenium to the Delta. Selenium concentrations in the Largemouth Bass were  
13 compared to criteria recommended for the protection of human health (based on  
14 fillets; 2 mg/kg, wet weight) and fish and wildlife health (based on whole-body  
15 fish; concern threshold of 4–9 mg/kg, dry weight) (Foe 2010). Geometric means  
16 and maximum concentrations (Table 6.23) did not exceed the draft criteria.

17 Sporadic sampling of selenium has been conducted at a few locations in the Delta.  
18 Five major sources, shown in Table 6.24, are Sacramento River, Yolo Bypass,  
19 Eastside Delta Tributaries, San Joaquin River, and Martinez/Suisun Bay. Total  
20 selenium concentrations in Sacramento and San Joaquin river surface waters just  
21 upstream of Mallard Island (near the western limit of the Delta [Regional  
22 Monitoring Program stations BG20 and BG30, respectively]) are considered more  
23 representative of generalized Delta concentrations than of the individual rivers  
24 (SWRCB 2008a). Total and dissolved selenium concentrations were somewhat  
25 lower at those locations during low flow in a dry year (<0.1 µg/l in August 2001)  
26 than during high flow (>0.1 µg/l in February 2001) (SWRCB 2008a). Cutter and  
27 Cutter (2004) reported similar flow-related patterns for those locations. The  
28 maximum selenium concentration found in the Delta was 2 µg/l at an Old/Middle  
29 River location in the south subarea of the Delta. Except for that location, the  
30 available data show geometric mean concentrations well below 1 µg/l.

1 **Table 6.24 Selenium Concentrations in Water at Inflow Sources to the Delta**

Source Water <sup>1</sup>	Sacramento River	San Joaquin River	San Francisco Bay	East Side Tributaries <sup>3</sup>	Agriculture in the Delta
Mean <sup>2</sup> (ng/L)	0.10	0.54	0.09	0.1	0.11
Minimum (ng/L)	0.04	0.07	0.03	0.1	0.11
Maximum (ng/L)	0.23	1.50	0.45	0.1	0.11
75 <sup>th</sup> Percentile (ng/L)	0.11	0.76	0.12	0.1	0.11
99 <sup>th</sup> Percentile (ng/L)	0.23	1.50	0.44	0.1	0.11
Data Source	USGS Website 2014b	USGS Website 2014c	SFEI 2014b	None	Lucas and Stewart 2007
Station(s)	Sacramento River at Freeport	San Joaquin River at Vernalis	Central-West; San Joaquin River Near Mallard Island	None	Mildred Island, Center
Date Range	11/2007-07/2014	11/2007-08/2014	02/2000-08/2013	None	2000, 2003-2004
ND Replaced with RL	Not Applicable	Not Applicable	Yes	Not Applicable	No
Data Omitted	None	None	-	Not Applicable	No
No. of Data Points	88	93	14	None	1

2 Sources: Adapted from DWR, Reclamation, USFWS and NMFS 2013; U.S. Geological  
3 Survey 2014b,c; San Francisco Estuary Institute 2014b; Lucas and Stewart 2007

4 1 Dissolved selenium concentration.

5 2 Geometric mean.

6 3 Dissolved selenium concentration in Mokelumne, Calaveras, and Cosumnes Rivers is  
7 assumed to be 0.1 µg/L because of lack of available data and lack of sources that would  
8 be expected to result in concentrations greater than 0.1 µg/L

9 In efforts to address the selenium in the Delta and water bodies downstream, the  
10 SFB RWQCB is conducting a new TMDL project to address selenium toxicity in

1 the North Bay (SFB RWQCB 2011, 2013). The North Bay selenium TMDL will  
2 identify and characterize selenium sources to the North Bay and the processes that  
3 control the uptake of selenium by fish and wildlife. The TMDL will quantify  
4 selenium loads, develop and assign waste load and load allocations among  
5 sources, and include an implementation plan designed to achieve the TMDL and  
6 protect beneficial uses.

7 USEPA's Action Plan for Water Quality Challenges in the San Francisco  
8 Bay/Sacramento-San Joaquin Estuary (USEPA 2012a) identifies selenium as one  
9 of seven priority items for action. The plan indicated that USEPA will draft new  
10 site-specific numeric selenium criteria by December 2012 to protect aquatic and  
11 terrestrial species dependent on the aquatic habitats of the Bay Delta Estuary.  
12 More stringent selenium water quality criteria will require actions that decrease  
13 allowable concentrations of selenium in surface waters of the Bay Delta Estuary  
14 and may set allowable levels of selenium in the tissue of fish and wildlife.  
15 Following the development of the Bay Delta selenium criteria, USEPA plans to  
16 develop site-specific criteria for other parts of California, including the San  
17 Joaquin Valley watershed (USEPA 2012a). USEPA also is engaged in other  
18 efforts to minimize selenium discharges to the San Joaquin River and the Bay  
19 Delta Estuary, including the Grasslands Bypass Project and the North San  
20 Francisco Bay TMDL.

#### 21 **6.3.3.3.4 PCBs**

22 The Sacramento-San Joaquin River Delta was placed on the 303(d) list approved  
23 by the USEPA in 2010 as impaired by PCBs (SWRCB 2011a). A TMDL for  
24 PCBs in the Sacramento River from Knights Landing to the Delta is expected to  
25 be completed in 2021 to protect the beneficial uses of the Sacramento River and  
26 other water bodies downstream (SWRCB 2011ax).

#### 27 **6.3.3.3.5 Pesticides**

28 Sacramento-San Joaquin River Delta (central, eastern, northern, northwestern,  
29 southern, western portions, the export area, and the Stockton Ship Channel) were  
30 placed on the Section 303(d) List approved by the USEPA in 2010 as impaired by  
31 pesticides (chlorpyrifos, DDT, Diazinon, Group A Pesticides, Chlordane,  
32 Dieldrin, Dioxin, and Furan and Dioxin compounds) (SWRCB 2011a).

33 Samples were collected from Sacramento River at Rio Vista, near Hood along the  
34 Sacramento/Yolo County line, San Joaquin River at Highway 4 and Antioch,  
35 1 1/2 miles upstream from the Mossdale launch ramp, and other locations north  
36 portion of the Delta waterways (SWRCB 2011at-bb).

37 In an effort to meet the water quality standards in Sacramento-San Joaquin River  
38 Delta, TMDLs are expected to be complete in 2019 with the exception of the  
39 TMDL for chlorpyrifos and diazinon. A Delta Diazinon and Chlorpyrifos TMDL  
40 Project was approved in 2007.

1 **6.3.3.3.6 Nutrients**

2 The Sacramento-San Joaquin River Delta was not placed on the 303(d) list  
3 approved by USEPA in 2010 as impaired by nutrients (SWRCB 2011a).  
4 However, nutrients are a cause of concern in the Delta (e.g., CVRWQCB 2010j)  
5 and have been the subject of discussion. A decline in pelagic fish species in the  
6 Delta, known as the pelagic organism decline (POD), including the endangered  
7 California Delta smelt, may be related to bottom-up effects from nutrients among  
8 other drivers (Baxter et al. 2010; Sommer et al. 2007). However, unlike most  
9 waterbodies where nutrients cause too much primary production, the problem  
10 affecting beneficial uses in parts of the Delta is too little primary production to  
11 support fish populations. Nutrient effects are also dependent on flow and other  
12 factors (e.g., temperature, turbidity, and invasive species) that are potentially  
13 associated with the POD. Specific hypotheses for an association between  
14 nutrients and the POD are that ammonium (a dominant form of nitrogen in the  
15 Delta and Suisun Bay, inhibits the uptake of nitrate which is a better fuel for algae  
16 blooms (Dugdale et al. 2007) and that changes in nutrient forms and ratios have  
17 caused a shift in the food web (Glibert et al. 2011). Alternatively, causes of the  
18 POD may be related to reduced phosphorus that has become a limiting factor for  
19 primary production (Van Nieuwenhuysse 2007), or that invasive clam  
20 consumption of algae have made this food source unavailable to zooplankton and  
21 fish since their introduction in the mid-1980s (Lucas and Thompson 2012;  
22 Kimmerer et al. 1994).

23 The Delta is a major source of anthropogenic ammonium loading to the Suisun  
24 Bay, which exchanges nutrients with Suisun Marsh, an estuarine habitat impaired  
25 by nutrients (Senn et al. 2014, Tetra Tech Inc. and WWR 2013). Primary sources  
26 of nutrients are erosion, agricultural runoff, urban runoff, and treated effluent.  
27 The Sacramento Regional Wastewater Treatment Plant (SRWTP) is the largest  
28 major point source of ammonium in the Delta, contributing 90 percent of  
29 ammonium in the river from 1986 to 2005 (Jassby 2008). Nitrogen inputs to the  
30 Delta will change as SRWTP's current NPDES permit (NO. CA0077682)  
31 includes effluent limits for nitrogen that require the addition of nitrification and  
32 denitrification treatment by 2020. Another source of ammonium loading has  
33 already changed as the Stockton Regional Wastewater Control Facility, which  
34 discharges to the San Joaquin River began implementing nitrification and  
35 denitrification treatment in 2007 (SWRCB 2012b).

36 Nutrients, primarily nitrogen and phosphorous, may trigger excessive growth of  
37 algae or toxic blue-green cyanobacteria. However, within the Delta, it is  
38 generally recognized that nutrients are too high in concentration to be limiting (as  
39 compared to light, for example) (Jassby et al. 2002). The secondary effects of  
40 nutrient enrichment and oxygen depletion are most often found in the central and  
41 southern Delta near Stockton rather than the Sacramento River.



#### 1 **6.3.3.3.7 Dissolved Oxygen**

2 The Stockton Ship Channel in the Delta waterways was placed on the  
3 Section 303(d) list approved by the USEPA in 2010 as impaired by dissolved  
4 oxygen (SWRCB 2011a).

5 Low dissolved oxygen is of concern in the central and southern Delta because of  
6 enhanced treated effluent loading from Stockton, agricultural runoff, and reduced  
7 flushing of dead-end channels. Middle River, Old River, and the Stockton Deep  
8 Water Ship Channel are listed as impaired due to dissolved oxygen depletion,  
9 with dissolved oxygen concentrations criteria set at 6 mg/L minimum for the San  
10 Joaquin River between Turner Cut and Stockton between September 1 and  
11 November 30 (SWRCB 2011a, SWRCB 2006a). Loading from the Stockton  
12 Regional Wastewater Control Facility had the greatest effect in reducing DO, with  
13 hydrologic flushing (as related to upstream river flows, upstream discharges of  
14 materials that increase biological oxygen demand), geometrical cross-sections of  
15 the channels, temperature, and phytoplankton being less important (Jassby and  
16 Niewenhuyse 2005). Following recent upgrades to the Stockton Regional  
17 Wastewater Control Facility in 2006, less oxygen demand constituents have been  
18 discharged into the channels.

19 A TMDL addressing impairment due to dissolved oxygen was approved by the  
20 USEPA in 2007 to meet the water quality standards in the Stockton Ship Channel.

#### 21 **6.3.3.3.8 Organics and Pathogens**

22 The Stockton Ship Channel in the Delta waterways was placed on the Section  
23 303(d) list approved by the USEPA in 2010 as impaired by organic enrichment  
24 and pathogens (SWRCB 2011a).

25 The Delta as a source of drinking water is impaired through the presence of  
26 disinfection byproducts from treated wastewater effluent and the interactions with  
27 bromide and dissolved organic carbon, which may produce potentially harmful  
28 disinfection byproducts such as the carcinogenic trihalomethanes and haloacetic  
29 acid (Healey et al. 2008). Bromide and organic carbon are natural chemical  
30 constituents of the estuarine ecosystem but they exacerbate drinking water quality  
31 impairment through discharges, agriculture drainage, or water management, when  
32 combined with disinfectants during water treatment processes. Changes to flow  
33 or use patterns or discharges to the Delta must be examined for their potential  
34 effects to concentrations of these disinfection byproduct precursors and  
35 compounds.

36 Pathogens are another potential concern impairing the Delta for drinking water  
37 use. Giardia and Cryptosporidium are common protozoans found in urban runoff  
38 and sometimes found to be in exceedance of drinking water standards in the Delta  
39 (SWRCB 2007). A TMDL addressing impairment due to pathogens was  
40 approved by the USEPA in 2008 to meet the water quality standards in the  
41 Stockton Ship Channel.

1 **6.3.3.3.9 Invasive Species**

2 Sacramento-San Joaquin River Delta (central, eastern, northern, northwestern,  
3 southern, western portions, the export area, and the Stockton Ship Channel) was  
4 placed on the Section 303(d) list approved by the USEPA in 2010 as impaired by  
5 invasive species (SWRCB 2011a).

6 A TMDL addressing impairment due to invasive species is expected to be  
7 completed in 2019 in an effort to meet the water quality standards in Sacramento-  
8 San Joaquin River Delta (central, eastern, northern, northwestern, southern,  
9 western portions, the export area, and the Stockton Ship Channel).

10 **6.3.3.3.10 Unknown Toxicity**

11 Sacramento-San Joaquin River Delta (central, eastern, northern, northwestern,  
12 southern, western portions, the export area, and the Stockton Ship Channel) were  
13 placed on the Section 303(d) list approved by the USEPA in 2010 as impaired by  
14 unknown toxicity (SWRCB 2011a).

15 A TMDL is expected to be completed in 2019 to protect the beneficial uses of  
16 Sacramento-San Joaquin River Delta and its waterways, including impaired warm  
17 fresh water habitat.

18 **6.3.3.4 Suisun Bay and Suisun Marsh**

19 Suisun Bay and Suisun Marsh are located in transition zones between upstream  
20 fresh water inputs and tidal saline flux from San Francisco Bay. Beneficial uses  
21 of these areas are summarized in Table 6.2. Constituents of concern are  
22 summarized in Table 6.1.

23 Historically, the chlorophyll maxima were found to coincide with the mixing  
24 (entrapment) zone but recent alterations by invasive species of benthic grazing  
25 clams has greatly altered the Suisun Bay food web and these historical patterns  
26 (Kimmerer 2004; Jassby et al. 2002). Although turbidity remains high and  
27 limiting to primary productivity in Suisun Bay, there has been a long term trend  
28 toward increased water clarity. Suisun Bay has low retention time, low salinity  
29 (average of 5.8 ppt), low nutrients, and high particulate matter and light  
30 attenuation (Cloern and Jassby 2012).

31 **6.3.3.4.1 Salinity**

32 The Suisun Marsh Wetlands was placed on the 303(d) list approved by the  
33 USEPA in 2010 for impairment by salinity. The wetlands are also impaired by  
34 TDS and chlorides (SWRCB 2011a).

35 In an effort to protect the beneficial uses, including estuarine habitat, narrative  
36 and numeric objectives were specified by the SWRCB in Decision 1641. The  
37 CVP and SWP are operated to achieve salinity objectives in the Delta, as  
38 described in detail in Appendix 3A, No Action Alternative: Central Valley Project  
39 and State Water Project Operations.

40 The salinity objective in Suisun Bay, X2, which is the location, as measured in  
41 kilometers upstream from the Golden Gate bridge, of the 2 ppt isohaline (2.64

1 mS/cm) was established as part of the Water Quality Control Plan of 1995  
 2 (SWRCB 1995). X2 is a constantly fluctuating position in the continuum  
 3 between the Delta fresh water (salinity less than 2 ppt) upstream and San  
 4 Francisco Bay tidal influence, downstream (salinity greater than 2 ppt).

5 **6.3.3.4.2 Mercury**

6 Mercury is a constituent of concern for Suisun Bay and Suisun Marsh, which  
 7 were placed on the 303(d) list in 2010 (SWRCB 2011a). For the Suisun Bay, a  
 8 TMDL was specified in the San Francisco Bay Mercury TMDL (SFB RWQCB  
 9 2013), which was approved by the USEPA in February 2008 and the  
 10 implementation plan is expected to attain the water quality standard 20 years after  
 11 the approval. For the Suisun Marsh, a TMDL was specified in the Sacramento-  
 12 San Joaquin Delta Methylmercury TMDL (CVRWQCB 2010a) and was  
 13 completed in September 2012 (SFB RWQCB 2012a).

14 Water quality objectives for Suisun Bay are specified in the San Francisco Bay  
 15 Mercury TMDL (SFB RWQCB 2013). Suisun Marsh standards, as specified in  
 16 Suisun Marsh TMDL, are shown in Table 6.25 (SFB RWQCB 2012a). There are  
 17 future plans to adopt the Suisun Bay standards for the Suisun Marsh as well as  
 18 implementation plans to improve the water quality in Suisun Marsh.

19 **Table 6.25 Water Quality Objectives for Total Mercury in Suisun Marsh**

For the Protection of Marine and Freshwater Aquatic Life	4-day average (adverse effects from acute toxicity <sup>1</sup> )	0.25 µg/l
	1-hour average (adverse effects from chronic toxicity)	2.1 µg/l

20 Source: SFB RWQCB 2012a

21 1 Applicable to marine aquatic life, where salinity is greater than 10 parts per thousand.  
 22 The same objectives apply to freshwater aquatic life because the marine objective is  
 23 more stringent.

24 **6.3.3.4.3 Selenium**

25 Although the Suisun Marsh Wetlands is not identified as an impaired water body  
 26 for selenium contamination on the 303(d) list in 2010, selenium is identified as a  
 27 cause for impairment for the adjacent water body, Suisun Bay (SWRCB 2011a).

28 The impairment of Suisun Bay by selenium can be attributed to exotic species as  
 29 well as discharge from industrial point sources and natural sources (SWRCB  
 30 2011bd). *Corbula (Potamocorbula) amurensis*, a species of clam that is an  
 31 important food source for sturgeon and certain ducks, is a bioaccumulator for  
 32 selenium (Beckon and Maurer 2008). This exotic species was first discovered in  
 33 Suisun Bay in 1986 and became very common by 1990 from San Pablo Bay  
 34 through Suisun Bay (Cohen 2011). Industrial point sources, such as oil refineries,  
 35 discharge waste containing selenium to the Suisun Bay (SFB RWQCB 2011).

36 To best protect the most susceptible fish, white sturgeon, from selenium toxicity,  
 37 a TMDL for Selenium in the North San Francisco Bay, defined to include also a  
 38 portion of the Delta, Suisun Bay, Carquinez Strait, San Pablo Bay, and the Central

1 Bay, is being completed and a Preliminary Project Report was released in 2011  
2 (SFB RWQCB 2011). A range of concentrations for selenium in fish tissue from  
3 6.0 to 8.1 µg/g dry weight was proposed as a numeric target. This range is based  
4 on the minimal effects of selenium in whole-body freshwater fish and the  
5 10 percent effect level concentration.

#### 6 **6.3.3.4.4 Nutrients**

7 Suisun Marsh is a water body in the San Francisco Bay that was placed on the  
8 Section 303(d) list approved by USEPA in 2010 as impaired by nutrients  
9 (SWRCB 2011a).

10 According to the Final California 2010 Integrated Report (303(d) list/305(b)  
11 Report) Supporting Information, nutrients in Suisun Marsh can be attributed to  
12 flow regulation/modification and urban runoff/storm sewers (SWRCB 2011bc).  
13 More specific sources of nutrients to Suisun Marsh include agricultural, urban,  
14 and livestock grazing drainage through tributaries, the Sacramento River and San  
15 Joaquin River through the Sacramento-San Joaquin River Delta, nutrient  
16 exchange with Suisun Bay, atmospheric deposition, and discharge from the  
17 Fairfield Suisun Sewer District wastewater treatment plant (Tetra Tech Inc. and  
18 WWR 2013).

19 Concentrations of ammonia from 2000-2011, in the receiving waters from  
20 Boynton, Peytonia, Sheldrake and Chadbourne Sloughs (0-0.4 mg/l), as well as in  
21 Suisun Slough (0-0.3mg/l), exceeded the maximum water quality objective  
22 concentration for ammonia (Tetra Tech Inc. and WWR 2013). Elevated  
23 concentrations of chlorophyll-a, in comparison to concentrations at reference sites  
24 at Mallard, suggest possible impairments by nutrients. Other possible  
25 impairments of the narrative criteria by nutrients were suggested resulting in  
26 excess algal growth in wetlands, elevated organic carbon, and impacts on  
27 dissolved oxygen and mercury methylation.

#### 28 **6.3.3.4.5 Dissolved Oxygen**

29 Suisun Marsh Wetlands were placed on the 303(d) list approved by the USEPA in  
30 2010 for dissolved oxygen impairment (SWRCB 2011a). Insufficient dissolved  
31 oxygen can alter the well-being of the estuarine habitat, fish spawning, warm  
32 freshwater habitat, and wildlife habitat (SFB RWQCB 2013).

33 Flow regulation and modification, as well as urban runoff and storm sewers  
34 dictate the dissolved oxygen levels in the marsh (SWRCB 2011bc). Specific  
35 oxygen demanding sources that cause low dissolved oxygen levels are “grazed  
36 open areas, nutrient-enriched wastewater discharge from Fairfield-Suisun Sewer  
37 District, wastes from boats in Suisun City marina, and tidal marshes,” in addition  
38 to tides, delta outflow, agricultural drainage from surrounding watersheds and  
39 urban areas, and managed wetlands (Tetra Tech, Inc. and WWR 2013). Slough  
40 size and hydrology also influenced the low dissolved oxygen conditions in Suisun  
41 Marsh Wetlands (Siegel et al. 2010).

1 Low dissolved oxygen levels in exceedances of water quality objectives between  
 2 2000 and 2011 in Suisun Slough, Montezuma Slough, and Goodyear Slough are  
 3 presented in Table 6.26 (Tetra Tech, Inc. and WWR 2013).

4 **Table 6.26 Percentage of Observations Exceeding Water Quality Objectives for**  
 5 **Dissolved Oxygen**

Location	WQO Exceedances	
	7 mg/l	< 80% Saturation <sup>1</sup>
Suisun Slough	10 – 40%	2%
Montezuma Slough	< 10%	60 – 68%
Goodyear, Peytonia, and Boynton Sloughs	> 50%	73 – 94% <sup>2</sup>

6 Source: Tetra Tech, Inc. and WWR2013

7 <sup>1</sup> 3-month median above 80 percent dissolved oxygen saturation

8 <sup>2</sup> Lower Goodyear Slough exceeded the 3-month media above 80 percent dissolved  
 9 oxygen saturation 48.1 percent of the time

10 To further protect the beneficial uses of the Suisun Marsh Wetlands from low  
 11 dissolved oxygen concentrations, water quality objectives more representative of  
 12 natural conditions are currently being developed (Tetra Tech, Inc. and WWR  
 13 2013). A TMDL for Suisun Creek, a tributary of Suisun Marsh Wetlands that is  
 14 impaired by low dissolved oxygen, is expected to be completed in 2021 (SWRCB  
 15 2011bc).

16 **6.3.3.4.6 Organics**

17 Suisun Marsh was placed on the 303(d) list approved by USEPA in 2010 for  
 18 organic enrichment (SWRCB 2011a). Organic enrichment enhances microbial  
 19 production and activity, such as the methylation of mercury, and the  
 20 decomposition of organic matter can cause low dissolved oxygen levels (Tetra  
 21 Tech, Inc. and WWR 2013).

22 **6.3.3.4.7 Pesticides**

23 Suisun Bay, and other water bodies in the San Francisco Bay area including  
 24 Carquinez Strait and San Pablo Bay were placed on the Section 303(d) list for  
 25 pesticides (chlordane, DDT, dieldrin) contamination per the list approved by  
 26 USEPA in 2010 (SWRCB 2011a). However, according to the 2013 Regional  
 27 Monitoring Program Report, pesticides (chlordane, DDT, and dieldrin) in the  
 28 estuary are being considered for delisting (SFEI 2013).

29 A TMDL for the Diazinon and Pesticide-related Toxicity in Urban Creeks was  
 30 added as an amendment to the Basin Plan and was approved by the USEPA in  
 31 2007 (SFB RWQCB 2005).

1     **6.3.3.4.8   PCBs**

2     Suisun Bay, and several other water bodies within San Francisco Bay area  
3     including Carquinez Strait and San Pablo Bay, were placed on the Section 303(d)  
4     list for the contamination of PCBs per the list approved by USEPA in 2010  
5     (SWRCB 2011a). The following is applicable to all water bodies specified in the  
6     San Francisco Bay PCBs TMDL, including Suisun Bay, Carquinez Strait, and San  
7     Pablo Bay (SFB RWQCB 2013).

8     A TMDL was approved by the USEPA in 2010. The TMDL allows 10 kilograms  
9     of PCBs to be discharged to San Francisco Bay per year (SFB RWQCB 2013). It  
10    is projected that this load allocation will be achieved in 20 years with  
11    implementation of plans and actions for external and internal sources, such as  
12    municipal and industrial dischargers, as stated in the San Francisco Bay TMDL.

13    **6.3.3.4.9   Other Constituents of Concern**

14    Suisun Bay was placed on the Section 303(d) list for invasive species  
15    contamination per the list approved by USEPA in 2010 (SWRCB 2011a).

16    Invasive species in Suisun Bay can be attributed to ballast water, fresh or salt  
17    water placed on a ship for stability (SWRCB 2011bd). *Corbula (Potamocorbula)*  
18    *amurensis*, a native clam of southern China estuaries, was discovered in Suisun  
19    Bay in 1986 and was introduced to San Pablo Bay shortly after (USFWS and  
20    NSGCP 1995). This species of clam is important as a food source for sturgeon,  
21    diving ducks, etc. and consequently a bioaccumulator of selenium (USFWS  
22    2008). Other species introduced to the Suisun Bay are reported in the  
23    *Nonindigenous Aquatic Species in a United States Estuary: A Case Study of the*  
24    *Biological Invasions of the San Francisco Bay and Delta* (USFWS and NSGCP  
25    1995).

26    Invasive species can affect the beneficial uses of Suisun Bay, as listed in Table  
27    6.2, including estuarine habitat. For the protection of marine aquatic life, a  
28    TMDL is expected to be completed in 2019.

29    Other contaminants in the Suisun Bay include furan compounds and dioxin  
30    compounds. These contaminants were placed on Section 303(d) list per the list  
31    approved by USEPA in 2010 (SWRCB 2011bd).

32    **6.3.4       Delta Water Quality Issues for CVP and SWP Water Users**

33    The designated beneficial uses and constituents of concern for the study area and  
34    for each RWQCB region are described in Section 6.3.1, Beneficial Uses of  
35    Surface Waters in the Study Area. In this section, the beneficial uses of water  
36    from the Delta are generalized and categorized by purpose of use into those  
37    associated with municipal and industrial, agricultural, groundwater recharge, and  
38    recycling and blending uses.

39    **6.3.4.1     Municipal and Industrial Uses**

40    The Delta is a source of drinking water supply to over 25 million people, or sixty  
41    percent of the state population. The CVP and SWP water users that use water  
42    from the Delta as a source of potable water supply for municipal and industrial

1 uses have two main water quality concerns: protection, preservation, and  
2 improvement of source water quality; and capability of treatment processes to  
3 meet stringent drinking water quality regulatory requirements. To protect public  
4 health and safety, water providers apply a multi-barrier approach: seek the highest  
5 quality source water available, protect and preserve the source water quality to  
6 ensure non-degradation, operate and periodically upgrade drinking water  
7 treatment processes, and maintain safe distribution systems.

8 The Delta, as a drinking water source, is compromised by high levels of naturally  
9 occurring and manmade constituents of concern. Some of the naturally occurring  
10 constituents, such as organic carbon and nutrients, are necessary components of  
11 the Delta ecosystem. Salinity, another natural constituent, is inherent with the  
12 tidal cycles of the estuary. Other anthropogenic constituents such as pathogens  
13 and contaminants are results of point and non-point source discharges into the  
14 Delta.

15 Water containing organic carbon reacts with chlorine, commonly used as a  
16 disinfectant in drinking water treatment processes, to form disinfection  
17 byproducts (DBP) such as trihalomethanes and haloacetic acids. Delta waters  
18 contain high levels of both dissolved organic compounds and bromide, increasing  
19 the formation of DBP. Use of chloramines for disinfection would reduce the  
20 production of DBP, but chloramination can lead to the formation of carcinogenic  
21 N-nitrosamines, including N-nitrosodimethylamine (NDMA). These interactions  
22 complicate the design of drinking water treatment processes and create the  
23 necessity to balance and trade off disinfection effectiveness with DBP creation.  
24 Balance and tradeoffs are also necessary between source water quality protection  
25 and ecosystem restoration actions that could increase the levels of organic carbon.

26 The Water Quality Control Plan for the Sacramento River and San Joaquin River  
27 Basins (Basin Plan) designated drinking water municipal and domestic supply  
28 beneficial use for most waters in the Central Valley, including the Delta. It  
29 includes narrative objectives for chemical constituents, taste and odor, sediment,  
30 suspended material, and toxicity, and numeric objectives for chemical  
31 constituents and salinity. The Basin Plan incorporates by reference the primary  
32 and secondary maximum contaminant levels specified in Title 22 of the California  
33 Code of Regulations for waters designated for municipal uses.

34 Through the triennial review process, stakeholders prioritized the need for a  
35 drinking water policy and identified a number of drinking water constituents of  
36 concern including: salt (including bromide), nutrients, organic carbon and  
37 pathogens such as *Cryptosporidium* and *Giardia*.

38 In 2013, the Central Valley RWQCB adopted Resolution No. R5-2013-0098, an  
39 amendment to the Basin Plan to establish a drinking water policy for surface  
40 waters of the Delta and its upstream tributaries. The amendment was approved by  
41 the SWRCB in the same year, and approved by the Office of Administrative Law  
42 and US EPA in 2014.

43 The Amendment modifies the water quality objectives of the Basin Plan to add a  
44 narrative water quality objective for *Cryptosporidium* and *Giardia*, and clarifies

1 that existing narrative objective for chemical constituents includes drinking water  
2 chemical constituents of concern, such as organic carbon. The Amendment also  
3 establishes a Drinking Water Policy to maintain high quality of water, anti-  
4 degradation, application of water quality objectives, implementation of toxics  
5 standards for inland surface waters, enclosed bays, and estuaries, and continued  
6 coordinated monitoring, assessment, and reporting of identified drinking water  
7 constituents of concern.

#### 8 **6.3.4.1.1 Organic Carbon**

9 Delta water is high in dissolved and suspended organic carbon, due to the high  
10 peat soil composition and estuarine environment. Organic carbon combines with  
11 disinfectants in drinking water treatment processes to produce DBP that are  
12 harmful to human health. In a 1998 study and a 2003 update, expert panels for  
13 the California Urban Water Agencies recommended that TOC in the Delta source  
14 water should not exceed 3.0 mg/L, in order for Delta-dependent water agencies to  
15 be able to meet treated drinking water regulatory requirements. This  
16 recommendation was based on an analysis of the various existing and planned  
17 treatment processes, residual (distribution systems) disinfection requirements, as  
18 well as the interaction among TOC and other DBP precursors.

19 In the 2013-14 Basin Plan amendment, indicates that the state waters shall not  
20 contain chemical constituents in concentrations that adversely affect beneficial  
21 uses, and that this includes drinking water chemical constituents of concern, such  
22 as organic carbon.

#### 23 **6.3.4.1.2 Bromide and Other Disinfection By-product (DBP) Precursors**

24 Bromide is a naturally occurring constituent in waters subjected to tidal influences  
25 such as the Delta. It reacts with ozone, a disinfectant often used for inactivation  
26 or removal of *Cryptosporidium* and for controlling taste and odor issues, to form  
27 bromate which is a regulated DBP for its cancer-causing potential. The  
28 combination of TOC and bromide in Delta waters poses an especially challenging  
29 scenario for treatment processes in balancing the need for microbiological  
30 removal and minimizing the formation of organically-based brominated DBP.  
31 The 1998/2003 expert panels for California Urban Water Agencies recommended  
32 that bromide levels should not exceed 50 µg/L in order for Delta-dependent water  
33 agencies to be able to meet treated water regulatory requirements.

#### 34 **6.3.4.1.3 Nutrients and Other Discharges**

35 Municipal discharges and agricultural return flows into the Sacramento and San  
36 Joaquin river watersheds and the Delta contribute pollutants and constituents of  
37 concern that could potentially degrade water quality.

38 Nutrients such as nitrogen and phosphorus originate from natural sources and  
39 from anthropogenic sources including point and non-point source discharges.  
40 Although nutrients are necessary for a healthy ecosystem, over enrichment of  
41 nitrogen and phosphorus can contribute to eutrophication and toxicity.  
42 Eutrophication also results in elevated levels of TOC, a DBP precursor.



1 In August 2015, USEPA published revisions to the federal Water Quality  
 2 Standards Regulations required the state to develop implementation methods to  
 3 conduct analyses if ongoing or future projects would degrade high quality waters.  
 4 The regulations require analysis of a range of non-degrading or less-degrading  
 5 alternatives and make a finding that degradation is necessary to accommodate  
 6 important social or economic development in the area where the waters are  
 7 located.

8 The SWRCB's Policy with Respect to Maintaining High Quality of Water in  
 9 California (Resolution No. 68-16) incorporates the federal antidegradation policy  
 10 and restricts reductions in water quality even if beneficial uses are protected. The  
 11 Drinking Water Policy in the 2013-14 Basin Plan amendment stated that drinking  
 12 water constituents of concern shall continue to be considered when waste  
 13 discharge facilities conduct antidegradation analyses. The 2013-14 Drinking  
 14 Water Policy also requires the RWQCBs to consider the necessity for inclusion of  
 15 monitoring of organic carbon, salinity, and nutrients for waste discharge permit  
 16 renewals if the facilities are located near drinking water intakes, if a concentration  
 17 load has significantly increased, and the importance of the data submitted by the  
 18 discharger to management decisions to protect drinking water.

#### 19 **6.3.4.1.4 Pathogens and Emerging Contaminants**

20 Point and non-point source discharges into Delta waters have the potential to  
 21 introduce and elevate the levels of pathogens and other contaminants.  
 22 *Cryptosporidium* and *Giardia* are two main pathogens of concern that are the  
 23 focus of drinking water regulatory requirements promulgated by USEPA. In  
 24 addition, other contaminants of emerging concern, particularly pharmaceuticals  
 25 and personal care products, have been widely distributed and persistent in the  
 26 environment. These chemicals bio-accumulate and cause endocrine disruption.

27 The 2013-14 Basin Plan amendment includes a narrative water quality objective  
 28 for *Cryptosporidium* and *Giardia* within the Sacramento-San Joaquin Delta and  
 29 its tributaries below the first major dams. Compliance with this objective will be  
 30 assessed at existing and new public water system intakes to maintain existing  
 31 levels of pathogens at public water system intakes.

32 The Basin Plan amendment also includes support of a one-time special study to  
 33 characterize ambient levels of *Cryptosporidium*, to better understand the  
 34 relationship between source loading and ambient *Cryptosporidium* concentrations,  
 35 and to better understand the movement of *Cryptosporidium* through the system.

#### 36 **6.3.4.1.5 Salinity and TDS**

37 Salinity is commonly measured in units of EC or TDS. Salinity standards, in the  
 38 form of chloride objectives, have been established in the Basin Plan to protect the  
 39 various beneficial uses. The most restrictive is the 150 mg/L chloride objective  
 40 for Contra Costa Canal and the City of Antioch intake. The objective was  
 41 originally established to protect an industrial manufacturing facility that has since  
 42 closed. In terms of drinking water, bromide is the most critical component of  
 43 salinity that impacts drinking water treatment processes. No standards have been

1 set for bromide, although there is a MCL for the disinfection byproduct bromate.  
2 Secondary MCLs for TDS (500 mg/L), chloride (250 mg/L), and sulfate (250  
3 mg/L) have been set to address cosmetic or aesthetic effects such as staining,  
4 mineral deposits, taste, odor, and color. The CV-SALTS Executive Committee is  
5 currently considering potential revisions to water quality objectives for secondary  
6 MCL, as part of the developing Salt and Nitrate Management Plan for the Central  
7 Valley.

8 Salinity also affects non-potable uses such as industrial processes, irrigation,  
9 groundwater recharge, and recycling. High salinity waters may render them  
10 infeasible for certain industrial processes, or reduce the efficiency by reducing the  
11 number of recirculation cycles. Impacts of salinity on irrigation, groundwater  
12 recharge, and recycling are discussed in the following subsections.

13 Changes in operation of the CVP and SWP could exacerbate salinity and bromide  
14 problems, through changes in allowable export pumping windows during the year  
15 and for different year types, as well as the operation of the Delta Cross-Channel  
16 gates, as described in Appendix 3A, No Action Alternative: Central Valley  
17 Project and State Water Project Operations.

#### 18 **6.3.4.2 Agricultural Uses**

19 The main water quality issues related to agricultural use of Delta exported  
20 supplies are salinity and drainage, as discussed in the following subsections.

##### 21 **6.3.4.2.1 Salinity, Sodium, and Toxicity**

22 Delta waters are high in salinity due to tidal influence and upstream discharges.  
23 High salinity in irrigation water inhibits water and nutrients intake by plants,  
24 resulting in yield reduction. Saline conditions could be a result of high salinity  
25 source water used for direct irrigation, or saline soil water due to saline water  
26 accumulation and poor drainage. Plant uptake of water through osmo-regulation  
27 is restricted when the soil water salinity is greater than the internal salinity of the  
28 plant. Water with a TDS above 1,500 to 2,600 mg/L (EC greater than 2.25 to 4  
29 mmho/cm) is generally considered problematic for irrigation use on crops with  
30 low or medium salt tolerance.

31 Irrigation water containing high levels of sodium is of special concern because of  
32 its potential to create a sodium hazard in the soil. Sodium hazard, expressed as  
33 sodium adsorption ratio, is the phenomenon when sodium is adsorbed and  
34 becomes attached to soil particles, rendering the soil hard and compact when dry  
35 and increasingly impervious to water penetration. Fine textured soils high in clay  
36 content are most vulnerable to the sodium hazard.

37 High salinity in irrigation water could also result in plant toxicity due to  
38 accumulation of ions in the leaves. The most common ions which cause toxicity  
39 are chloride, sodium, and boron. Boron is particularly troublesome because  
40 toxicity can occur in very low concentrations, despite the fact that boron is an  
41 essential plant nutrient. Boron can also accumulate in the soil.

1 Sulfate salts affect sensitive crops by limiting the uptake of calcium and  
2 increasing the adsorption of sodium and potassium, upsetting the cationic balance  
3 within the plant. High concentrations of potassium may introduce a magnesium  
4 deficiency and iron chlorosis.

5 Different crops have different toleration for salinity, with forage crops being the  
6 most resistant and fruit crops being the most sensitive. Crops are also most  
7 sensitive to salinity during seed germination, and more tolerant during later  
8 growth stages. Changes in salinity of Delta waters due to seasonal fluctuations or  
9 different year types may affect crops, depending on the timing within the growth  
10 cycle. To protect salt sensitive crops during the irrigation season, the EC overall  
11 objectives in the San Joaquin River and the interior southern Delta are generally  
12 at 0.7 mS/cm (700  $\mu$ S/cm) during the irrigation season (April to August) and at  
13 1.0 mS/cm for the remainder of the year.

14 Generally, salinity in groundwater is higher than surface water in the San Joaquin  
15 Valley. Changing from irrigating with surface water to groundwater, due to  
16 shortages of CVP and/or SWP water supplies, could exacerbate salinity issues.

#### 17 **6.3.4.2.2 Agricultural Drainage**

18 The Central Valley RWQCB initiated the Irrigated Lands Regulatory Program  
19 (ILRP) in 2003 to prevent agricultural runoff containing pesticides, fertilizers,  
20 salts, pathogens, and sediment from impairing surface waters. Waste discharge  
21 requirements were subsequently developed and adopted to address irrigated  
22 agricultural discharges throughout the Central Valley, in order to protect both  
23 surface water and groundwater for all beneficial uses. The waste discharge  
24 requirements replaced pre-2003 waivers and previous interim regulatory  
25 requirements under a Conditional Waiver of Waste Discharge Requirements. All  
26 commercial irrigated lands, including nurseries and managed wetlands, are  
27 required to obtain regulatory coverage by joining a coalition group, or obtaining  
28 coverage as an individual grower under general waste discharge requirements, or  
29 obtaining an individual permit.

30 The recently adopted waste discharge requirements have been expanded to  
31 include discharges to groundwater, in order to address the critical need to protect  
32 this drinking water source from contaminants such as nitrate that are associated  
33 with fertilizer application. The waste discharge requirements are tailored to  
34 known threats to water quality and specific geographic areas or commodities.

35 According to the Central Valley RWQCB, there are about 35,000 growers in the  
36 Central Valley and nearly 5 million acres of land that are part of water quality  
37 coalition groups. The coalition groups conduct water quality monitoring and  
38 analysis, perform vulnerability assessments, prepare regional plans to address  
39 water quality problems, determine the effectiveness of management actions, and  
40 perform education and outreach to growers. Coalitions are required to prepare  
41 Water Quality Management Plans anytime water quality objectives have been  
42 exceeded more than once in three years. The growers are required to implement  
43 management practices to protect surface and groundwater, especially in areas  
44 where monitoring has identified problems associated with irrigated agriculture

1 such as the pesticides chlorpyrifos and diazinon, indicators of pathogens such as  
2 *e. coli*, or nitrates. Growers are required to conduct farm evaluations to determine  
3 the effectiveness of farm practices in protecting water quality. Nutrient  
4 management is a key element for all growers. A certified nitrogen management  
5 plan is required for growers in areas where groundwater is known to be severely  
6 impacted by nitrates, pesticides or other constituents associated with agriculture.

#### 7 **6.3.4.3 Groundwater Recharge Uses**

8 In addition to direct use for municipal, industrial, and agricultural purposes, some  
9 of the CVP and SWP water from the Delta is used for groundwater recharge  
10 purposes through direct application or indirect potable recharge by blending with  
11 recycled water. The quality of the applied water could affect hydrogeological  
12 properties of the aquifer, or impair the quality of groundwater for subsequent use.

13 Hydrogeological properties of the aquifer could be affected by precipitation  
14 reactions between the recharge water and native soil material or groundwater,  
15 causing mechanical blockage of aquifer pores. Ion exchange reactions could  
16 adversely affect the shrink/swell properties of some clays present in an aquifer.  
17 Sodium adsorption is particularly of concern due to the high salinity of Delta  
18 water.

19 Chemical and microbial contaminants in the recharge water could build up in the  
20 aquifer and impair the subsequent use of the groundwater. Secondarily treated  
21 domestic wastewaters and many industrial wastewaters, urban stormwater  
22 drainage, agricultural and rural stormwater runoff, and irrigation return waters  
23 contain high concentrations of a wide variety of inorganic and organic, dissolved,  
24 particulate, and colloidal contaminants that can adversely impact groundwater and  
25 aquifer quality. Nonconventional and emergent contaminants in pharmaceuticals  
26 and body care products may not have been removed through conventional  
27 secondary treatment. Furthermore, chloramination of wastewater effluents  
28 especially during water reuse processes could create NDMA, a known carcinogen.  
29 For some CVP and SWP water users, the CVP and/or SWP water supplies are  
30 used to dilute some of these potential contaminants to protect groundwater  
31 quality.

#### 32 **6.3.4.4 Water Recycling Use**

33 Salinity in Delta waters reduces the utility of the water for reuse or blending  
34 purposes by CVP and SWP water users. A higher salinity source water  
35 exacerbates the increase in salinity from use and reuse, reducing the applicability  
36 of the recycled water for non-potable purposes such as landscape and agricultural  
37 irrigation or industrial cooling and reuse. Residential use of water could add 200  
38 to 300 mg/L of TDS to the wastewater stream. Conventional wastewater  
39 treatment processes are designed to remove suspended solids but not dissolved  
40 solids. Depending on the TDS levels of the source water, the TDS levels in  
41 recycled water could reach beyond the threshold of market acceptance for  
42 irrigation. TDS removal or demineralization would require an advanced  
43 treatment process and add to the cost of recycling.

#### 1 **6.3.4.5 Blending Use**

2 Some SWP water users in Southern California rely on Delta water exported from  
3 the SWP to blend with the higher TDS water from the Colorado River. Water  
4 imported through the Colorado River Aqueduct has an average TDS of 650 mg/L,  
5 and has exceeded 900 mg/L during drought events. Delta water imported through  
6 the SWP has a lower TDS by comparison, with an average TDS of 250 to 325  
7 mg/L. The real time TDS levels fluctuate significantly due to variations in  
8 hydrology, tidal cycles, and project operations. Article 19 of the SWP long-term  
9 water supply contracts contains a water quality objective for TDS of below 440  
10 ppm for monthly averages, and below 220 ppm for 10-year averages. These  
11 objectives were set in the 1960s when SWP deliveries were thought to be more  
12 assured. Metropolitan Water District of Southern California has used these SWP  
13 delivered water quality objectives to set a salinity-by-blending objective of 500  
14 mg/L for its blended supply. Reduced SWP deliveries would pose challenges in  
15 meeting this blending objective.

#### 16 **6.3.4.6 San Luis Reservoir Low-Point Issues**

17 As described in Chapter 5, Surface Water Resources and Water Supplies, the San  
18 Luis Reservoir provides off-stream storage for CVP water used by Santa Clara  
19 Valley Water District and San Benito County Water District. These districts  
20 withdraw their CVP supplies from the Upper Pacheco Intake at the San Luis  
21 Reservoir. This supply is at risk when water elevations in San Luis Reservoir  
22 reach very low levels during late summer and early fall. High temperatures  
23 combined with low water levels foster algae growth to as much as 35 feet thick on  
24 the water surface. Algae captured in the intake and conveyed to the CVP water  
25 users is not suitable for municipal water treatment or agricultural drip irrigation  
26 systems. As water levels continue to drop below the level of the intake, water  
27 supply to these CVP water users ceases.

28 The Santa Clara Valley Water District has partnered with Reclamation and the  
29 San Luis and Delta-Mendota Water Authority to complete the San Luis Low Point  
30 Improvement Project. The project purpose is to identify a feasible alternative that  
31 will address the uncertainty of CVP delivery schedules and the water supply  
32 reliability problems associated with the low-point issues.

#### 33 **6.3.5 Drought Impacts on Water Quality**

34 California is currently in the fourth consecutive year of a severe drought, with  
35 precipitation way below average and record high temperatures. The availability  
36 of water supplies throughout the state have declined substantially as described in  
37 Section 5.3.4, Surface Water Resources and Water Supplies during Droughts. In  
38 addition, there are chronic and significant shortages in supplies and historically  
39 low groundwater levels, as described in Chapter 7, Groundwater Resources and  
40 Groundwater Quality. Drought conditions affect many Delta water quality  
41 constituents, including changes in temperatures and dissolved oxygen conditions  
42 in the lower San Joaquin River, temperature in the Sacramento River, and salinity  
43 in the Delta.

1     **6.3.5.1     Water Quality Conditions in the Lower San Joaquin River**

2     The San Joaquin River watershed in particular has experienced severely dry  
3     conditions, with water year 2012 classified as dry and water years 2013-2015  
4     classified as critically dry. Lack of precipitation has resulted in historically low  
5     reservoir storage levels, creating significant concerns about low flows, high  
6     temperatures, low dissolved oxygen conditions and other factors that have  
7     significant effects on steelhead and fall-run Chinook Salmon.

8     As described in Section 5.3.4, Surface Water Resources and Water Supplies  
9     during Droughts, Reclamation and DWR filed a Temporary Urgency Change  
10    Petition (TUCP) with the SWRCB on January 23, 2015, seeking to make changes  
11    to their water right permits and license for the CVP and SWP. The TUCP sought  
12    changes to D-1641 requirements on flow-dependent and operational water quality  
13    objectives. The TUCP was approved in part on February 3, 2015, subject to  
14    conditions, and modified on March 5, 2015 and April 6, 2015. Reclamation  
15    submitted a request on May 21, 2015 to modify and renew the TUCP Order,  
16    which was approved on July 3, 2015 and modified on August 4, 2015 with  
17    changes effective through November 30, 2015.

18    The August 4, 2015 Order conditionally approved a change to Reclamation's  
19    water rights to modify the Stanislaus River dissolved oxygen requirement from  
20    7.0 mg/L to 5.0 mg/L at and below Ripon on the Stanislaus River. It also  
21    included other conditions, including the development, coordinated  
22    implementation, evaluation, and update of operations plans that would affect  
23    flows, temperatures and dissolved oxygen conditions, to ensure that the change  
24    can be made without unreasonable effects on fish, wildlife, or other instream  
25    beneficial uses, and to ensure that the change is in the public interest.

26    **6.3.5.2     Temperature Conditions in the Lower San Joaquin River**

27    Reclamation files an annual Sacramento River Temperature Management Plan to  
28    guide the release of water from Shasta Lake in order to maintain downstream  
29    water temperatures to protect the fisheries during the higher temperature months  
30    of summer and fall. In 2014, temperature targets were not achieved in the upper  
31    reaches of the Sacramento River late in the fall, despite Reclamation's efforts.

32    In early 2015, Reclamation developed a release plan in conjunction with DWR,  
33    USFWS, NMFS, CDFW, SWRCB, and others to meet the CVP authorized  
34    purposes and regulatory requirements to the extent possible. The plan was  
35    submitted and provisionally approved by the SWRCB on May 14, 2015. On May  
36    29, 2015, Reclamation informed the SWRCB that the proposed temperature target  
37    will unlikely be met, due to faulty equipment used to obtain temperature data for  
38    modeling. The SWRCB suspended the plan in June while Reclamation developed  
39    and submitted a revised Temperature Plan on June 25, 2015. On July 1, 2015,  
40    NMFS provided conditional concurrence with the revised plan. On July 7, 2015,  
41    the SWRCB conditionally approved the June 25, 2015 plan, placing numerous  
42    monitoring, consultation, and update requirements on Reclamation, as well as  
43    correlating the Temperature Plan with conditions in the July 3, 2015 approved  
44    TUCP filed by Reclamation and DWR.

### 1 **6.3.5.3 Delta Salinity Conditions**

2 As described in Section 5.3.4, Surface Water Resources and Water Supplies  
3 during Droughts, in early 2015, as a result of very low precipitation and  
4 diminished reservoir storage, DWR planned and installed an emergency drought  
5 barrier on West False River in the Delta to help repel salt water intrusion into the  
6 central Delta and to minimize the amount of upstream reservoir releases. The  
7 barrier installation was completed in early June. Removal began on September 8,  
8 2015 and must be completed by mid-November to provide capacity for wet  
9 weather flows in the winter season and to comply with fisheries protection  
10 requirements.

11 In June and July 2015, some of the salinity objectives were not met, despite the  
12 drought barrier and other project operations to mitigate for the effects of the  
13 severe drought. Exceedances were reported by Reclamation and DWR at: the  
14 South Delta agricultural objective at San Joaquin River near Brandt Bridge  
15 compliance station, the two western Delta agricultural objectives of 14-day  
16 running average EC values at Sacramento River at Three Mile Slough and San  
17 Joaquin River at Jersey Point, and the 30-day running average EC value at Old  
18 River near Middle River.

19 Salinity in CVP and SWP water supplies has increased since the onset of the  
20 drought.

### 21 **6.3.5.4 Municipal and Industrial Water Users Responses to Drought-** 22 **related Water Quality Impacts**

23 With low surface water runoff, increased temperature, and concentrated nutrient  
24 levels due to the drought, algae growth in surface water proliferated, leading to  
25 increased turbidity, taste and odor issues, as well as increased potential for algal  
26 cyanotoxins from the blue-green algae, *Microcystis*. Urban water agencies that  
27 have alternative supply sources use blending, coupled with changes in treatment  
28 processes such as increased use of ozone, to address the taste and odor issues.  
29 Some of the larger urban agencies are participating in studies to investigate  
30 alternative treatment processes to address algal toxin issues. Other studies raised  
31 concern with respect to changes in pH due to low flows and their effects on  
32 toxicity and bioaccumulation of ionizable contaminants. The Metropolitan Water  
33 District of Southern California announced plans to apply copper sulfate to treat  
34 algae at Lake Skinner, Lake Mathews, and Diamond Valley Lake in accordance  
35 with its NPDES permit.

36 Many urban water agencies accelerated their investments in recycled water  
37 development during the current drought. Most notably, a lot of these investments  
38 are focused on advanced treatment processes for indirect, as well as direct,  
39 potable reuse. For example, the Santa Clara Valley Water District began  
40 operations of the 8 million gallon/day Silicon Valley Advanced Water  
41 Purification Center in 2014, to test and demonstrate its advanced treatment  
42 processes in producing highly purified recycled water that meets drinking water  
43 standards. Advanced treated recycled water has historically been used to blend  
44 with tertiary-treated recycled water to reduce the level of total dissolved solids for

1 expanded industrial and irrigation use, thereby offsetting potable demand during  
 2 droughts.

### 3 **6.4 Impact Analysis**

4 This section describes the potential mechanisms and analytical methods for  
 5 change in surface water quality; results of the impact analysis; potential  
 6 mitigation measures; and cumulative effects.

#### 7 **6.4.1 Potential Mechanisms for Change and Analytical Methods**

8 As described in Chapter 4, Approach to Environmental Analysis, the impact  
 9 analysis considers changes in surface water quality conditions related to changes  
 10 in CVP and SWP operations under the alternatives as compared to the No Action  
 11 Alternative and Second Basis of Comparison.

12 Changes in CVP and SWP operations under the alternatives as compared to the  
 13 No Action Alternative and Second Basis of Comparison could result in changes to  
 14 surface water quality due to changes in river flows and surface water deliveries.  
 15 Based on the discussion above, the following water quality changes are further  
 16 analyzed in the Evaluation of Alternatives section.

17 As described in Section 6.3 Affected Environment, there are numerous  
 18 constituents of concern that have been identified in the study area. These  
 19 components are not all critical in each region and may not be all affected by  
 20 changes in CVP and SWP operations considered in the alternatives of this EIS.  
 21 The groups of constituents that could be affected by implementation of the  
 22 alternatives has been identified through consideration of constituents of concern  
 23 described in Section 6.3, Affected Environment, and the anticipated  
 24 implementation of TMDLs by 2030. These constituents were grouped into major  
 25 categories, as shown in Table 6.27. The constituents that already have approved  
 26 TMDLs in certain regions are not further analyzed for those regions, as it is  
 27 expected that the TMDL will be implemented by 2030. A complete list of  
 28 TMDLs and the anticipated completion dates is provided in Table 6.1.

29 **Table 6.27 List of Surface Water Quality Constituents Considered for this Analysis**

<b>Constituent/Parameter Group</b>	<b>Individual Constituents/Parameters</b>
Water Temperature	Water Temperature
Salinity Indicators	EC, TDS, Chloride, Bromide, Delta X2
Nutrients	Nitrate, phosphorus
Mercury	Mercury, methylmercury
Selenium	Selenium
Dissolved Oxygen	Dissolved Oxygen
Other Constituents	Pesticides, PCBs, DOC/TOC, Boron, Trace Metals, Pathogens, TSS, Turbidity, Unknown Toxicity



1 Each constituent group is further discussed below, to determine whether changes  
2 would occur due to implementation of the alternatives.

### 3 **6.4.1.1 Changes in Water Temperature**

4 Changes in CVP and SWP operations would change water temperatures in rivers  
5 downstream of CVP and SWP reservoirs. Changes in water temperatures are  
6 presented in Appendix 6B, Surface Water Temperature Modeling. However, the  
7 effects of change in temperature are related to the changes on aquatic habitat.  
8 Therefore, analysis of changes in temperature is presented in Chapter 9, Fish and  
9 Aquatic Resources.

### 10 **6.4.1.2 Changes in Salinity**

11 Changes in salinity due to changes in CVP and SWP operations would be focused  
12 in the Delta. Salinity indicators generally considered in this analysis include  
13 electrical conductivity, total dissolved solids, chloride, bromide, and X2.

14 The DSM2, a one-dimensional hydrodynamic and water quality simulation  
15 model, is used to evaluate changes in salinity (as represented by EC) in the Delta  
16 and at the CVP/SWP export locations. CalSim II outputs are used to evaluate  
17 changes in location of X2 in the Delta.

### 18 **6.4.1.3 Changes in Mercury/Methylmercury Concentrations**

19 Changes in CVP and SWP operations under the alternatives could affect mercury  
20 concentrations in the Delta and Suisun Marsh. The changes in CVP and SWP  
21 operations would not affect mercury concentrations in the tributaries to the  
22 Sacramento and San Joaquin rivers.

23 A modeling framework is used to evaluate changes in methylmercury  
24 concentrations in the Delta reaches and qualitatively estimate mercury  
25 concentration changes at the San Luis Reservoir and O'Neill Forebay.

26 The methylmercury impacts analysis uses CalSim II, DSM2, and the Central  
27 Valley Regional Water Quality Control Board Total Maximum Daily Load model  
28 (RWQCB model) to assess and quantify effects of the alternatives on the long-  
29 term operations and the environment, as described in Appendix 6C,  
30 Methylmercury Model Documentation.

31 The QUAL module of DSM2 is used to simulate source water finger printing  
32 which can determine the relative contributions of water sources to the volume at  
33 any specified location. DSM2 water quality and volumetric fingerprinting results  
34 are used to assess changes in concentration of methylmercury in Delta waters.  
35 CalSim II, DSM2 (water), and the RWQCB model (fish tissue) are used in  
36 sequence to estimate the effects of CVP and SWP operations on water and fish  
37 tissue quality in the Delta.

### 38 **6.4.1.4 Changes in Selenium Concentrations**

39 Changes in CVP and SWP operations under the alternatives could affect selenium  
40 concentrations in the San Joaquin River, Delta, and Suisun Marsh. Selenium also

1 is of a concern in the Southern California Region because the use of water  
2 supplies from both the Delta and the Colorado River.

3 A suite of modeling tools is used to evaluate changes in selenium concentrations  
4 in the Delta reaches and in the San Francisco Bay, based on the western Delta  
5 model outputs. The selenium impacts analysis uses CalSim II, DSM2, and Delta-  
6 specific selenium bioaccumulation modeling to assess and quantify effects of the  
7 alternatives on the long-term operations and the environment. Appendix 6D,  
8 Selenium Model Documentation, provides information about the development  
9 and calibration of a Delta-wide bioaccumulation model for selenium in fish, use  
10 of outputs from that model to estimate bioaccumulation in bird eggs and fish  
11 fillets, and modeling of selenium bioaccumulation in sturgeon living in the  
12 western Delta using inputs from other models. Modeling assumptions for the  
13 selenium analysis are also provided in that appendix.

14 The selenium impact analysis focuses on evaluation of changes to selenium  
15 concentrations in tissues that affect the health of fish as well as wildlife and  
16 humans consuming fish in the Delta.

17 CalSim II, DSM2, and bioaccumulation modeling are used in sequence to  
18 estimate the effects of CVP and SWP operations on water quality relative to  
19 selenium in the Delta. The DSM2-QUAL module simulates one-dimensional  
20 source tracking in the Delta. Results from DSM2 are multiplied by source  
21 concentrations to determine annual average waterborne selenium concentrations  
22 in the Delta for all year types. Output from the DSM2-QUAL model (expressed  
23 as percent inflow from different sources) is used in combination with the available  
24 measured waterborne selenium concentrations to model concentrations of  
25 selenium at locations throughout the Delta. These modeled waterborne selenium  
26 concentrations are used in the relationship model to estimate bioaccumulation of  
27 selenium in whole-body fish and in bird eggs.

#### 28 **6.4.1.5 Changes in Nutrient Concentrations**

29 Nutrients generally considered in this analysis include nitrate and phosphorus.  
30 The two main anthropogenic sources of these constituents are urban point sources  
31 (wastewater effluent), and agricultural non-point sources (agricultural runoff and  
32 return flows of fertilizers mixed in irrigation water). By 2030, wastewater  
33 treatment plants that discharge into the Sacramento and San Joaquin rivers  
34 watersheds and the Delta that are currently implementing nutrient removal  
35 projects will have completed those projects. Agricultural non-point source  
36 discharges are regulated under the Long-Term Irrigated Lands Regulatory  
37 Program (ILRP) Waste Discharge Requirements, which mandate monitoring of  
38 nutrients in the major agricultural reaches and the implementation of Best  
39 Management Practices to reduce nutrient discharges to streams, and controlling  
40 fertilizer application and management. Since nutrient loadings would be managed  
41 through regulatory processes by 2030, it is anticipated that nutrient conditions  
42 would be similar under the No Action Alternative, Alternatives 1 through 5, and  
43 the Second Basis of Comparison. Therefore, changes in nutrients are not  
44 evaluated in this EIS.

1     **6.4.1.6     Changes in Dissolved Oxygen Concentrations**

2     Dissolved oxygen has been found to be a parameter of concern primarily in the  
3     lower Klamath River, Sacramento-San Joaquin River Delta, and the Suisun  
4     Marsh. By 2030, it is anticipated that TMDLs would be implemented to address  
5     the dissolved oxygen issues. Since dissolved oxygen conditions would be  
6     managed through regulatory processes by 2030, it is anticipated that dissolved  
7     oxygen conditions would similar under the No Action Alternative, Alternatives 1  
8     through 5, and the Second Basis of Comparison. Therefore, changes in dissolved  
9     oxygen are not evaluated in this EIS.

10    **6.4.1.7     Changes in Other Constituents**

11    Conditions for other water quality constituents are expected to be similar under  
12    the No Action Alternative, Alternatives 1 through 5, and the Second Basis of  
13    Comparison because critical factors that affect the sources, transport mechanisms  
14    or chemical transformations are not expected to be affected by changes in CVP  
15    and SWP operations. Therefore, changes in the other constituents are not  
16    analyzed in this EIS.

17    **6.4.1.8     Effects Related to Water Transfers**

18    Historically water transfer programs have been developed on an annual basis.  
19    The demand for water transfers is dependent upon the availability of water  
20    supplies to meet water demands. Water transfer transactions have increased over  
21    time as CVP and SWP water supply availability decreased, especially during drier  
22    water years.

23    Parties seeking water transfers generally acquire water from sellers who have  
24    available surface water who can make the water available through releasing  
25    previously stored water, pump groundwater instead of using surface water  
26    (groundwater substitution); crop idling; or substituting crops that uses less water  
27    in order to reduce normal consumptive use of surface water.

28    Water transfers using CVP and SWP Delta pumping plants and south of Delta  
29    canals generally occur when there is unused capacity in these facilities. These  
30    conditions generally occur in drier water year types when the flows from  
31    upstream reservoirs plus unregulated flows are adequate to meet the Sacramento  
32    Valley water demands and the reduced CVP and SWP export allocations. In non-  
33    wet years, the CVP and SWP water allocations would be less than full contract  
34    amounts; therefore, capacity may be available in the CVP and SWP conveyance  
35    facilities to move water from other sources.

36    Projecting future water quality conditions related to water transfer activities is  
37    difficult because of the wide variability in sources of transfer water, conveyance,  
38    and recipients involved in each specific water transfer action. Use of the transfer  
39    water would change each year due to changing hydrological conditions, CVP and  
40    SWP water availability, specific local agency operations, and local cropping  
41    patterns. Reclamation recently prepared a long-term regional water transfer  
42    environmental document which evaluated potential changes in conditions related  
43    to water transfer actions (Reclamation 2014c). Results from this analysis were

1 used to inform the impact assessment of potential effects of water transfers under  
2 the alternatives as compared to the No Action Alternative and the Second Basis of  
3 Comparison.

#### 4 **6.4.2 Conditions in Year 2030 without Implementation of** 5 **Alternatives 1 through 5**

6 This EIS includes two bases of comparison, as described in Chapter 3,  
7 Description of Alternatives: the No Action Alternative and the Second Basis of  
8 Comparison. Both of these bases are evaluated at 2030 conditions. Changes that  
9 would occur over the next 15 years without implementation of the alternatives are  
10 not analyzed in this EIS. Changes to water quality that are assumed to occur by  
11 2030 under the No Action Alternative and the Second Basis of Comparison are  
12 summarized in this section and included in all alternatives. Many of the changed  
13 conditions would occur in the same manner under both the No Action Alternative  
14 and the Second Basis of Comparison.

##### 15 **6.4.2.1 Common Changes in Conditions under the No Action Alternative** 16 **and Second Basis of Comparison**

17 Conditions in 2030 would be different than existing conditions due to:

- 18 • Climate change and sea level rise
- 19 • General plan development throughout California, including increased water  
20 demands in portions of Sacramento Valley
- 21 • Implementation of reasonable and foreseeable water resources management  
22 projects to provide water supplies

##### 23 **6.4.2.1.1 Effects due to Climate Change and Sea Level Rise**

24 It is anticipated that climate change would result in more short-duration high-  
25 rainfall events and less snowpack runoff in the winter and early spring months.  
26 The reservoirs would be full more frequently by the end of April or May by 2030  
27 than in recent historical conditions. However, as the water is released in the  
28 spring, there would be less snowpack to refill the reservoirs. This condition  
29 would reduce reservoir storage and available water supplies, including water  
30 supplies released to maintain freshwater conditions in the western Delta and at the  
31 CVP and SWP Delta intakes. Ambient temperatures are also expected to  
32 increase. Therefore, water temperatures in the CVP and SWP reservoirs and in  
33 the rivers downstream of the reservoirs are expected to increase by 2030 under the  
34 No Action Alternative as compared to recent historical conditions.

##### 35 **6.4.2.1.2 Effects due to Reasonable and Foreseeable Projects and Programs**

36 Under the No Action Alternative and the Second Basis of Comparison, land uses  
37 in 2030 would occur in accordance with adopted general plans. Development  
38 under the general plans would change water quality, especially near municipal  
39 areas.

40 The No Action Alternative and the Second Basis of Comparison assumes  
41 completion of water resources management and environmental restoration

1 projects that would have occurred without implementation of Alternatives 1  
2 through 5, including regional and local recycling projects, surface water and  
3 groundwater storage projects, conveyance improvement projects, and desalination  
4 projects, as described in Chapter 3, Description of Alternatives. The No Action  
5 Alternative and the Second Basis of Comparison also assumes implementation of  
6 actions included in the 2008 U.S. Fish and Wildlife Service (USFWS) Biological  
7 Opinion (BO) and 2009 National Marine Fisheries Service (NMFS) BO that  
8 would have been implemented without the BOs by 2030, as described in Chapter  
9 3, Description of Alternatives. These projects would include several projects that  
10 could affect surface water quality in beneficial and adverse manners, including  
11 restoration of more than 10,000 acres of intertidal and associated subtidal  
12 wetlands in Suisun Marsh and Cache Slough; and at least 17,000 to 20,000 acres  
13 of seasonal floodplain restoration in Yolo Bypass.

14 The reasonable and foreseeable projects also would include issuance and  
15 implementation of TMDL programs and other programs to improve water quality,  
16 including those that address salinity, mercury, and selenium.

#### 17 *Potential Changes in Salinity Indicators*

18 In the Central Valley, changes in salinity under the No Action Alternative and the  
19 Second Basis of Comparison as compared to recent historical conditions are  
20 anticipated primarily to occur in the Delta. The salinity in the Delta is anticipated  
21 to increase with projected sea level rise; and therefore, the region of the Delta  
22 influenced by daily tidal fluctuations will increase, and the increased tidal mixing  
23 may result in salt transport further upstream. The average water depth in the  
24 Delta will increase, allowing for increased gravitational circulation and upstream  
25 transport of salinity further into the Delta. The increased salinity potentially will  
26 decrease the flexibility to meet regulatory requirements at compliance locations,  
27 municipal and industrial water intakes, and export facilities.

#### 28 *Potential Changes in Mercury Concentrations*

29 In the Central Valley, mercury concentrations in the Sacramento River watershed  
30 would be similar under the No Action Alternative and the Second Basis of  
31 Comparison as compared to recent historical conditions. Programs would be  
32 implemented to reduce the sources of mercury into water bodies by 2030;  
33 however, the results of those programs are not anticipated to change mercury  
34 concentrations prior to 2030.

35 Changes in mercury in the Yolo Bypass are also anticipated under the No Action  
36 Alternative and the Second Basis of Comparison as floodplain restoration is  
37 implemented, as compared to recent historical conditions.

38 Under the No Action Alternative and the Second Basis of Comparison, it is  
39 anticipated that mercury concentrations in fish tissue within the Delta will be  
40 either similar or greater than recent historical conditions. Phase 1 of the Delta  
41 Mercury Program mandated by the CVRWQCB is currently being completed to  
42 protect people eating one meal per week of larger fish from the Delta, including  
43 Largemouth Bass. This program also would reduce wildlife exposure to excess  
44 mercury. Phase 1 is focused on studies and pilot projects to develop and evaluate

1 management practices to control methylmercury from mercury sources in the  
2 Delta and Yolo Bypass; and to reduce total mercury loading to the San Francisco  
3 Bay. Following completion of Phase 1 in 2019, Phase 2 will be implemented  
4 through 2030. Phase 2 will focus on methylmercury control programs and  
5 reduction programs for total inorganic mercury. Due to the length of these studies  
6 and limited time for implementation of recommendations, it is not anticipated that  
7 changes in methylmercury or total mercury concentrations in fish tissue would be  
8 reduced by 2030 under the No Action Alternative and the Second Basis of  
9 Comparison as compared to recent historical conditions.

10 The No Action Alternative and the Second Basis of Comparison include the same  
11 projected tidal wetland and floodplain restoration within or adjacent to the Delta.  
12 These projects considered in the No Action Alternative and the Second Basis of  
13 Comparison have undergone environmental compliance and include methods to  
14 reduce mercury loading. For example, in Suisun Marsh, tidal wetland restoration  
15 activities will include cooperation with regional monitoring and research efforts,  
16 and sediment and fish monitoring. The collected information would be used  
17 adaptively to correct long-term construction and management plans and activities  
18 associated with tidal wetland restoration (Reclamation et al. 2011).

19 *Potential Changes in Selenium Concentrations*

20 Selenium is a constituent of concern in the San Joaquin Valley and the Delta, and  
21 TMDLs have been adopted for the San Joaquin River from Mud Slough to  
22 Merced River, Grasslands Marshes, Agatha Canal, and Mud Slough. It is  
23 assumed that water quality concerns for selenium in those reaches will be  
24 addressed before 2030. TMDLs are anticipated prior to 2030 for Panoche Creek  
25 and Mendota Pool. However, it is assumed that these TMDLs for water quality  
26 issues related to selenium may not be fully implemented by 2030.

27 It is expected that a TMDL may be developed separately for the Delta. To  
28 increase the database for evaluation of constituents of concern in the Delta, a large  
29 number of fish tissue samples were collected from the Sacramento and San  
30 Joaquin River watersheds and the Delta between 2000 and 2007 for selenium  
31 analysis. As part of the Strategic Workplan for Activities in the San Francisco  
32 Bay/Sacramento–San Joaquin Delta Estuary (State Water Resources Control  
33 Board 2008b), archived Largemouth Bass samples were analyzed for selenium to  
34 determine the primary source of the selenium being bioaccumulated in bass in the  
35 Delta and whether selenium concentrations in bass were above recommended  
36 criteria for the protection of human and wildlife health (Foe 2010). There were  
37 no differences in selenium concentrations in Largemouth Bass caught in the  
38 Sacramento River at Rio Vista and in the San Joaquin River at Vernalis in 2000,  
39 2005, and 2007. However, because the TMDL is not yet under development, it is  
40 assumed that it would not be in place by 2030 under the No Action Alternative  
41 and the Second Basis of Comparison.

42 Reclamation is actively engaged with the Grassland Area Farmers who discharge  
43 subsurface agricultural drainage waters through the Grassland Bypass Project,  
44 which is a significant source of selenium to the San Joaquin River and to the  
45 Delta. Reclamation and the Grassland Area Farmers are continuing to reduce the

1 amount of agricultural drainage water produced in the Grassland Drainage Area,  
 2 preventing the discharge of this water into local Grassland wetland water supply  
 3 channels, and improving the quality of water in the San Joaquin River. The  
 4 Grassland Bypass Project is based upon an agreement between Reclamation and  
 5 the San Luis and Delta-Mendota Water Authority to use a 28-mile segment of the  
 6 San Luis Drain to convey agricultural subsurface drainage water from the  
 7 Grassland Drainage Area to Mud Slough (North), a tributary of the San Joaquin  
 8 River. An extensive monitoring program (e.g., San Francisco Estuary Institute  
 9 [SFEI] 2013) continues to document the effectiveness of actions such as source  
 10 control and other measures being taken by the Grassland Area Farmers. These  
 11 actions by the Grassland Area Farmers are described in Chapter 2 of SFEI (2013).  
 12 Briefly, these activities have included the Grassland Bypass Project and the San  
 13 Joaquin River Improvement Project, formation of a regional drainage entity,  
 14 newsletters and other communication with the farmers, a monitoring program,  
 15 using State Revolving Fund loans for improved irrigation systems, installing and  
 16 using drainage recycling systems to mix subsurface drainage water with irrigation  
 17 supplies under strict limits, tiered water pricing and a tradable loads programs.

### 18 **6.4.3 Evaluation of Alternatives**

19 Alternatives 1 through 5 have been compared to the No Action Alternative; and  
 20 the No Action Alternative and Alternatives 1 through 5 have been compared to  
 21 the Second Basis of Comparison.

22 During review of the numerical modeling analyses used in this EIS, an error was  
 23 determined in the CalSim II model assumptions related to the Stanislaus River  
 24 operations for the Second Basis of Comparison, Alternative 1, and Alternative 4  
 25 model runs. Appendix 5C includes a comparison of the CalSim II model run  
 26 results presented in this chapter and CalSim II model run results with the error  
 27 corrected. Appendix 5C also includes a discussion of changes in the comparison  
 28 of groundwater conditions for the following alternative analyses.

- 29 • No Action Alternative compared to the Second Basis of Comparison
- 30 • Alternative 1 compared to the No Action Alternative
- 31 • Alternative 3 compared to the Second Basis of Comparison
- 32 • Alternative 5 compared to the Second Basis of Comparison.

#### 33 **6.4.3.1 No Action Alternative**

34 The No Action Alternative is compared to the Second Basis of Comparison.

##### 35 **6.4.3.1.1 Potential Changes in Salinity Indicators**

36 Salinity in the Sacramento River at Emmaton would be lower in September  
 37 through January, higher in June, and similar in all other months over long-term  
 38 average conditions under the No Action Alternative as compared to the Second  
 39 Basis of Comparison, as summarized in Appendix 6E, Table 6E.2.4.

40 Salinity in the San Joaquin River at Vernalis would be lower in April and  
 41 October, and higher in all other months under the No Action Alternative as

1 compared to the Second Basis of Comparison, as summarized in Appendix 6E,  
2 Table 6E.15.4.

3 Salinity in the San Joaquin River at Jersey Point would be lower in September  
4 through January, higher in June, and similar in all other months, for long-term  
5 average conditions under the No Action Alternative as compared to the Second  
6 Basis of Comparison, as summarized in Appendix 6E, Table 6E.3.4.

7 Salinity in the western Delta at Port Chicago, Chipps Island, and Collinsville  
8 would be substantially lower in September through January, moderately lower  
9 February through May, higher in June, and similar in all other months, for long-  
10 term average conditions under the No Action Alternative as compared to the  
11 Second Basis of Comparison, as summarized in Appendix 6E, Table 6E.6.4,  
12 6E.4.4, and 6E.2.4.

13 Salinity at the CVP Contra Costa Canal and Jones pumping plants and the SWP  
14 Banks Pumping Plant intakes in the Delta would be lower in September through  
15 January, and higher in all other months for long-term average conditions under  
16 the No Action Alternative as compared to the Second Basis of Comparison, as  
17 summarized in Appendix 6E, Tables 6.E.11.4, 6E.7.4, and 6E.8.4. Salinity at the  
18 Contra Costa Water District Old River and Middle River intakes also would be  
19 lower in September through January, and higher in all other months for long-term  
20 average conditions under the No Action Alternative as compared to the Second  
21 Basis of Comparison, as summarized in Appendix 6E, Tables 6E.12.4 and  
22 6E.13.4. Changes in salinity at the intakes would influence the salinity in water  
23 delivered in the San Joaquin Valley which could influence salinity in water bodies  
24 that receive agricultural return flows from CVP and SWP water users. Chloride  
25 and bromide concentrations at the intakes are expected to change in a similar  
26 manner to other salinity indicators.

27 Another indication of salinity is the measurement of X2. X2 decreases with  
28 increases in Delta outflow as freshwater from the Central Valley flows towards  
29 San Francisco Bay. Under the No Action Alternative, Delta outflow would  
30 increase and X2 would move towards the west as compared to the Second Basis  
31 of Comparison, as shown in Table C.16.4 and Figures C.16.1.1 through C.16.1.8  
32 and C.16.2.1 through C.16.2.8 in Appendix 5A, Section C, CalSim II and DSM2  
33 Modeling Results. X2 distances would be lower in September through May, and  
34 similar in all other months in long-term average conditions under the No Action  
35 Alternative as compared to the Second Basis of Comparison.

36 **6.4.3.1.2 Potential Changes in Mercury Concentrations**

37 Changes in mercury from the rivers result in changes in mercury concentrations in  
38 fish used for human consumption in the Delta, including Largemouth Bass, as  
39 summarized in Tables 6.28 and 6.29 for long-term average conditions and dry and  
40 critical dry years, respectively. All values exceed the threshold of 0.24 milligram/  
41 kilogram wet weight (mg/kg ww) for mercury.



1 **Table 6.28 Changes in Mercury Concentrations 350-millimeter Largemouth Bass**  
 2 **over the Long-term Average Conditions under the No Action Alternative as**  
 3 **Compared to the Second Basis of Comparison**

<b>Delta Location</b>	<b>No Action Alternative (mg/kg ww)</b>	<b>Second Basis of Comparison (mg/kg ww)</b>	<b>Changes</b>
San Joaquin River at Stockton	1.00	0.99	0.1%
San Joaquin River at Turner Cut	0.89	0.87	3%
San Joaquin River at San Andreas Landing	0.59	0.58	3%
San Joaquin River at Jersey Point	0.57	0.54	5%
Victoria Canal	0.85	0.82	4%
Sacramento River at Emmaton	0.50	0.49	2%
San Joaquin River at Antioch	0.50	0.47	7%
Montezuma Slough at Hunter Cut and Beldon's Landing (Suisun Marsh)	0.35	0.32	7%
SWP Barker Slough Pumping Plant Intake	0.56	0.56	1%
CVP Contra Costa Pumping Plant Intake	0.73	0.68	6%
SWP Banks Pumping Plant Intake	0.79	0.75	5%
CVP Jones Pumping Plant Intake	0.83	0.79	3%

4 Notes:

5 Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical  
 6 dry years values calculated using 1987-1991 results from DSM2 model.

7 Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

8 mg/kg – milligram/kilogram; ww – wet weight

1 **Table 6.29 Changes in Mercury Concentrations 350-millimeter Largemouth Bass in**  
 2 **Dry and Critical Dry Years under the No Action Alternative as Compared to the**  
 3 **Second Basis of Comparison**

<b>Delta Location</b>	<b>No Action Alternative (mg/kg ww)</b>	<b>Second Basis of Comparison (mg/kg ww)</b>	<b>Changes</b>
San Joaquin River at Stockton	1.06	1.06	0.3%
San Joaquin River at Turner Cut	0.84	0.81	4%
San Joaquin River at San Andreas Landing	0.54	0.53	3%
San Joaquin River at Jersey Point	0.52	0.50	4%
Victoria Canal	0.82	0.76	7%
Sacramento River at Emmaton	0.48	0.47	2%
San Joaquin River at Antioch	0.43	0.41	5%
Montezuma Slough at Hunter Cut and Beldon's Landing (Suisun Marsh)	0.28	0.26	5%
SWP Barker Slough Pumping Plant Intake	0.59	0.57	2%
CVP Contra Costa Pumping Plant Intake	0.67	0.62	8%
SWP Banks Pumping Plant Intake	0.75	0.69	8%
CVP Jones Pumping Plant Intake	0.82	0.77	7%

4 Notes:

5 Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical  
 6 dry years values calculated using 1987-1991 results from DSM2 model.

7 Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

8 mg/kg – milligram/kilogram; ww – wet weight

### 6.4.3.1.3 Potential Changes in Selenium Concentrations

It is anticipated that the selenium loadings would be similar under the No Action Alternative and the Second Basis of Comparison; and that selenium concentrations in the San Joaquin River also would be similar.

Selenium in the water column at various locations in the Delta under No Action Alternative and the Second Basis of Comparison are shown in Appendix 6D, Selenium Model Documentation. Selenium in the water column at the three western Delta locations under No Action Alternative would be identical to conditions under the Second Basis of Comparison, as shown in Appendix 6D, Table 6D.16. Selenium in the water column would be below the NTR criterion of 5 µg/L for the San Francisco Bay. Similarly, they would be below the draft USEPA (2014b) criterion for lentic aquatic systems (1.3 µg/L).

In the western Delta and at the Barker Slough Pumping Plant intake, the selenium would be similar (within 5 percent change) under the No Action Alternative and the Second Basis of Comparison.

Selenium at the Contra Costa Pumping Plant intake would be similar under the No Action Alternative and Second Basis of Comparison, as shown in Table 6D.9 of Appendix 6D. Selenium at the Jones and Banks pumping plant intakes under the No Action Alternative would be slightly higher than Second Basis of Comparison, as shown in Appendix 6D, Table 6D.9.

Estimated selenium concentration in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) at all locations in the Delta under the No Action Alternative would be similar as under the Second Basis of Comparison, as shown in Appendix 6D, Table 6D.10. As shown in Appendix 6D, Table 6D.13, Exceedance Quotients (EQs) computed with respect to the applicable benchmarks show that selenium concentrations in biota under the No Action Alternative would be below the thresholds identified for ecological risk.

For sturgeon in the western Delta, modeling also suggests that whole-body concentrations would be similar under the No Action Alternative and the Second Basis of Comparison (Appendix 6D, Table 6D.17), and the EQs would be similar (Appendix 6D, Table 6D.18). Low Toxicity Threshold EQs for selenium concentrations in sturgeon in the western Delta would remain under 1.0 for long-term average conditions, and slightly exceed 1.0 (indicating a higher probability for adverse effects) for drought years at the three western Delta locations under both the No Action Alternative and the Second Basis of Comparison (Table 6D.18 of Appendix 6D). Estimated EQs for High Toxicity Threshold at all locations are less than 1.0 under all hydrologic conditions.

### 6.4.3.1.4 Effects Related to Cross Delta Water Transfers

Potential effects to water quality could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c). Potential effects to water quality were identified as:

- 1 • Potential for sediment and other constituents to be transported from crop idled  
2 lands into adjacent water bodies.
- 3 • Water transfer practices could change reservoir storage or stream flow  
4 patterns in a manner that would affect water quality, including upstream  
5 temperatures and Delta water quality.
- 6 • Use of transferred water could increase drainage flows in the purchaser's  
7 service areas.

8 The analysis indicated that these potential impacts would not be substantial  
9 because the amount of land subject to crop changes in the seller's and purchaser's  
10 service areas would be within the historical range of irrigated lands and crop idled  
11 lands. The groundwater substitution practices would be implemented with  
12 monitoring and mitigation programs to avoid long-term adverse impacts,  
13 including impacts to water quality. The water transfers would not be allowed to  
14 occur if the program harmed other water users or the environment, including  
15 changes to water quality in the rivers or the Delta. Therefore, water quality  
16 conditions would be similar with and without the water transfers.

17 Under the No Action Alternative, the timing of cross Delta water transfers would  
18 be limited to July through September and include annual volumetric limits, in  
19 accordance with the 2008 USFWS BO and 2009 NMFS BO. Under the Second  
20 Basis of Comparison, water could be transferred throughout the year without an  
21 annual volumetric limit. Overall, the potential for cross Delta water transfers  
22 would be less under the No Action Alternative than under the Second Basis of  
23 Comparison.

#### 24 **6.4.3.2 Alternative 1**

25 As described in Chapter 3, Description of Alternatives, Alternative 1 is identical  
26 to the Second Basis of Comparison. As described in Chapter 4, Approach to  
27 Environmental Analysis, Alternative 1 is compared to the No Action Alternative  
28 and the Second Basis of Comparison. However, because water quality factors  
29 under Alternative 1 are identical to water quality factors under the Second Basis  
30 of Comparison; Alternative 1 is only compared to the No Action Alternative.

##### 31 **6.4.3.2.1 Alternative 1 Compared to the No Action Alternative**

###### 32 *Potential Changes in Salinity Indicators*

33 Salinity in the Sacramento River at Emmaton would be higher in September  
34 through January, lower in June, and similar in all other months over long-term  
35 average conditions under Alternative 1 as compared to the No Action Alternative,  
36 as summarized in Appendix 6E, Table 6E.2.1.

37 Salinity in the San Joaquin River at Vernalis would be higher in April and  
38 October, lower in May through June, lower in November through February and  
39 similar in March and July through September and higher in all other months under  
40 Alternative 1 as compared to the No Action Alternative, as summarized in  
41 Appendix 6E, Table 6E.15.1.

1 Salinity in the San Joaquin River at Jersey Point would be higher in September  
2 through January, lower in June, and similar in all other months, for long-term  
3 average conditions under Alternative 1 as compared to the No Action Alternative,  
4 as summarized in Appendix 6E, Table 6E.3.1.

5 Salinity in the Delta at Port Chicago, Chipps Island, and Collinsville would be  
6 higher in September through January, moderately higher February through May,  
7 lower in June, and similar in all other months, for long-term average conditions  
8 under Alternative 1 as compared to the No Action Alternative, as summarized in  
9 Appendix 6E, Tables 6E.6.1, 6E.4.1, and 6E.2.1.

10 Salinity at the CVP Contra Costa Canal and Jones pumping plants and the SWP  
11 Banks Pumping Plant intakes in the Delta would be higher in September through  
12 January, and lower in all other months for long-term average conditions under  
13 Alternative 1 as compared to the No Action Alternative, as summarized in  
14 Appendix 6E, Tables 6E.11.1, 6E.7.1, and 6E.8.1. Salinity at the Contra Costa  
15 Water District Old River and Middle River intakes also would be higher in  
16 September through January, and lower in all other months, for long-term average  
17 conditions under Alternative 1 as compared to the No Action Alternative, as  
18 summarized in Appendix 6E, Tables 6E.12.1 and 6E.13.1. Changes in salinity at  
19 the intakes would influence the salinity in water delivered in the San Joaquin  
20 Valley which could influence salinity in water bodies that receive agricultural  
21 return flows from CVP and SWP water users. Chloride and bromide  
22 concentrations at the intakes are expected to change in a similar manner to other  
23 salinity indicators.

24 X2 decreases with increases in Delta outflow as freshwater from the Central  
25 Valley flows towards San Francisco Bay. Under Alternative 1, Delta outflow  
26 would decrease and X2 would move towards the east as compared to the No  
27 Action Alternative, as shown in Table C.16.1 and Figures C.16.1.1 through  
28 C.16.1.8 and C.16.2.1 through C.16.2.8 in Appendix 5A, Section C, CalSim II  
29 and DSM2 Modeling Results. X2 distances would be higher in September  
30 through May, and similar in all other months in long-term average conditions  
31 under Alternative 1 as compared to the No Action Alternative.

### 32 *Potential Changes in Mercury Concentrations*

33 Changes in mercury from the rivers result in changes in mercury concentrations in  
34 fish used for human consumption in the Delta, including Largemouth Bass, as  
35 summarized in Tables 6.30 and 6.31 for long-term average conditions and dry and  
36 critical dry years, respectively. All values exceed the threshold of 0.24 milligram/  
37 kilogram wet weight (mg/kg ww) for mercury.

1 **Table 6.30 Changes in Mercury Concentrations 350-millimeter Largemouth Bass**  
 2 **over the Long-term Average Conditions under Alternative 1 as Compared to the No**  
 3 **Action Alternative**

<b>Delta Location</b>	<b>Alternative 1 (mg/kg ww)</b>	<b>No Action Alternative (mg/kg ww)</b>	<b>Changes</b>
San Joaquin River at Stockton	0.99	1.00	0%
San Joaquin River at Turner Cut	0.87	0.89	-3%
San Joaquin River at San Andreas Landing	0.58	0.59	-3%
San Joaquin River at Jersey Point	0.54	0.57	-4%
Victoria Canal	0.82	0.85	-4%
Sacramento River at Emmaton	0.49	0.50	-2%
San Joaquin River at Antioch	0.47	0.50	-6%
Montezuma Slough at Hunter Cut and Beldon's Landing (Suisun Marsh)	0.32	0.35	-6%
SWP Barker Slough Pumping Plant Intake	0.56	0.56	0%
CVP Contra Costa Pumping Plant Intake	0.68	0.73	-6%
SWP Banks Pumping Plant Intake	0.75	0.79	-5%
CVP Jones Pumping Plant Intake	0.79	0.83	-4%

4 Notes:

5 Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical  
 6 dry years values calculated using 1987-1991 results from DSM2 model.

7 Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

8 mg/kg – milligram/kilogram; ww – wet weight

1 **Table 6.31 Changes in Mercury Concentrations 350-millimeter Largemouth Bass in**  
 2 **Dry and Critical Dry Years under the Alternative 1 as Compared to the No Action**  
 3 **Alternative**

<b>Delta Location</b>	<b>Alternative 1 (mg/kg ww)</b>	<b>No Action Alternative (mg/kg ww)</b>	<b>Changes</b>
San Joaquin River at Stockton	1.06	1.06	0%
San Joaquin River at Turner Cut	0.81	0.84	-4%
San Joaquin River at San Andreas Landing	0.53	0.54	-3%
San Joaquin River at Jersey Point	0.50	0.52	-4%
Victoria Canal	0.76	0.82	-6%
Sacramento River at Emmaton	0.47	0.48	-2%
San Joaquin River at Antioch	0.41	0.43	-5%
Montezuma Slough at Hunter Cut and Beldon's Landing (Suisun Marsh)	0.26	0.28	-5%
SWP Barker Slough Pumping Plant Intake	0.57	0.59	-2%
CVP Contra Costa Pumping Plant Intake	0.62	0.67	-7%
SWP Banks Pumping Plant Intake	0.69	0.75	-8%
CVP Jones Pumping Plant Intake	0.77	0.82	-6%

4 Notes:

5 Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical  
 6 dry years values calculated using 1987-1991 results from DSM2 model.

7 Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

8 mg/kg – milligram/kilogram; ww – wet weight

1 *Potential Changes in Selenium Concentrations*

2 It is anticipated that the selenium loadings would be similar under Alternative 1 as  
3 compared to the No Action Alternative; and that selenium concentrations in the  
4 San Joaquin River also would be similar.

5 Selenium in the water column at various locations in the Delta under Alternative 1  
6 as compared to the No Action Alternative are shown in Appendix 6D, Selenium  
7 Model Documentation. Selenium in the water column at the three western Delta  
8 locations under Alternative 1 would be identical to conditions under the No  
9 Action Alternative, as shown in Appendix 6D, Table 6D.16. Selenium in the  
10 water column would be below the NTR criterion of 5 µg/L for the San Francisco  
11 Bay. Similarly, they would be below the draft USEPA (2014b) criterion for lentic  
12 aquatic systems (1.3 µg/L).

13 In the western Delta and at the Barker Slough Pumping Plant intake, selenium in  
14 the water column would be similar under Alternative 1 as compared to the No  
15 Action Alternative.

16 Selenium at the Contra Costa Pumping Plant intake would be similar under  
17 Alternative 1 as compared to the No Action Alternative, as shown in Table 6D.9  
18 of Appendix 6D. Selenium at the Jones and Banks pumping plant intakes under  
19 Alternative 1 would be lower than under the No Action Alternative, as shown in  
20 Appendix 6D, Table 6D.9.

21 Estimated selenium concentration in biota (whole-body fish, bird eggs  
22 [invertebrate diet], bird eggs [fish diet], and fish fillets) at all locations in the  
23 Delta under Alternative 1 would be similar as under the No Action Alternative, as  
24 shown in Appendix 6D, Table 6D.10. As shown in Appendix 6D, Table 6D.13,  
25 EQs computed with respect to the applicable benchmarks show that selenium  
26 concentrations in biota under Alternative 1 would be below the thresholds  
27 identified for ecological risk.

28 For sturgeon in the western Delta, modeling also suggests that whole-body  
29 concentrations would be similar under Alternative 1 and the No Action  
30 Alternative (Appendix 6D, Table 6D.17), and the EQs would be similar  
31 (Appendix 6D, Table 6D.18). Low Toxicity Threshold EQs for selenium  
32 concentrations in sturgeon in the western Delta would remain under 1.0 for long-  
33 term average conditions, and slightly exceed 1.0 (indicating a higher probability  
34 for adverse effects) for drought years at the three western Delta locations under  
35 Alternative 1 and the No Action Alternative (Table 6D.18 of Appendix 6D).  
36 Estimated EQs for High Toxicity Threshold at all locations are less than 1.0 under  
37 all hydrologic conditions.

38 *Effects Related to Cross Delta Water Transfers*

39 Potential effects to water quality could be similar to those identified in a recent  
40 environmental analysis conducted by Reclamation for long-term water transfers  
41 from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described  
42 above under the No Action Alternative compared to the Second Basis of  
43 Comparison. For the purposes of this EIS, it is anticipated that similar conditions



1 would occur during implementation of cross Delta water transfers under  
 2 Alternative 1 and the No Action Alternative, and that impacts on water quality  
 3 would not be substantial in the seller's service area due to implementation  
 4 requirements of the transfer programs.

5 Under Alternative 1, water could be transferred throughout the year without an  
 6 annual volumetric limit. Under the No Action Alternative, the timing of cross  
 7 Delta water transfers would be limited to July through September and include  
 8 annual volumetric limits, in accordance with the 2008 USFWS BO and 2009  
 9 NMFS BO. Overall, the potential for cross Delta water transfers would be  
 10 increased under Alternative 1 as compared to the No Action Alternative.

#### 11 **6.4.3.2.2 Alternative 1 Compared to the Second Basis of Comparison**

12 Alternative 1 is identical to the Second Basis of Comparison.

#### 13 **6.4.3.3 Alternative 2**

14 The CVP and SWP operations under Alternative 2 are identical to the CVP and  
 15 SWP operations under the No Action Alternative; therefore, Alternative 2 is only  
 16 compared to the Second Basis of Comparison.

#### 17 **6.4.3.3.1 Alternative 2 Compared to the Second Basis of Comparison**

18 The CVP and SWP operations under Alternative 2 are identical to the CVP and  
 19 SWP operations under the No Action Alternative. Therefore, changes to surface  
 20 water quality under Alternatives 2 as compared to the Second Basis of  
 21 Comparison would be the same as the impacts described in Section 6.4.3.1, No  
 22 Action Alternative.

#### 23 **6.4.3.4 Alternative 3**

24 As described in Chapter 3, Description of Alternatives, CVP and SWP operations  
 25 under Alternative 3 are similar to the Second Basis of Comparison and  
 26 Alternative 1 with modified Old and Middle River flow criteria. As described in  
 27 Chapter 4, Approach to Environmental Analysis, Alternative 3 is compared to the  
 28 No Action Alternative and the Second Basis of Comparison.

#### 29 **6.4.3.4.1 Alternative 3 Compared to the No Action Alternative**

##### 30 *Potential Changes in Salinity Indicators*

31 Salinity in the Sacramento River at Emmaton would be higher in September  
 32 through January, lower in June, and similar in all other months over long-term  
 33 average conditions under Alternative 3 as compared to the No Action Alternative,  
 34 as summarized in Appendix 6E, Table 6E.2.2.

35 Salinity in the San Joaquin River at Vernalis would be higher in February through  
 36 July and in October, lower in November through December, and similar in other  
 37 months under Alternative 3 as compared to the No Action Alternative, as  
 38 summarized in Appendix 6E, Table 6E.15.2.

39 Salinity in the San Joaquin River at Jersey Point would be higher in September  
 40 through January, lower in June, and similar in all other months, for long-term

1 average conditions under Alternative 3 as compared to the No Action Alternative,  
2 as summarized in Appendix 6E, Table 6E.3.2.

3 Salinity in the Delta at Port Chicago, Chippis Island, and Collinsville would be  
4 higher in September through December, moderately higher January and April, and  
5 similar in all other months, for long-term average conditions under Alternative 3  
6 as compared to the No Action Alternative, as summarized in Appendix 6E,  
7 Tables 6E.6.2, 6E.4.2, and 6E.2.2.

8 Salinity at the CVP Jones Pumping Plant and the SWP Banks Pumping Plant  
9 intakes in the Delta would be higher in September through January, and lower or  
10 similar in all other months for long-term average conditions under Alternative 3  
11 as compared to the No Action Alternative, as summarized in Appendix 6E, Table  
12 6E.7.2 and Table 6E.8.2. Salinity at the CVP Contra Costa Canal Pumping Plant  
13 and at the Contra Costa Water District Old River and Middle River intakes would  
14 be higher in September through January, lower in February through June, and  
15 similar in July and August for long-term average conditions under Alternative 3  
16 as compared to the No Action Alternative, as summarized in Appendix 6E,  
17 Tables 6E.11.2, 6E.12.2, and 6E.13.2. Changes in salinity at the intakes would  
18 influence the salinity in water delivered in the San Joaquin Valley which could  
19 influence salinity in water bodies that receive agricultural return flows from CVP  
20 and SWP water users. Chloride and bromide concentrations at the intakes are  
21 expected to change in a similar manner to other salinity indicators.

22 X2 decreases with increases in Delta outflow as freshwater from the Central  
23 Valley flows towards San Francisco Bay. Under Alternative 3, Delta outflow  
24 would decrease and X2 would move towards the east as compared to the No  
25 Action Alternative, as shown in Table C.16.2 and Figures C.16.1.1 through  
26 C.16.1.8 and C.16.2.1 through C.16.2.8 in Appendix 5A, Section C, CalSim II  
27 and DSM2 Modeling Results. X2 distances would be higher in September  
28 through December and in April and May, and similar in all other months in long-  
29 term average conditions under Alternative 3 as compared to the No Action  
30 Alternative.

### 31 *Potential Changes in Mercury Concentrations*

32 Changes in mercury from the rivers result in changes in mercury concentrations in  
33 fish used for human consumption in the Delta, including Largemouth Bass, as  
34 summarized in Tables 6.32 and 6.33 for long-term average conditions and dry and  
35 critical dry years, respectively. All values exceed the threshold of 0.24  
36 milligram/kilogram wet weight (mg/kg ww) for mercury.

1 **Table 6.32 Changes in Mercury Concentrations 350-millimeter Largemouth Bass**  
 2 **over the Long-term Average Conditions under Alternative 3 as Compared to the No**  
 3 **Action Alternative**

<b>Delta Location</b>	<b>Alternative 3 (mg/kg ww)</b>	<b>No Action Alternative (mg/kg ww)</b>	<b>Changes</b>
San Joaquin River at Stockton	1.00	1.00	1%
San Joaquin River at Turner Cut	0.88	0.89	-2%
San Joaquin River at San Andreas Landing	0.58	0.59	-3%
San Joaquin River at Jersey Point	0.55	0.57	-4%
Victoria Canal	0.83	0.85	-2%
Sacramento River at Emmaton	0.49	0.50	-2%
San Joaquin River at Antioch	0.48	0.50	-6%
Montezuma Slough at Hunter Cut and Beldon's Landing (Suisun Marsh)	0.33	0.35	-6%
SWP Barker Slough Pumping Plant Intake	0.56	0.56	0%
CVP Contra Costa Pumping Plant Intake	0.69	0.73	-5%
SWP Banks Pumping Plant Intake	0.77	0.79	-3%
CVP Jones Pumping Plant Intake	0.81	0.83	-3%

4 Notes:

5 Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical  
 6 dry years values calculated using 1987-1991 results from DSM2 model.

7 Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

8 mg/kg – milligram/kilogram; ww – wet weight

1 **Table 6.33 Changes in Mercury Concentrations 350-millimeter Largemouth Bass in**  
 2 **Dry and Critical Dry Years under the Alternative 3 as Compared to the No Action**  
 3 **Alternative**

<b>Delta Location</b>	<b>Alternative 3 (mg/kg ww)</b>	<b>No Action Alternative (mg/kg ww)</b>	<b>Changes</b>
San Joaquin River at Stockton	1.07	1.06	1%
San Joaquin River at Turner Cut	0.82	0.84	-3%
San Joaquin River at San Andreas Landing	0.53	0.54	-2%
San Joaquin River at Jersey Point	0.51	0.52	-2%
Victoria Canal	0.79	0.82	-3%
Sacramento River at Emmaton	0.47	0.48	-1%
San Joaquin River at Antioch	0.42	0.43	-3%
Montezuma Slough at Hunter Cut and Beldon's Landing (Suisun Marsh)	0.27	0.28	-3%
SWP Barker Slough Pumping Plant Intake	0.58	0.59	-1%
CVP Contra Costa Pumping Plant Intake	0.64	0.67	-4%
SWP Banks Pumping Plant Intake	0.72	0.75	-4%
CVP Jones Pumping Plant Intake	0.80	0.82	-3%

4 Notes:

5 Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical  
 6 dry years values calculated using 1987-1991 results from DSM2 model.

7 Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

8 mg/kg – milligram/kilogram; ww – wet weight

1 *Potential Changes in Selenium Concentrations*

2 It is anticipated that the selenium loadings would be similar under Alternative 3 as  
3 compared to the No Action Alternative; and that selenium concentrations in the  
4 San Joaquin River also would be similar.

5 Selenium in the water column at various locations in the Delta under Alternative 3  
6 as compared to the No Action Alternative are shown in Appendix 6D, Selenium  
7 Model Documentation. Selenium in the water column at the three western Delta  
8 locations under Alternative 3 would be similar to conditions under the No Action  
9 Alternative, as shown in Appendix 6D, Table 6D.9. Selenium in the water  
10 column would be below the NTR criterion of 5 µg/L for the San Francisco Bay.  
11 Similarly, they would be below the draft USEPA (2014b) criterion for lentic  
12 aquatic systems (1.3 µg/L).

13 In the western Delta and at the Barker Slough Pumping Plant intake, selenium in  
14 the water column would be similar under Alternative 3 as compared to the No  
15 Action Alternative.

16 Selenium at the Contra Costa Pumping Plant intake would be similar under  
17 Alternative 3 as compared to the No Action Alternative, as shown in Table 6D.9  
18 of Appendix 6D. Selenium at the Jones and Banks pumping plant intakes under  
19 Alternative 3 would be lower than under the No Action Alternative, as shown in  
20 Appendix 6D, Table 6D.9.

21 Estimated selenium concentration in biota (whole-body fish, bird eggs  
22 [invertebrate diet], bird eggs [fish diet], and fish fillets) at all locations in the  
23 Delta under Alternative 3 would be similar as under the No Action Alternative, as  
24 shown in Appendix 6D, Table 6D.10. As shown in Appendix 6D, Table 6D.14,  
25 EQs computed with respect to the applicable benchmarks show that selenium  
26 concentrations in biota under Alternative 3 would be below the thresholds  
27 identified for ecological risk.

28 For sturgeon in the western Delta, modeling also suggests that whole-body  
29 concentrations would be similar under Alternative 3 and the No Action  
30 Alternative (Appendix 6D, Table 6D.17), and the EQs would be similar  
31 (Appendix 6D, Table 6D.18). Low Toxicity Threshold EQs for selenium  
32 concentrations in sturgeon in the western Delta would remain under 1.0 for long-  
33 term average conditions, and slightly exceed 1.0 (indicating a higher probability  
34 for adverse effects) for drought years at the three western Delta locations under  
35 Alternative 3 and the No Action Alternative (Table 6D.18 of Appendix 6D).  
36 Estimated EQs for High Toxicity Threshold at all locations are less than 1.0 under  
37 all hydrologic conditions.

38 *Effects Related to Cross Delta Water Transfers*

39 Potential effects to water quality could be similar to those identified in a recent  
40 environmental analysis conducted by Reclamation for long-term water transfers  
41 from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described  
42 above under the No Action Alternative compared to the Second Basis of  
43 Comparison. For the purposes of this EIS, it is anticipated that similar conditions

1 would occur during implementation of cross Delta water transfers under  
2 Alternative 3 and the No Action Alternative, and that impacts on water quality  
3 would not be substantial in the seller's service area due to implementation  
4 requirements of the transfer programs.

5 Under Alternative 3, water could be transferred throughout the year without an  
6 annual volumetric limit. Under the No Action Alternative, the timing of cross  
7 Delta water transfers would be limited to July through September and include  
8 annual volumetric limits, in accordance with the 2008 USFWS BO and 2009  
9 NMFS BO. Overall, the potential for cross Delta water transfers would be  
10 increased under Alternative 3 as compared to the No Action Alternative.

#### 11 **6.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison**

##### 12 *Potential Changes in Salinity Indicators*

13 Salinity in the Sacramento River at Emmaton would be higher in October through  
14 November and June, lower in December through March and July through  
15 September, and similar in April and May over long-term average conditions under  
16 Alternative 3 as compared to the Second Basis of Comparison, as summarized in  
17 Appendix 6E, Table 6E.2.5.

18 Salinity in the San Joaquin River at Vernalis would be higher in November  
19 through March and May through June, and similar in all other months under  
20 Alternative 3 as compared to the Second Basis of Comparison, as summarized in  
21 Appendix 6E, Table 6E.15.5.

22 Salinity in the San Joaquin River at Jersey Point would be higher in October  
23 through November and June through August, lower in December through March  
24 and September, and similar in April and May for long-term average conditions  
25 under Alternative 3 as compared to the Second Basis of Comparison, as  
26 summarized in Appendix 6E, Table 6E.3.5.

27 Salinity in the western Delta at Port Chicago, Chipps Island, and Collinsville  
28 would be lower in December through April and July through September, higher in  
29 May and June, and similar in all other months, for long-term average conditions  
30 under Alternative 3 as compared to the Second Basis of Comparison, as  
31 summarized in Appendix 6E, Tables 6E.6.5, 6E.4.5, and 6E.2.5.

32 Salinity at the CVP Contra Costa Canal intake would be lower in December  
33 through February, as summarized in Appendix 6E, Table 6E.11.5. Salinity at  
34 Jones Pumping Plant and the SWP Banks Pumping Plant intakes in the Delta  
35 would be higher in January through May, lower in June, and similar in all other  
36 months for long-term average conditions under Alternative 3 as compared to the  
37 Second Basis of Comparison, as summarized in Appendix 6E, Table 6E.7.5 and  
38 Table 6E.8.5. Salinity at the Contra Costa Water District Old River and Middle  
39 River intakes also would be higher in January through April, lower in May and  
40 June, and similar in all other months, for long-term average conditions under  
41 Alternative 3 as compared to the Second Basis of Comparison, as summarized in  
42 Appendix 6E, Tables 6E.12.5 and 6E.13.5. Changes in salinity at the intakes  
43 would influence the salinity in water delivered in the San Joaquin Valley which

1 could influence salinity in water bodies that receive agricultural return flows from  
2 CVP and SWP water users.

3 X2 decreases with increases in Delta outflow as freshwater from the Central  
4 Valley flows towards San Francisco Bay. Under Alternative 3, Delta outflow  
5 generally would increase and X2 would move towards the west as compared to  
6 the Second Basis of Comparison, as shown in Table C.16.5 and Figures C.16.1.1  
7 through C.16.1.8 and C.16.2.1 through C.16.2.8 in Appendix 5A, Section C,  
8 CalSim II and DSM2 Modeling Results. X2 distances would be lower (towards  
9 the west) in December through April and July through September, higher in May  
10 and June (towards the east), and similar in all other months in long-term average  
11 conditions under Alternative 3 as compared to the Second Basis of Comparison.

#### 12 *Potential Changes in Mercury Concentrations*

13 Changes in flows in the rivers result in similar changes to erosional inputs and  
14 resuspension of both inorganic and methylmercury fractions. Changes in mercury  
15 from the rivers result in changes in mercury concentrations in fish used for human  
16 consumption in the Delta, including Largemouth Bass, as summarized in Tables  
17 6.34 and 6.35 for long-term average conditions and dry and critical dry years,  
18 respectively. All values exceed the threshold of 0.24 milligram/kilogram wet  
19 weight (mg/kg ww) for mercury.

1 **Table 6.34 Changes in Mercury Concentrations 350-millimeter Largemouth Bass**  
 2 **over the Long-term Average Conditions under Alternative 3 as Compared to the**  
 3 **Second Basis of Comparison**

<b>Delta Location</b>	<b>Alternative 3 (mg/kg ww)</b>	<b>Second Basis of Comparison (mg/kg ww)</b>	<b>Changes</b>
San Joaquin River at Stockton	1.00	0.99	1%
San Joaquin River at Turner Cut	0.88	0.87	1%
San Joaquin River at San Andreas Landing	0.58	0.58	0%
San Joaquin River at Jersey Point	0.55	0.54	1%
Victoria Canal	0.83	0.82	2%
Sacramento River at Emmaton	0.49	0.49	0%
San Joaquin River at Antioch	0.48	0.47	1%
Montezuma Slough at Hunter Cut and Beldon's Landing (Suisun Marsh)	0.33	0.32	1%
SWP Barker Slough Pumping Plant Intake	0.56	0.56	0%
CVP Contra Costa Pumping Plant Intake	0.69	0.68	1%
SWP Banks Pumping Plant Intake	0.77	0.75	2%
CVP Jones Pumping Plant Intake	0.81	0.79	2%

4 Notes:

5 Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical  
 6 dry years values calculated using 1987-1991 results from DSM2 model.

7 Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

8 mg/kg – milligram/kilogram; ww – wet weight



1 **Table 6.35 Changes in Mercury Concentrations 350-millimeter Largemouth Bass in**  
 2 **Dry and Critical Dry Years under Alternative 3 as Compared to the Second Basis of**  
 3 **Comparison**

<b>Delta Location</b>	<b>Alternative 3 (mg/kg ww)</b>	<b>Second Basis of Comparison (mg/kg ww)</b>	<b>Changes</b>
San Joaquin River at Stockton	1.07	1.06	1%
San Joaquin River at Turner Cut	0.82	0.81	1%
San Joaquin River at San Andreas Landing	0.53	0.53	1%
San Joaquin River at Jersey Point	0.51	0.50	2%
Victoria Canal	0.79	0.76	3%
Sacramento River at Emmaton	0.47	0.47	0%
San Joaquin River at Antioch	0.42	0.41	2%
Montezuma Slough at Hunter Cut and Beldon's Landing (Suisun Marsh)	0.27	0.26	2%
SWP Barker Slough Pumping Plant Intake	0.58	0.57	2%
CVP Contra Costa Pumping Plant Intake	0.64	0.62	4%
SWP Banks Pumping Plant Intake	0.72	0.69	4%
CVP Jones Pumping Plant Intake	0.80	0.77	4%

4 Notes:

5 Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical  
 6 dry years values calculated using 1987-1991 results from DSM2 model.

7 Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

8 mg/kg – milligram/kilogram; ww – wet weight

1 *Potential Changes in Selenium Concentrations*

2 It is anticipated that the selenium loadings would be similar under Alternative 3  
3 and the Second Basis of Comparison; and that selenium concentrations in the San  
4 Joaquin River also would be similar.

5 Selenium in the water column at various locations in the Delta under Alternative 3  
6 and the Second Basis of Comparison are shown in Appendix 6D, Selenium Model  
7 Documentation. Selenium in the water column at the three western Delta  
8 locations under Alternative 3 would be identical to conditions under the Second  
9 Basis of Comparison, as shown in Appendix 6D, Table 6D.16. Selenium in the  
10 water column would be below the NTR criterion of 5 µg/L for the San Francisco  
11 Bay. Similarly, they would be below the draft USEPA (2014b) criterion for lentic  
12 aquatic systems (1.3 µg/L).

13 In the western Delta and at the Barker Slough Pumping Plant intake, the selenium  
14 would be similar under Alternative 3 and the Second Basis of Comparison.

15 Selenium at the Contra Costa Pumping Plant and Banks Pumping Plant intakes  
16 would be similar under Alternative 3 and Second Basis of Comparison, as shown  
17 in Appendix 6D, Table 6D.9. Selenium at the Jones Pumping Plant intake under  
18 Alternative 3 would be slightly higher than Second Basis of Comparison, as  
19 shown in Appendix 6D, Table 6D.9.

20 Estimated selenium concentration in biota (whole-body fish, bird eggs  
21 [invertebrate diet], bird eggs [fish diet], and fish fillets) at all locations in the  
22 Delta under Alternative 3 would be similar as under the Second Basis of  
23 Comparison, as shown in Appendix 6D, Table 6D.11. As shown in Appendix 6D,  
24 Table 6D.14, EQs computed with respect to the applicable benchmarks show that  
25 selenium concentrations in biota under Alternative 3 would be below the  
26 thresholds identified for ecological risk.

27 For sturgeon in the western Delta, modeling also suggests that whole-body  
28 concentrations would be similar under Alternative 3 and the Second Basis of  
29 Comparison (Appendix 6D, Table 6D.17), and the EQs would be similar  
30 (Appendix 6D, Table 6D.18). Low Toxicity Threshold EQs for selenium  
31 concentrations in sturgeon in the western Delta would remain under 1.0 for long-  
32 term average conditions, and slightly exceed 1.0 (indicating a higher probability  
33 for adverse effects) for drought years at the three western Delta locations under  
34 both Alternative 3 and Second Basis of Comparison (Table 6D.18 of Appendix  
35 6D). Estimated EQs for High Toxicity Threshold at all locations are less than 1.0  
36 under all hydrologic conditions.

37 *Effects Related to Cross Delta Water Transfers*

38 Potential effects to water quality could be similar to those identified in a recent  
39 environmental analysis conducted by Reclamation for long-term water transfers  
40 from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described  
41 above under the No Action Alternative compared to the Second Basis of  
42 Comparison. For the purposes of this EIS, it is anticipated that similar conditions  
43 would occur during implementation of cross Delta water transfers under

1 Alternative 3 and the Second Basis of Comparison, and that impacts on water  
 2 quality would not be substantial in the seller's service area due to implementation  
 3 requirements of the transfer programs.

4 Under Alternative 3 and the Second Basis of Comparison, water could be  
 5 transferred throughout the year without an annual volumetric limit. Overall, the  
 6 potential for cross Delta water transfers would be similar under Alternative 3 and  
 7 the Second Basis of Comparison.

#### 8 **6.4.3.5 Alternative 4**

9 Water quality under Alternative 4 would be identical to the conditions under the  
 10 Second Basis of Comparison; therefore, Alternative 4 is only compared to the No  
 11 Action Alternative.

##### 12 **6.4.3.5.1 Alternative 4 Compared to the No Action Alternative**

13 The CVP and SWP operations under Alternative 4 are identical to the CVP and  
 14 SWP operations under the Second Basis of Comparison and Alternative 1.  
 15 Therefore, changes in water quality under Alternative 4 as compared to the No  
 16 Action Alternative would be the same as the impacts described in  
 17 Section 12.4.3.2.1, Alternative 1 Compared to the No Action Alternative.

#### 18 **6.4.3.6 Alternative 5**

19 As described in Chapter 3, Description of Alternatives, CVP and SWP operations  
 20 under Alternative 5 are similar to the No Action Alternative with modified Old  
 21 and Middle River flow criteria and New Melones Reservoir operations. As  
 22 described in Chapter 4, Approach to Environmental Analysis, Alternative 5 is  
 23 compared to the No Action Alternative and the Second Basis of Comparison.

##### 24 **6.4.3.6.1 Alternative 5 Compared to the No Action Alternative**

###### 25 *Potential Changes in Salinity Indicators*

26 Salinity in the Sacramento River at Emmaton would be lower in May through  
 27 September, and similar in all other months over long-term average conditions  
 28 under Alternative 5 as compared to the No Action Alternative, as summarized in  
 29 Appendix 6E, Table 6E.2.3.

30 Salinity in the San Joaquin River at Vernalis would be lower in April and May,  
 31 and similar in all other months under Alternative 5 as compared to the No Action  
 32 Alternative, as summarized in Appendix 6E, Table 6E.15.3.

33 Salinity in the San Joaquin River at Jersey Point would be lower in December  
 34 through February, higher in June through August, and similar in all other months,  
 35 for long-term average conditions under Alternative 5 as compared to the No  
 36 Action Alternative, as summarized in Appendix 6E, Table 6E.3.3.

37 Salinity in the Delta at Port Chicago, Chipps Island, and Collinsville would be  
 38 lower in April through June, and similar in all other months, for long-term  
 39 average conditions under Alternative 5 as compared to the No Action Alternative,  
 40 as summarized in Appendix 6E, Tables 6E.6.3, 6E.4.3, and 6E.2.3.

1 Salinity at the Jones pumping plants and the SWP Banks Pumping Plant intakes in  
2 the Delta would be lower in May and slightly higher in June through September,  
3 and similar in all other months for long-term average conditions under Alternative  
4 5 as compared to the No Action Alternative, as summarized in Appendix 6E,  
5 Table 6E.7.3 and Table 6E.8.3. Salinity at the CVP Contra Costa Canal intake  
6 and at the Contra Costa Water District Old River and Middle River intakes also  
7 would be higher in April through September, and similar in all other months, for  
8 long-term average conditions under Alternative 5 as compared to the No Action  
9 Alternative, as summarized in Appendix 6E, Tables 6E.11.3, 6E.12.3, and  
10 6E.13.3. Changes in salinity at the intakes would influence the salinity in water  
11 delivered in the San Joaquin Valley which could influence salinity in water bodies  
12 that receive agricultural return flows from CVP and SWP water users. Chloride  
13 and bromide concentrations at the intakes are expected to change in a similar  
14 manner to other salinity indicators.

15 X2 decreases with increases in Delta outflow as freshwater from the Central  
16 Valley flows towards San Francisco Bay. Under Alternative 5, Delta outflow  
17 would increase and X2 would move towards the west as compared to the No  
18 Action Alternative, as shown in Table C.16.3 and Figures C.16.1.1 through  
19 C.16.1.8 and C.16.2.1 through C.16.2.8 in Appendix 5A, Section C, CalSim II  
20 and DSM2 Modeling Results. X2 distances would be lower (towards the west) in  
21 April and May, and similar in all other months in long-term average conditions  
22 under Alternative 5 as compared to the No Action Alternative.

### 23 *Potential Changes in Mercury Concentrations*

24 Changes in flows in the rivers result in similar changes in erosional inputs and  
25 resuspension of both inorganic and methylmercury fractions. Changes in mercury  
26 from the rivers results in changes in mercury concentrations in fish used for  
27 human consumption in the Delta, including Largemouth Bass, as summarized in  
28 Tables 6.36 and 6.37 for long-term average conditions and dry and critical dry  
29 years, respectively. All values exceed the threshold of 0.24 milligram/kilogram  
30 wet weight (mg/kg ww) for mercury.

1 **Table 6.36 Changes in Mercury Concentrations 350-millimeter Largemouth Bass**  
 2 **over the Long-term Average Conditions under Alternative 5 as Compared to the No**  
 3 **Action Alternative**

<b>Delta Location</b>	<b>Alternative 5 (mg/kg ww)</b>	<b>No Action Alternative (mg/kg ww)</b>	<b>Changes</b>
San Joaquin River at Stockton	1.00	1.00	0%
San Joaquin River at Turner Cut	0.89	0.89	0%
San Joaquin River at San Andreas Landing	0.55	0.59	1%
San Joaquin River at Jersey Point	0.57	0.57	1%
Victoria Canal	0.85	0.85	0%
Sacramento River at Emmaton	0.50	0.50	0%
San Joaquin River at Antioch	0.51	0.50	1%
Montezuma Slough at Hunter Cut and Beldon's Landing (Suisun Marsh)	0.35	0.35	1%
SWP Barker Slough Pumping Plant Intake	0.56	0.56	0%
CVP Contra Costa Pumping Plant Intake	0.74	0.73	2%
SWP Banks Pumping Plant Intake	0.79	0.79	0%
CVP Jones Pumping Plant Intake	0.83	0.83	0%

4 Notes:

5 Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical  
 6 dry years values calculated using 1987-1991 results from DSM2 model.

7 Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

8 mg/kg – milligram/kilogram; ww – wet weight

1 **Table 6.37 Changes in Mercury Concentrations 350-millimeter Largemouth Bass in**  
 2 **Dry and Critical Dry Years under the Alternative 5 as Compared to the No Action**  
 3 **Alternative**

<b>Delta Location</b>	<b>Alternative 5 (mg/kg ww)</b>	<b>No Action Alternative (mg/kg ww)</b>	<b>Changes</b>
San Joaquin River at Stockton	1.05	1.06	0%
San Joaquin River at Turner Cut	0.85	0.84	1%
San Joaquin River at San Andreas Landing	0.55	0.54	2%
San Joaquin River at Jersey Point	0.53	0.52	2%
Victoria Canal	0.82	0.82	0%
Sacramento River at Emmaton	0.49	0.48	1%
San Joaquin River at Antioch	0.44	0.43	2%
Montezuma Slough at Hunter Cut and Beldon's Landing (Suisun Marsh)	0.28	0.28	0%
SWP Barker Slough Pumping Plant Intake	0.58	0.59	0%
CVP Contra Costa Pumping Plant Intake	0.70	0.67	5%
SWP Banks Pumping Plant Intake	0.74	0.75	-1%
CVP Jones Pumping Plant Intake	0.82	0.82	1%

4 Notes:

5 Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical  
 6 dry years values calculated using 1987-1991 results from DSM2 model.

7 Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

8 mg/kg – milligram/kilogram; ww – wet weight

1 *Potential Changes in Selenium Concentrations*

2 It is anticipated that the selenium loadings would be similar under Alternative 5 as  
3 compared to the No Action Alternative; and that selenium concentrations in the  
4 San Joaquin River also would be similar.

5 Selenium in the water column at various locations in the Delta under Alternative 5  
6 as compared to the No Action Alternative are shown in Appendix 6D, Selenium  
7 Model Documentation. Selenium in the water column at the three western Delta  
8 locations under Alternative 5 would be similar to conditions under the No Action  
9 Alternative, as shown in Appendix 6D, Table 6D.16. Selenium in the water  
10 column would be below the NTR criterion of 5 µg/L for the San Francisco Bay.  
11 Similarly, they would be below the draft USEPA (2014b) criterion for lentic  
12 aquatic systems (1.3 µg/L).

13 In the western Delta and at the Barker Slough Pumping Plant intake, selenium in  
14 the water column would be similar under Alternative 5 as compared to the No  
15 Action Alternative.

16 Selenium at the Contra Costa Pumping Plant and Banks Pumping Plant intakes  
17 would be higher under Alternative 5 as compared to the No Action Alternative, as  
18 shown in Table 6D.9 of Appendix 6D. Selenium at the Jones Pumping Plant  
19 intake under Alternative 5 would be similar to conditions under the No Action  
20 Alternative, as shown in Appendix 6D, Table 6D.9.

21 Estimated selenium concentration in biota (whole-body fish, bird eggs  
22 [invertebrate diet], bird eggs [fish diet], and fish fillets) at all locations in the  
23 Delta under Alternative 5 would be similar as under the No Action Alternative, as  
24 shown in Appendix 6D, Table 6D.12. As shown in Appendix 6D, Table 6D.15,  
25 Exceedance Quotients (EQs) computed with respect to the applicable benchmarks  
26 show that selenium concentrations in biota under Alternative 5 would be below  
27 the thresholds identified for ecological risk.

28 For sturgeon in the western Delta, modeling also suggests that whole-body  
29 concentrations would be higher under Alternative 5 than under the No Action  
30 Alternative (Appendix 6D, Table 6D.17), and the EQs would be similar  
31 (Appendix 6D, Table 6D.18). Low Toxicity Threshold EQs for selenium  
32 concentrations in sturgeon in the western Delta would remain under 1.0 for long-  
33 term average conditions, and slightly exceed 1.0 (indicating a higher probability  
34 for adverse effects) for drought years at the three western Delta locations under  
35 Alternative 5 and the No Action Alternative (Table 6D.18 of Appendix 6D).  
36 Estimated EQs for High Toxicity Threshold at all locations are less than 1.0 under  
37 all hydrologic conditions.

38 *Effects Related to Cross Delta Water Transfers*

39 Potential effects to water quality could be similar to those identified in a recent  
40 environmental analysis conducted by Reclamation for long-term water transfers  
41 from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described  
42 above under the No Action Alternative compared to the Second Basis of  
43 Comparison. For the purposes of this EIS, it is anticipated that similar conditions

1 would occur during implementation of cross Delta water transfers under  
2 Alternative 5 and the No Action Alternative, and that impacts on water quality  
3 would not be substantial in the seller's service area due to implementation  
4 requirements of the transfer programs.  
5 Under Alternative 5 and the No Action Alternative, the timing of cross Delta  
6 water transfers would be limited to July through September and include annual  
7 volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO.  
8 Overall, the potential for cross Delta water transfers would be similar under  
9 Alternative 5 and the No Action Alternative.

#### 10 **6.4.3.6.2 Alternative 5 Compared to the Second Basis of Comparison**

##### 11 *Potential Changes in Salinity Indicators*

12 Salinity in the Sacramento River at Emmaton would be lower in September  
13 through January, higher in June, and similar in all other months over long-term  
14 average conditions under Alternative 5 as compared to the Second Basis of  
15 Comparison, as summarized in Appendix 6E, Table 6E.2.6.

16 Salinity in the San Joaquin River at Vernalis would be lower in April through  
17 May and October, higher in November through March, and similar in all other  
18 months under Alternative 5 as compared to the Second Basis of Comparison, as  
19 summarized in Appendix 6E, Table 6E.15.6.

20 Salinity in the San Joaquin River at Jersey Point would be lower in September  
21 through January, higher in July and August, and similar in all other months for  
22 long-term average conditions under Alternative 5 as compared to the Second  
23 Basis of Comparison, as summarized in Appendix 6E, Table 6E.3.6.

24 Salinity in the western Delta at Port Chicago, Chipps Island, and Collinsville  
25 would be lower in all months for long-term average conditions under Alternative  
26 5 as compared to the Second Basis of Comparison, as summarized in Appendix  
27 6E, Tables 6E.6.6, 6E.4.6, and 6E.2.6.

28 Salinity at Jones Pumping Plant and the SWP Banks Pumping Plant intakes in the  
29 Delta would be lower in September through January, and higher in all other  
30 months for long-term average conditions under Alternative 5 as compared to the  
31 Second Basis of Comparison, as summarized in Appendix 6E, Table 6E.7.6 and  
32 Table 6E.8.6. Salinity at the CVP Contra Costa Canal intake and the Contra  
33 Costa Water District Old River and Middle River intakes also would be lower in  
34 September through January and higher in February through August for long-term  
35 average conditions under Alternative 5 as compared to the Second Basis of  
36 Comparison, as summarized in Appendix 6E, Tables 6E.11.6, 6E.12.6, and  
37 6E.13.6. Changes in salinity at the intakes would influence the salinity in water  
38 delivered in the San Joaquin Valley which could influence salinity in water bodies  
39 that receive agricultural return flows from CVP and SWP water users.

40 X2 decreases with increases in Delta outflow as freshwater from the Central  
41 Valley flows towards San Francisco Bay. Under Alternative 5, Delta outflow  
42 generally would increase and X2 would move towards the west, especially in  
43 September through May, as compared to the Second Basis of Comparison, as



1 shown in in Table C.16.6 and Figures C.16.1.1 through C.16.1.8 and C.16.2.1  
2 through C.16.2.8 in Appendix 5A, Section C, CalSim II and DSM2 Modeling  
3 Results.

4 *Potential Changes in Mercury Concentrations*

5 Changes in mercury from the rivers result in changes in mercury concentrations in  
6 fish used for human consumption in the Delta, including Largemouth Bass, as  
7 summarized in Tables 6.38 and 6.39 for long-term average conditions and dry and  
8 critical dry years, respectively. All values exceed the threshold of 0.24  
9 milligram/kilogram wet weight (mg/kg ww) for mercury.

1 **Table 6.38 Changes in Mercury Concentrations 350-millimeter Largemouth Bass**  
 2 **over the Long-term Average Conditions under Alternative 5 as Compared to the**  
 3 **Second Basis of Comparison**

<b>Delta Location</b>	<b>Alternative 5 (mg/kg ww)</b>	<b>Second Basis of Comparison (mg/kg ww)</b>	<b>Changes</b>
San Joaquin River at Stockton	1.00	0.99	0%
San Joaquin River at Turner Cut	0.89	0.87	3%
San Joaquin River at San Andreas Landing	0.55	0.58	4%
San Joaquin River at Jersey Point	0.57	0.54	5%
Victoria Canal	0.85	0.82	4%
Sacramento River at Emmaton	0.50	0.49	3%
San Joaquin River at Antioch	0.51	0.47	7%
Montezuma Slough at Hunter Cut and Beldon's Landing (Suisun Marsh)	0.35	0.32	7%
SWP Barker Slough Pumping Plant Intake	0.56	0.56	1%
CVP Contra Costa Pumping Plant Intake	0.74	0.68	8%
SWP Banks Pumping Plant Intake	0.79	0.75	5%
CVP Jones Pumping Plant Intake	0.83	0.79	5%

4 Notes:

5 Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical  
 6 dry years values calculated using 1987-1991 results from DSM2 model.

7 Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

8 mg/kg – milligram/kilogram; ww – wet weight

1 **Table 6.39 Changes in Mercury Concentrations 350-millimeter Largemouth Bass in**  
 2 **Dry and Critical Dry Years under Alternative 5 as Compared to the Second Basis of**  
 3 **Comparison**

<b>Delta Location</b>	<b>Alternative 5 (mg/kg ww)</b>	<b>Second Basis of Comparison (mg/kg ww)</b>	<b>Changes</b>
San Joaquin River at Stockton	1.05	1.06	0%
San Joaquin River at Turner Cut	0.85	0.81	4%
San Joaquin River at San Andreas Landing	0.55	0.53	4%
San Joaquin River at Jersey Point	0.53	0.50	5%
Victoria Canal	0.82	0.76	7%
Sacramento River at Emmaton	0.49	0.47	3%
San Joaquin River at Antioch	0.44	0.41	7%
Montezuma Slough at Hunter Cut and Beldon's Landing (Suisun Marsh)	0.28	0.26	7%
SWP Barker Slough Pumping Plant Intake	0.58	0.57	2%
CVP Contra Costa Pumping Plant Intake	0.70	0.62	13%
SWP Banks Pumping Plant Intake	0.74	0.69	7%
CVP Jones Pumping Plant Intake	0.82	0.77	7%

4 Notes:

5 Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical  
 6 dry years values calculated using 1987-1991 results from DSM2 model.

7 Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

8 mg/kg – milligram/kilogram; ww – wet weight

1 *Potential Changes in Selenium Concentrations*

2 It is anticipated that the selenium loadings would be similar under Alternative 5  
3 and the Second Basis of Comparison; and that selenium concentrations in the San  
4 Joaquin River also would be similar.

5 In the Delta, selenium concentrations are related to the movement of flows from  
6 the San Joaquin River and the accumulation in certain areas of the Delta due to  
7 tidal flow patterns.

8 Selenium in the water column at various locations in the Delta under Alternative 5  
9 and the Second Basis of Comparison are shown in Appendix 6D, Selenium Model  
10 Documentation. Selenium in the water column at the three western Delta  
11 locations under Alternative 5 would be similar to conditions under the Second  
12 Basis of Comparison, as shown in Appendix 6D, Table 6D.16. Selenium in the  
13 water column would be below the NTR criterion of 5 µg/L for the San Francisco  
14 Bay. Similarly, they would be below the draft USEPA (2014b) criterion for lentic  
15 aquatic systems (1.3 µg/L).

16 In the western Delta and at the Barker Slough Pumping Plant intake, the selenium  
17 would be similar under Alternative 5 and the Second Basis of Comparison. There  
18 would be small increases in selenium along the Sacramento River at Emmaton  
19 under Alternative 5 as compared to the Second Basis of Comparison.

20 Selenium at the Contra Costa Pumping Plant, Jones Pumping Plant, and Banks  
21 Pumping Plant intakes would be higher under Alternative 5 than Second Basis of  
22 Comparison, as shown in Appendix 6D, Table 6D.9.

23 Estimated selenium concentration in biota (whole-body fish, bird eggs  
24 [invertebrate diet], bird eggs [fish diet], and fish fillets) at all locations in the  
25 Delta under Alternative 5 would be similar as under the Second Basis of  
26 Comparison, as shown in Appendix 6D, Table 6D.12. As shown in Appendix 6D,  
27 Table 6D.13, EQs computed with respect to the applicable benchmarks show that  
28 selenium concentrations in biota under Alternative 5 would be below the  
29 thresholds identified for ecological risk.

30 For sturgeon in the western Delta, modeling also suggests that whole-body  
31 concentrations would be higher under Alternative 5 than the Second Basis of  
32 Comparison (Appendix 6D, Table 6D.17), and the EQs would be similar  
33 (Appendix 6D, Table 6D.18). Low Toxicity Threshold EQs for selenium  
34 concentrations in sturgeon in the western Delta would remain under 1.0 for long-  
35 term average conditions, and slightly exceed 1.0 (indicating a higher probability  
36 for adverse effects) for drought years at the three western Delta locations under  
37 both Alternative 5 and Second Basis of Comparison (Table 6D.18 of  
38 Appendix 6D). Estimated EQs for High Toxicity Threshold at all locations are  
39 less than 1.0 under all hydrologic conditions.

40 *Effects Related to Cross Delta Water Transfers*

41 Potential effects to water quality could be similar to those identified in a recent  
42 environmental analysis conducted by Reclamation for long-term water transfers  
43 from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described

1 above under the No Action Alternative compared to the Second Basis of  
2 Comparison. For the purposes of this EIS, it is anticipated that similar conditions  
3 would occur during implementation of cross Delta water transfers under  
4 Alternative 5 and the Second Basis of Comparison, and that impacts on water  
5 quality would not be substantial in the seller's service area due to implementation  
6 requirements of the transfer programs.

7 Under Alternative 5, the timing of cross Delta water transfers would be limited to  
8 July through September and include annual volumetric limits, in accordance with  
9 the 2008 USFWS BO and 2009 NMFS BO. Under the Second Basis of  
10 Comparison, water could be transferred throughout the year without an annual  
11 volumetric limit. Overall, the potential for cross Delta water transfers would be  
12 reduced under Alternative 5 as compared to the Second Basis of Comparison.

#### 13 **6.4.3.7 Summary of Environmental Consequences**

14 The results of the environmental consequences of implementation of Alternatives  
15 1 through 5 as compared to the No Action Alternative and the Second Basis of  
16 Comparison are presented in Tables 6.40 and 6.41.

17 It should be noted that since concentrations of nutrients, dissolved oxygen, and  
18 other constituents of current concern (except salinity, mercury, and selenium)  
19 would be managed through regulatory processes by 2030, it is assumed that  
20 concentrations of these constituents would be similar under the No Action  
21 Alternative, Alternatives 1 through 5, and the Second Basis of Comparison, as  
22 described in Section 6.4.1., Potential Mechanisms of Change and Analytical  
23 Methods.

24 Environmental effects associated with changes in water temperatures are related  
25 to impacts on biological resources (as described in Chapter 9, Fish and Aquatic  
26 Resources. Therefore, the, potential impacts of the action alternatives related to  
27 changes in water temperature, including changes resulting from including  
28 reasonably and foreseeable actions are presented in Chapter 9.

29  
30

1

**Table 6.40 Comparison of Alternatives 1 through 5 to No Action Alternative**

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	<p>Salinity increases near Emmaton in almost all months (5 to 377 percent), particularly in September, October and November of wet and above normal years; decreases in June except for June of critical years; and is similar in wet and above normal of spring months (February through May); and dry and critical years of August and September.</p> <p>Salinity increases near Antioch (5 to 265 percent) in almost all months except it decreases in June of wet, above normal, and below normal years ( 7 to 14 percent) and when it is similar in February, March, and April of wet years, July and August, and September of below normal, dry and critically dry years.</p> <p>Salinity increases near CVP and SWP intakes (6 to 36 percent) in October, November, and December (and January for only SWP), decreases (5 to 22 percent) in February through June, and is similar in other months.</p> <p>Salinity increases near Contra Costa Water District intakes (8 to 65 percent) in October through January and September of wet and above normal years, decreases (5 to 32 percent) March through May and June of wet, above normal, and below normal years, and is similar in other months. Changes in Contra Costa Water District intakes are different for each location. Please refer to Appendix 6E for a detailed summary of the changes in salinity.</p> <p>Salinity increases (5 to 96 percent) near Port Chicago October through February, April, March of below normal, dry, and critically dry years, and September of wet and above normal years; and is similar in other months.</p> <p>Similar mercury concentrations in Largemouth Bass in most of the Delta; and a 6 percent decrease near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough over the long-term conditions.</p> <p>Similar selenium concentrations in whole body fish, bird eggs, and fish fillets.</p>	<p>Coordination of CVP and SWP operations between Reclamation, DWR, USFWS, and NMFS to reduce salinity near the CVP, SWP, Contra Costa Water District, and Antioch intakes and near Emmaton.</p>

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 2	Water quality conditions would be the same as under the No Action Alternative.	None needed
Alternative 3	<p>Salinity increases near Emmaton (7 to 378 percent) October through January and September of wet and above normal years, in September, October and November of wet and above normal years; decreases (7 and 8 percent) in June of above normal years and September of below normal years, and is similar in all other months.</p> <p>Salinity increases near Antioch (6 to 262 percent) in almost all months except it is similar in March, July, August, below normal, dry, and critically dry years of September, and wet, above normal, and dry years of February.</p> <p>Salinity increases near CVP intakes (6 to 29 percent) in October, November, and December, decreases (5 to 13 percent) in June, and is similar in other months.</p> <p>Salinity increases near SWP intakes (5 to 41 percent) in October, November, December, and January, decreases (5 to 19 percent) in April through June, and is similar in other months.</p> <p>Salinity increases near Contra Costa Water District intakes (6 to 76 percent) in October through December, January of above normal, below normal, and dry years, and September of wet and above normal years; decreases (5 to 34 percent) April through June; and is similar in other months.</p> <p>Salinity increases (6 to 95 percent) near Port Chicago October through January, April, and May, June and September of wet and above normal years; and is similar in other months.</p> <p>Similar mercury concentrations in Largemouth Bass in most of the Delta; and a 6 percent decrease near San Joaquin River at Antioch and Montezuma Slough over the long-term conditions.</p> <p>Similar selenium concentrations in whole body fish, bird eggs, and fish fillets.</p>	Coordination of CVP and SWP operations between Reclamation, DWR, USFWS, and NMFS to reduce salinity near the CVP, SWP, Contra Costa Water District, and Antioch intakes.
Alternative 4	Same effects as described for Alternative 1 compared to the No Action Alternative.	None needed
Alternative 5		None needed

Alternative	Potential Change	Consideration for Mitigation Measures
	<p>Salinity near Emmaton is similar in all months except it increases (6 and 8 percent) January and February and decreases (6 to 15 percent) in April through June of critically dry years.</p> <p>Salinity decreases (9 to 20 percent) near Antioch in April and May of below normal, dry, and critically dry years and June of critically dry years; increases (7 percent) in February of critically dry years; and is similar in all other months.</p> <p>Salinity is similar near CVP and SWP intakes in most months, and increases (8 to 12 percent) in June of dry and critically dry years.</p> <p>Salinity increases near Contra Costa Water District intakes (6 to 40 percent) in April, May, and June of below normal, dry, and critical years; and is similar in other months. Changes in Contra Costa Water District intakes are different for each location. Please refer to Appendix 6E for a detailed summary of the changes in salinity.</p> <p>Salinity near Port Chicago is similar in all months except it decreases (5 to 8 percent) in April and May of dry and critical years.</p> <p>Similar mercury concentrations in Largemouth Bass throughout the Delta.</p> <p>Similar selenium concentrations in whole body fish, bird eggs, and fish fillets.</p>	

1 Notes:

2 1 In general, D-1641 Delta salinity standards are met in all alternatives except for few dry  
3 and critical years where there is no stored fresh water available for release The  
4 differences in salinity between alternatives mostly point to results of other operations  
5 beyond meeting the D-1641 salinity standards; such as whether or not reservoirs are  
6 releasing to meet 2008 USFWS Biological Opinion Action 4 (Fall X2), Delta Cross  
7 Channel operations, or whether or not south Delta exports are allowed in a particular  
8 month. As a result, changes in salinity for each location in Delta shows wide month to  
9 month variation between alternatives. Please refer to Appendix 6E for detailed  
10 comparison of salinity between the alternatives.

11 2 Due to the limitations and uncertainty in the CalSim II monthly model and other  
12 analytical tools, incremental differences of 5 percent or less between alternatives and the  
13 Second Basis of Comparison are considered to be “similar.”



1 **Table 6.41 Comparison of No Action Alternative and Alternatives 1 through 5 to**  
 2 **Second Basis of Comparison**

<b>Alternative</b>	<b>Potential Change</b>	<b>Consideration for Mitigation Measures</b>
No Action Alternative	<p>Salinity decreases near Emmaton in almost all months (5 to 79 percent), particularly in September, October and November of wet and above normal years; increases (9 to 21 percent) in June except for June of critical years; and is similar in wet and above normal of spring months (February through May); and dry and critical years of August and September.</p> <p>Salinity decreases near Antioch (5 to 73 percent) in almost all months except it increases (7 to 16 percent) in June of wet, above normal, and below normal years; and is similar in February, March, and April of wet years, July and August, and September of below normal, dry and critically dry years.</p> <p>Salinity decreases near CVP and SWP intakes (6 to 28 percent) in October, November, and December (and January for only SWP), increases (5 to 23 percent) in February through June, and is similar in other months.</p> <p>Salinity decreases near Contra Costa Water District intakes (7 to 42 percent) in October through January and September of wet and above normal years, increases (5 to 47 percent) March through May and June of wet, above normal, and below normal years, and is similar in other months. Changes in Contra Costa Water District intakes are different for each location. Please refer to Appendix 6E for a detailed summary of the changes in salinity.</p> <p>Salinity decreases (6 to 49 percent) near Port Chicago October through May, and September of wet and above normal years; and is similar in other months.</p> <p>Similar mercury concentrations in Largemouth Bass in the most of the Delta; and a 7 percent increase near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough over the long-term conditions.</p> <p>Similar selenium concentrations in whole body fish, bird eggs, and fish fillets.</p>	Not considered for this comparison.

<b>Alternative</b>	<b>Potential Change</b>	<b>Consideration for Mitigation Measures</b>
Alternative 1	No effects on public health issues.	Not considered for this comparison.
Alternative 2	Same effects as described for No Action Alternative as compared to the Second Basis of Comparison.	Not considered for this comparison.
Alternative 3	<p>Salinity increases near Emmaton (5 to 35 percent) in June except for critically dry years; decreases (5 to 24 percent) in December and January of above normal years, January through March and July through September of below normal years, January, February, and July of dry years, and March of critically dry years; and it is similar in all other months.</p> <p>Salinity increases near Antioch (8 to 20 percent) in June except critically dry years and in May of wet years; decreases (7 to 40 percent) in January through April, and is similar in all other months.</p> <p>Salinity is similar near CVP and SWP intakes except for increase (5 to 23 percent) mostly in February through May of dry and critically dry years.</p> <p>Salinity increases near Contra Costa Water District intakes (5 to 16 percent) in March and April of dry and critically dry years; decreases (5 to 23 percent) in December, January and February of dry and critically dry years; and is similar in other months. Changes in Contra Costa Water District intakes are different for each location. Please refer to Appendix 6E for a detailed summary of the changes in salinity.</p> <p>Salinity decreases (5 to 25 percent) near Port Chicago January through March; increases (7 to 9 percent) in June of wet, above normal, and below normal years; and is similar in other months.</p> <p>Similar mercury concentrations in Largemouth Bass throughout the Delta.</p> <p>Similar selenium concentrations in whole body fish, bird eggs, and fish fillets.</p>	Not considered for this comparison.
Alternative 4	No effects on water quality issues.	Not considered for this comparison.
Alternative 5	Salinity decreases near Emmaton in almost all months (5 to 79 percent), particularly in September, October and November of wet and above normal	Not considered for this comparison.

Alternative	Potential Change	Consideration for Mitigation Measures
	<p>years; increases (7 to 21 percent) in June except for June of critical years; and is similar in wet and above normal of spring months (February through May); and dry and critical years of August and September.</p> <p>Salinity decreases near Antioch (5 to 73 percent) in almost all months except it increases (7 to 14 percent) in June of wet, above normal, and below normal years; and is similar in February, March, and April of wet years, July and August, and September of below normal, dry and critically dry years.</p> <p>Salinity decreases near CVP and SWP intakes (5 to 28 percent) in October, November, and December (and January for only SWP), increases (5 to 26 percent) in February through June, and is similar in other months.</p> <p>Salinity decreases near Contra Costa Water District intakes (7 to 41 percent) in October through January and September of wet and above normal years, increases (5 to 63 percent) March through June, and is similar in other months. Changes in Contra Costa Water District intakes are different for each location. Please refer to Appendix 6E for a detailed summary of the changes in salinity.</p> <p>Salinity decreases (5 to 49 percent) near Port Chicago October through May, and September of wet and above normal years; and is similar in other months.</p> <p>Similar mercury concentrations in Largemouth Bass in the most of the Delta; and a 7 percent increase near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough over the long-term conditions.</p> <p>Similar selenium concentrations in whole body fish, bird eggs, and fish filets.</p>	

1 Notes:

2 1 In general, D-1641 Delta salinity standards are met in all alternatives except for few dry  
3 and critical years where there is no stored fresh water available for release. The  
4 differences in salinity between alternatives mostly point to results of other operations  
5 beyond meeting the D-1641 salinity standards; such as whether or not reservoirs are  
6 releasing to meet 2008 USFWS Biological Opinion Action 4 (Fall X2), Delta Cross  
7 Channel operations, or whether or not south Delta exports are allowed in a particular  
8 month. As a result, changes in salinity for each location in Delta shows wide month to

1 month variation between alternatives. Please refer to Appendix 6E for detailed  
2 comparison of salinity between the alternatives.

3 2 Due to the limitations and uncertainty in the CalSim II monthly model and other  
4 analytical tools, incremental differences of 5 percent or less between alternatives and the  
5 Second Basis of Comparison are considered to be “similar.”

#### 6 **6.4.3.8 Potential Mitigation Measures**

7 Mitigation measures are presented in this section to avoid, minimize, rectify,  
8 reduce, eliminate, or compensate for adverse environmental effects of  
9 Alternatives 1 through 5 as compared to the No Action Alternative. Mitigation  
10 measures were not included to address adverse impacts under the alternatives as  
11 compared to the Second Basis of Comparison because this analysis was included  
12 in this EIS for information purposes only.

13 Environmental effects associated with changes in water temperatures are related  
14 to impacts on biological resources (as described in Chapter 9, Fish and Aquatic  
15 Resources. Therefore, mitigation measures related to changes in temperatures as  
16 compared to the No Action Alternative conditions are presented in Chapter 9.

#### 17 **6.4.3.8.1 Salinity Water Quality Conditions**

18 Implementation of Alternatives 1 through 5 would not result in adverse impacts to  
19 mercury and selenium concentrations as compared to the No Action Alternative.  
20 Therefore, no mitigation measures are required for these constituents.

21 Implementation of Alternatives 1, 3, and 4 would result in adverse impacts to  
22 salinity concentrations as compared to the No Action Alternative. A potential  
23 mitigation measure to reduce these effects would be:

- 24 • Coordination of CVP and SWP operations between Reclamation, DWR,  
25 USFWS, and NMFS to reduce salinity near the CVP, SWP, Contra Costa  
26 Water District, and Antioch intakes.

27 Under the No Action Alternative and Alternatives 1 through 5, it is anticipated  
28 that the ongoing real-time decision making meetings between Reclamation,  
29 DWR, USFWS, and NMFS would continue in a manner similar to that described  
30 in Section 3A.3 of Appendix 3A, No Action Alternative: Central Valley Project  
31 and State Water Project Operations. Under this mitigation measure, a specific  
32 agenda item would be added to the groups’ actions to reduce salinity impacts on  
33 the beneficial uses in the Delta. Potential changes could be to modify intake  
34 operations in accordance with real-time flows, observations related to fish  
35 presence, and real-time water quality observations.

#### 36 **6.4.3.9 Cumulative Effects Analysis**

37 As described in Chapter 3, the cumulative effects analysis considers projects,  
38 programs, and policies that are not speculative; and are based upon known or  
39 reasonably foreseeable long-range plans, regulations, operating agreements, or  
40 other information that establishes them as reasonably foreseeable.

1 The cumulative effects analysis Alternatives 1 through 5 for Water Quality are  
 2 summarized in Table 6.42.

3 **Table 6.42 Summary of Cumulative Effects on Water Quality of Alternatives 1**  
 4 **through 5 as Compared to the No Action Alternative**

Scenarios	Actions	Cumulative Effects of Actions
<p>Past &amp; Present, and Future Actions included in the No Action Alternative and in All Alternatives in Year 2030</p>	<p>Consistent with Affected Environment conditions plus:</p> <p>Actions in the 2008 USFWS BO and 2009 NMFS BO that Would Have Occurred without implementation of the BOs, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives), including climate change and sea level rise</p> <p>Actions not included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives):</p> <ul style="list-style-type: none"> <li>- Implementation of Federal and state policies and programs, including Clean Water Act (e.g., Total Maximum Daily Loads); Safe Drinking Water Act; Clean Air Act; and flood management programs</li> <li>- Trinity River Restoration Program.</li> <li>- Central Valley Project Improvement Act programs</li> <li>- Iron Mountain Mine Superfund Site</li> <li>- Dutch Slough Tidal Marsh Restoration</li> <li>- Suisun Marsh Habitat Management, Preservation, and Restoration Plan Implementation</li> <li>- Tidal Wetland Restoration: Yolo Ranch, Northern Liberty Island Fish Restoration Project, Prospect Island Restoration Project, and Calhoun Cut/Lindsey Slough Tidal Habitat Restoration Project</li> <li>- San Joaquin River Restoration Program</li> <li>- Stockton Deep Water Ship Channel Dissolved Oxygen Project</li> <li>- Grasslands Bypass Project</li> <li>- Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS)</li> <li>- Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities</li> </ul>	<p><u>These effects would be the same in all alternatives.</u></p> <p>Climate change and sea level rise area anticipated to increase salinity in the Delta and expand the region of the Delta influenced by tidal fluctuations.</p> <p>Water quality programs to reduce nutrient loadings from wastewater treatment plant effluent and other point source discharges under the TMDLs would be fully implemented by 2020; and it is anticipated that nutrient concentrations would be reduced by 2030.</p> <p>Programs to meet TMDLs related to dissolved oxygen, pesticides, mercury, selenium, and other constituents of concern are anticipated to be fully defined and implemented in the early 2020s to reduce, but not necessarily meet TMDL objectives, by 2030. These programs include projects to reduce effects of agricultural drainage.</p> <p>Tidal restoration programs would change salinity gradients in the Delta, including increased salinity in the western and central Delta, depending upon the location of the tidal restoration lands. Estuarine tidal restoration could reduce constituents from runoff of adjacent upland areas, depending upon the location of the restored lands.</p>

Chapter 6: Surface Water Quality

Scenarios	Actions	Cumulative Effects of Actions
	(projects with completed environmental documents)	
Future Actions considered as Cumulative Effects Actions in All Alternatives in Year 2030	<p>Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives):</p> <ul style="list-style-type: none"> <li>- Bay-Delta Water Quality Control Plan Update</li> <li>- FERC Relicensing Projects</li> <li>- Bay Delta Conservation Plan (including the California WaterFix alternative)</li> <li>- EcoRestore</li> <li>- Irrigated Lands Regulatory Program</li> <li>- San Luis Reservoir Low Point Improvement Project</li> <li>- <i>Westlands Water District v. United States Settlement</i></li> <li>- Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects that did not have completed environmental documents during preparation of the EIS)</li> </ul>	<p><u>These effects would be the same in all alternatives.</u></p> <p>Some of the future reasonably foreseeable actions are anticipated to reduce water quality issues, including Bay-Delta Water Quality Control Plan Update, FERC Relicensing Projects, agricultural drainage programs, and San Luis Reservoir Low Point Improvement Project.</p> <p>Future reasonably foreseeable actions related to tidal restoration projects could increase salinity and mercury water quality issues.</p>
No Action Alternative with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO	<p>Implementation of No Action Alternative would result in increased salinity in the western and central Delta due to climate change and sea level rise.</p> <p>Numerous projects would be implemented by 2030 to reduce water quality issues related to nutrients, agricultural drainage, and other discharges of constituents of concern by 2030.</p> <p>Depending upon the location of tidal restoration lands, salinity in the No Action Alternative could increase in the western and interior Delta.</p>
Alternatives 1 and 4 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	<p>Implementation of Alternatives 1 and 4 with reasonably foreseeable actions would increase salinity in the western and interior Delta as compared to the No Action Alternative with these added actions. Other water quality conditions under Alternatives 1 through 4 with reasonably foreseeable actions would be similar to conditions under the No Action Alternative with the added actions.</p>

Scenarios	Actions	Cumulative Effects of Actions
Alternative 2 with Associated Cumulative Effects Actions in Year 2030	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions</p> <p>No implementation of structural improvements or other actions that require further study to develop a more detailed action description.</p>	Implementation of Alternative 2 with reasonably foreseeable actions would result in the same conditions as under the No Action Alternative with the added actions.
Alternative 3 with Associated Cumulative Effects Actions in Year 2030	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)</p> <p>Slight increase in positive Old and Middle River flows in the winter and spring months</p>	Implementation of Alternative 3 with reasonably foreseeable actions would increase salinity in the western and interior Delta as compared to the No Action Alternative with the added actions. Other water quality conditions under Alternative 3 with reasonably foreseeable actions would be similar to conditions under the No Action Alternative with the added actions.
Alternative 5 with Associated Cumulative Effects Actions in Year 2030	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO</p> <p>Positive Old and Middle River flows and increased Delta outflow in spring months</p>	Implementation of Alternative 5 with reasonably foreseeable actions would result in similar salinity conditions as compared to the No Action Alternative with the added actions. Other water quality conditions under Alternative 5 with with reasonably foreseeable actions would be similar to conditions under the No Action Alternative with the added actions.

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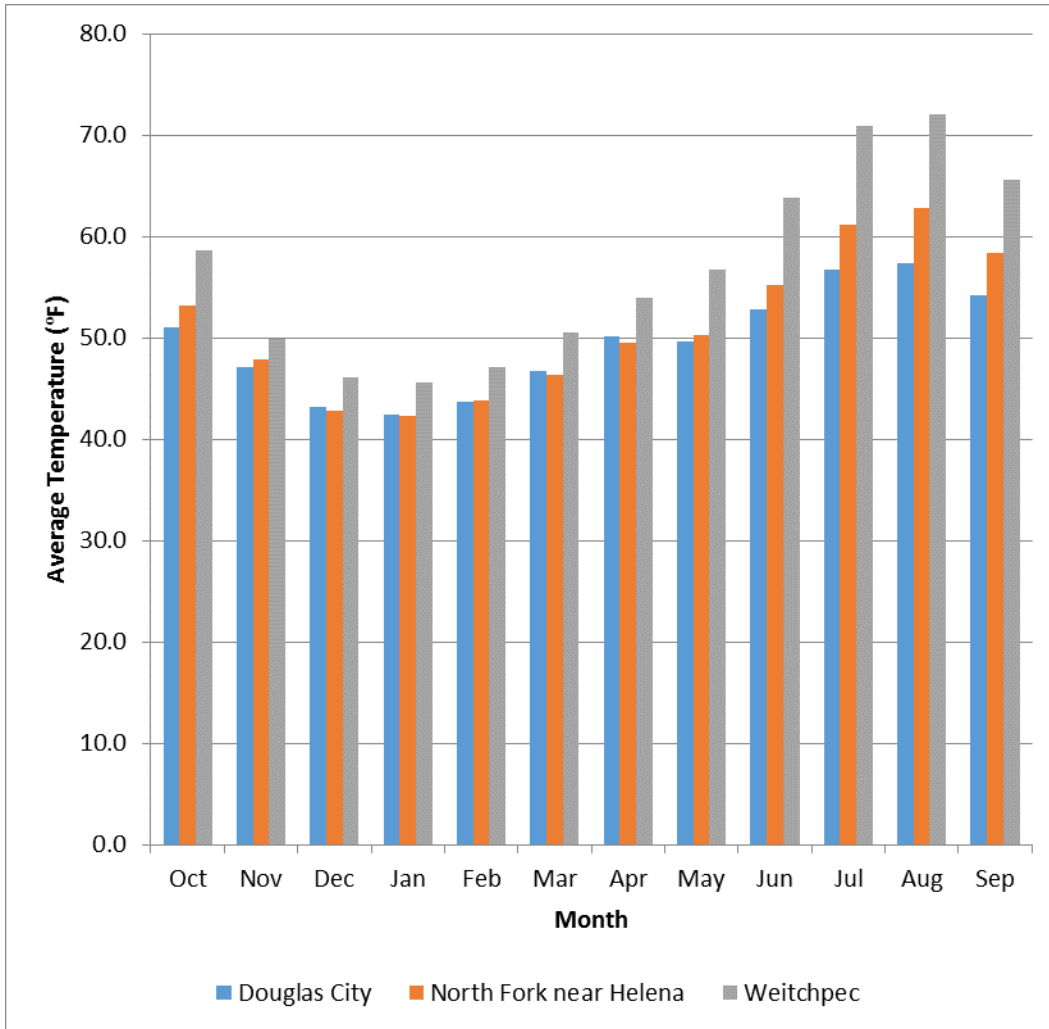
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- 14 Wiener, J. G., C. C. Gilmour, and D. P. Krabbenhoft. 2003. *Mercury Strategy for*  
15 *the Bay-Delta Ecosystem: A Unifying Framework for Science, Adaptive*  
16 *Management, and Ecological Restoration*. Final Report to the California  
17 Bay-Delta Authority.

**Chapter 6**

1 **Surface Water Quality Figures**

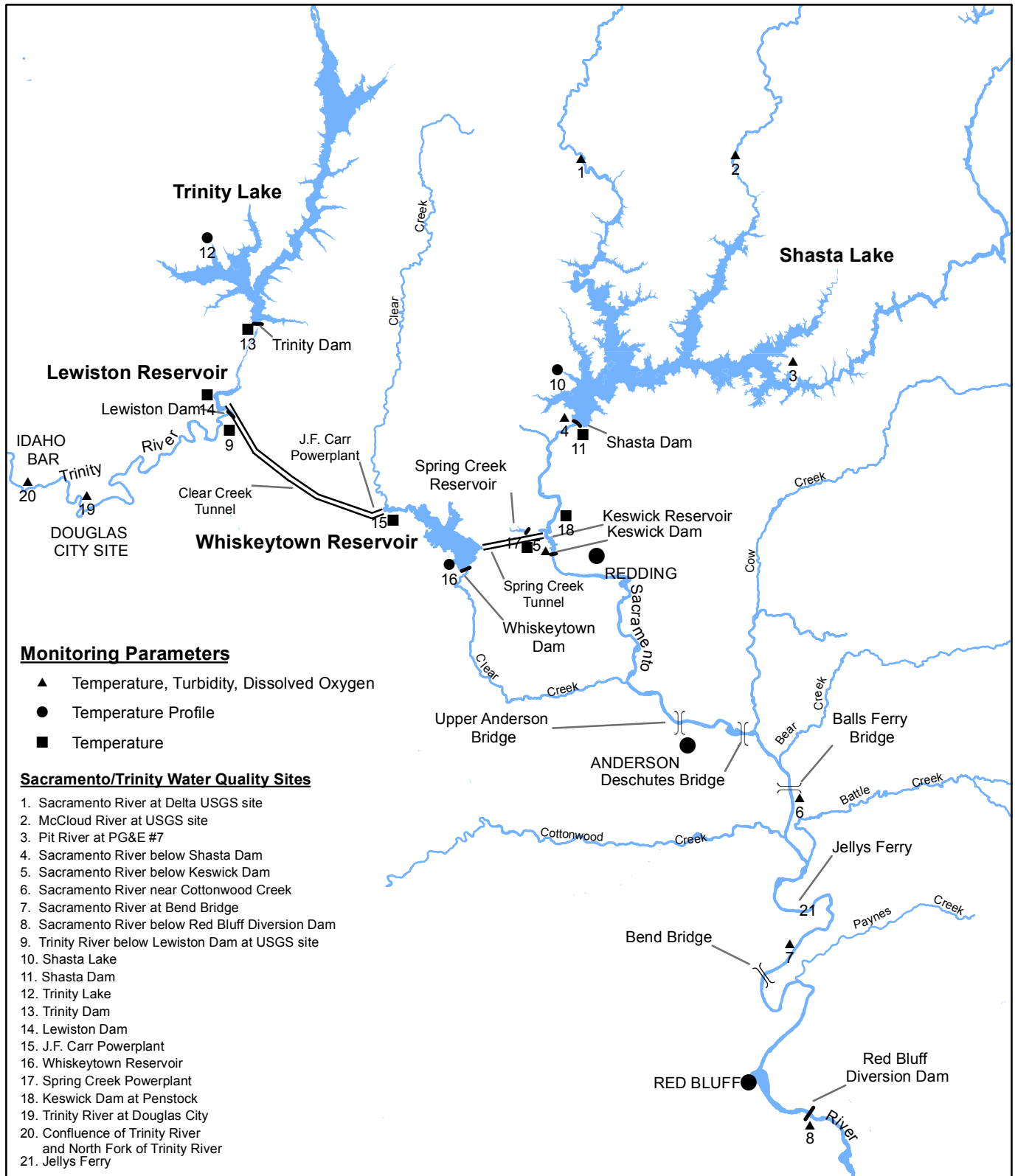
2 The following figures are included in Chapter 6, Surface Water Quality.

- 3 • 6.1 Monthly Average of Water Temperatures Recorded at Trinity River  
4 Compliance Locations (2001-2012)
- 5 • 6.2 Water Quality Compliance Stations Along Trinity River and Upper  
6 Sacramento River
- 7 • 6.3 Monthly Average of Water Temperatures Recorded at Sacramento River  
8 Compliance Locations (2001-2012)
- 9 • 6.4 Monthly Average Specific Conductance in San Joaquin River at Vernalis  
10 (Reclamation 2013e)
- 11 • 6.5 Water Quality Compliance Stations in the Delta
- 12 • 6.6 Monthly Average Specific Conductance in Sacramento River at  
13 Collinsville (Reclamation 2013e)
- 14 • 6.7 Monthly Average Specific Conductance in Sacramento River at Emmaton  
15 (Reclamation 2013e)
- 16 • 6.8 Monthly Average Specific Conductance in Sacramento River at Rio Vista  
17 (Reclamation 2013e)
- 18 • 6.9 Monthly Average Specific Conductance in Delta Mendota Canal Intake  
19 (Reclamation 2013e)



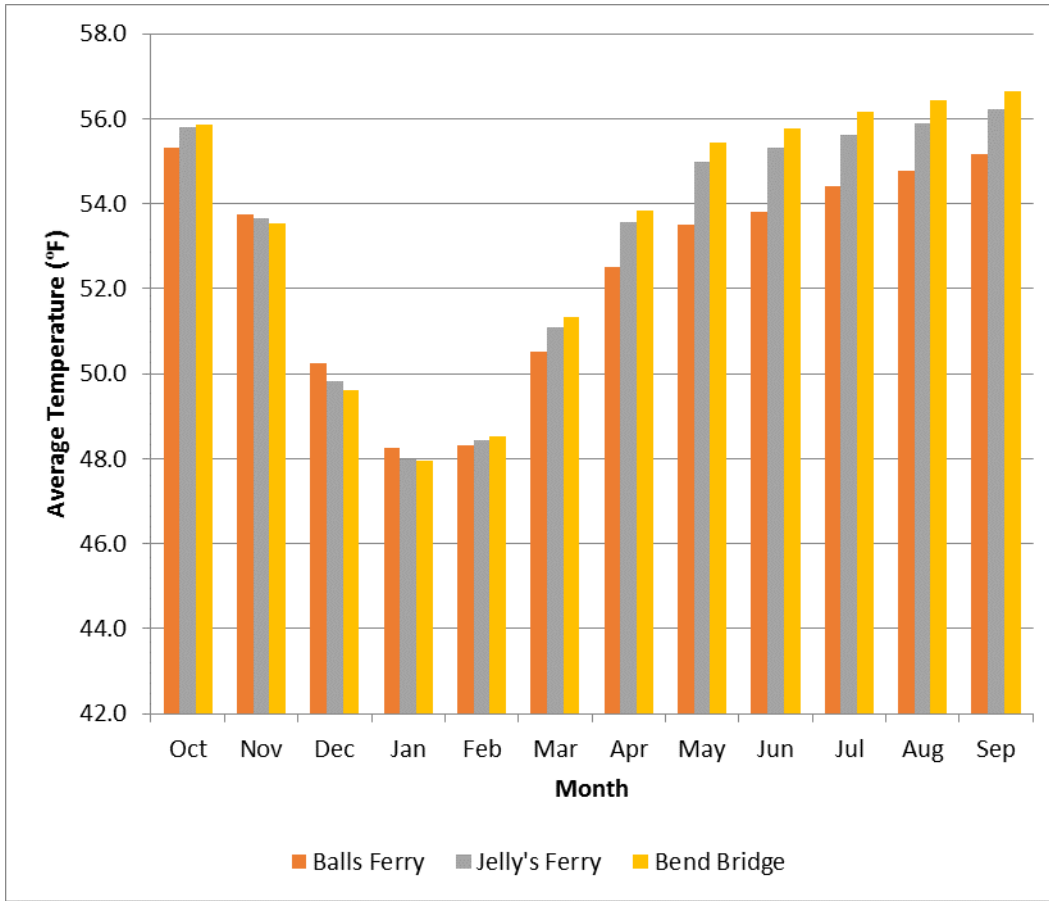
1

2 **Figure 6.1 Monthly Average of Water Temperatures Recorded at Trinity River**  
3 **Compliance Locations (2001-2012)**



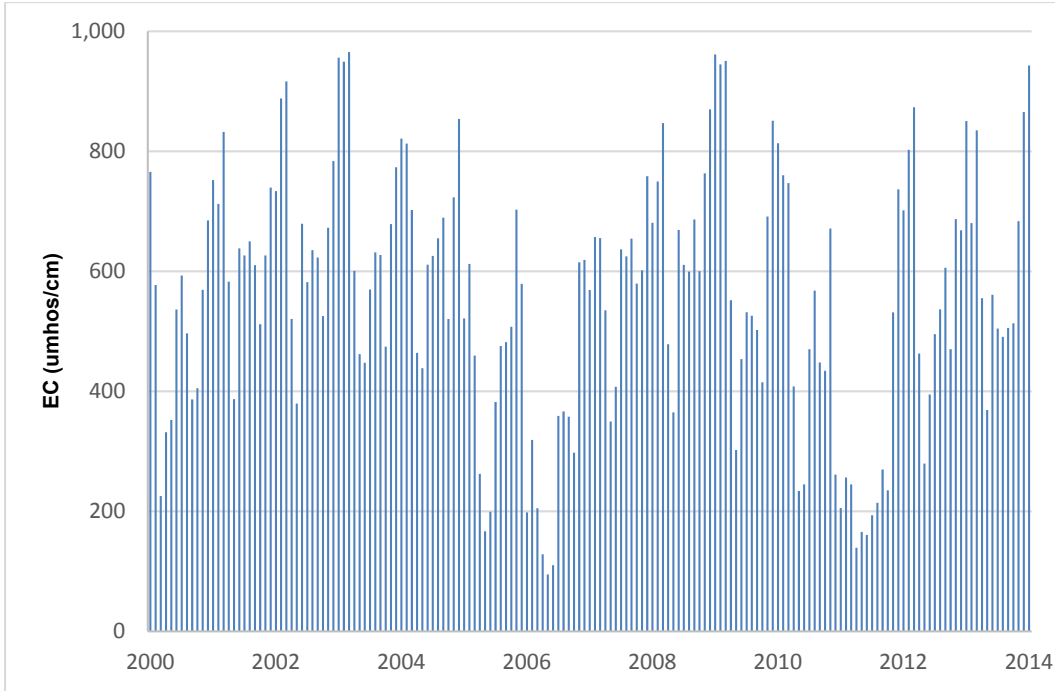
**Figure 6.2 Water Quality Compliance Stations Along Trinity River and Upper Sacramento River**





1

2 **Figure 6.3 Monthly Average of Water Temperatures Recorded at Sacramento River**  
3 **Compliance Locations (2001-2012)**



1

2 **Figure 6.4 Monthly Average Specific Conductance in San Joaquin River at Vernalis**  
3 **(Reclamation 2013e)**

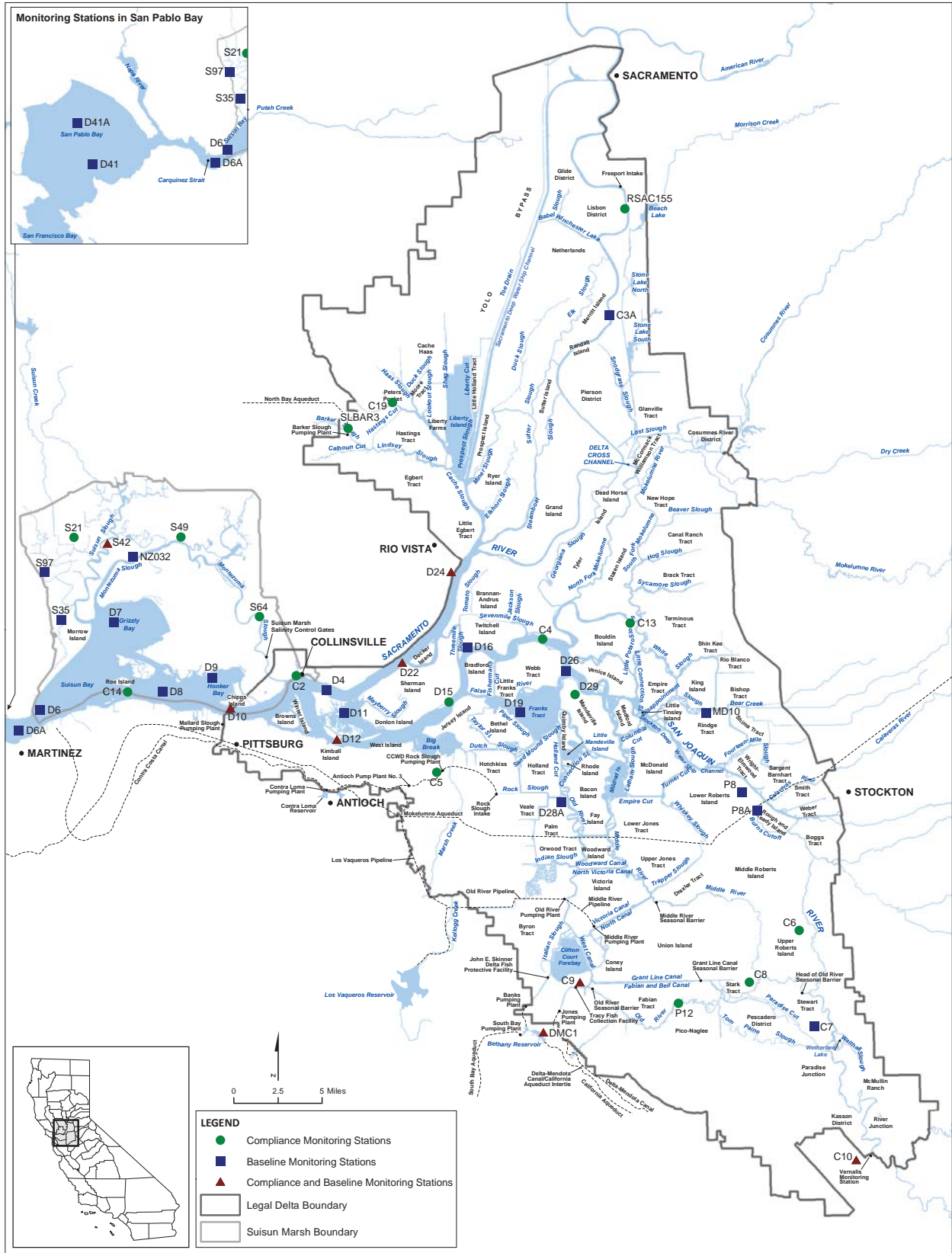
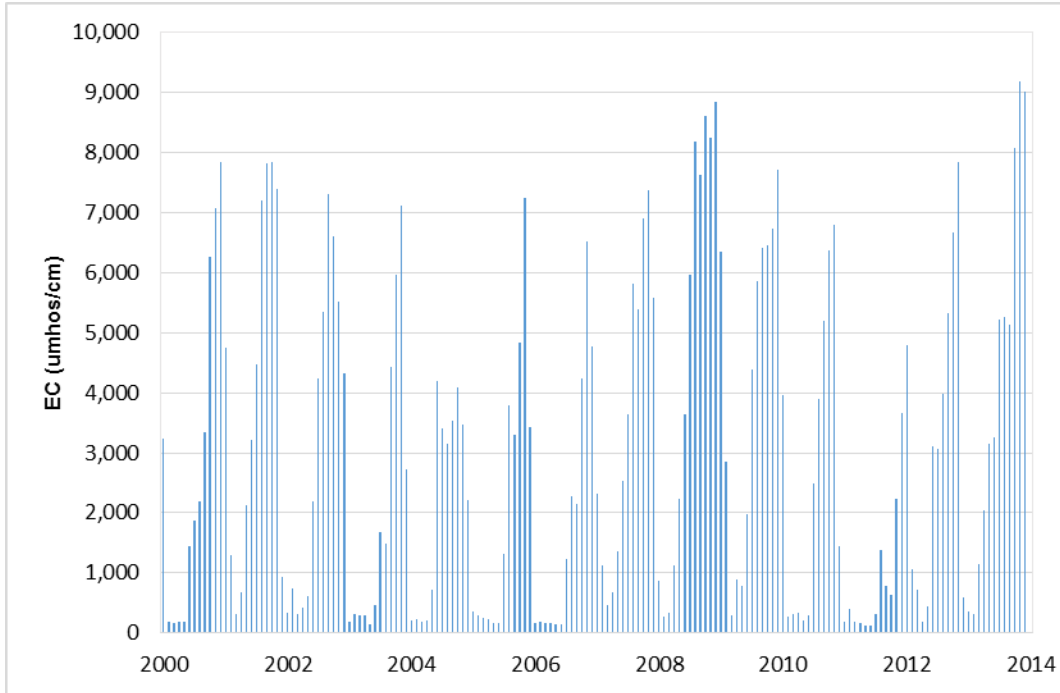
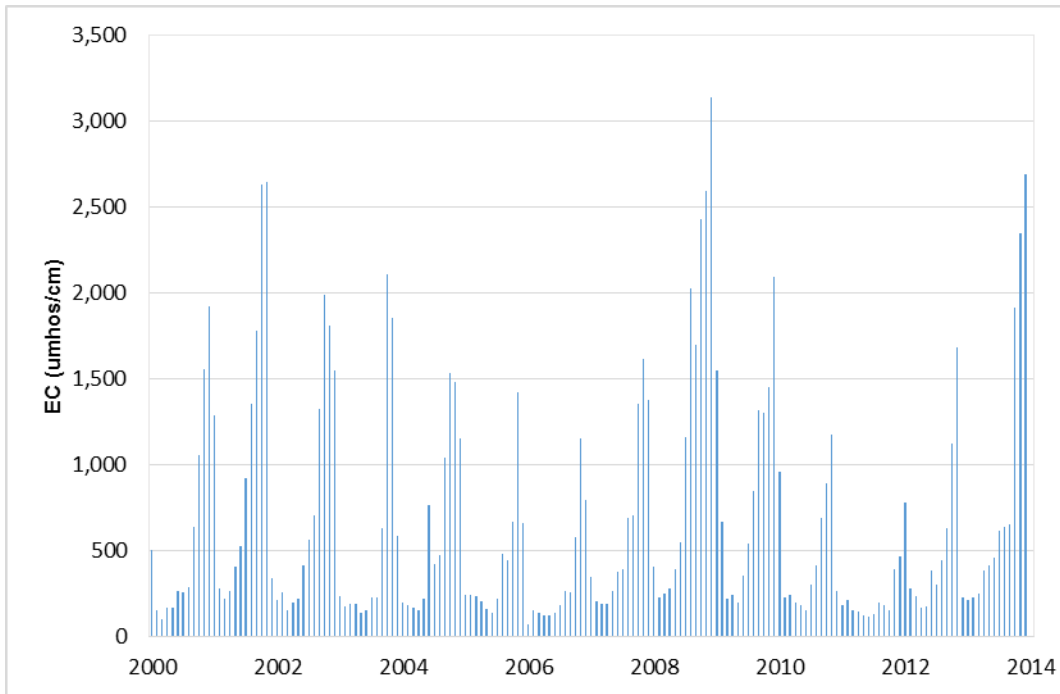


Figure 6.5. Water Quality Compliance Stations in the Delta



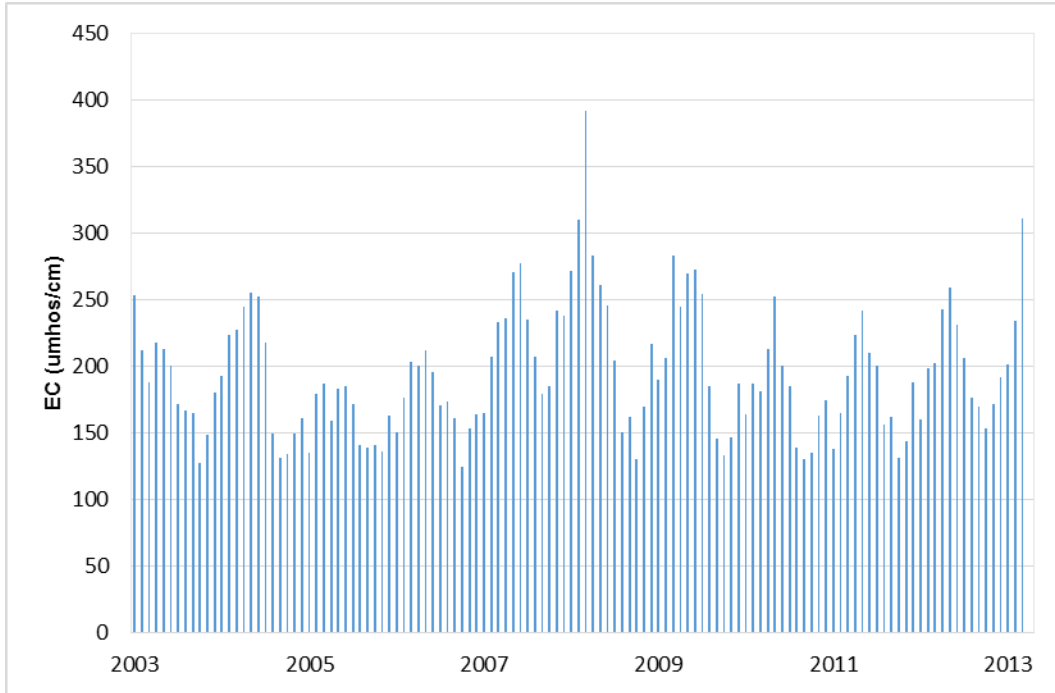
1

2 **Figure 6.6 Monthly Average Specific Conductance in Sacramento River at**  
3 **Collinsville (Reclamation 2013e)**



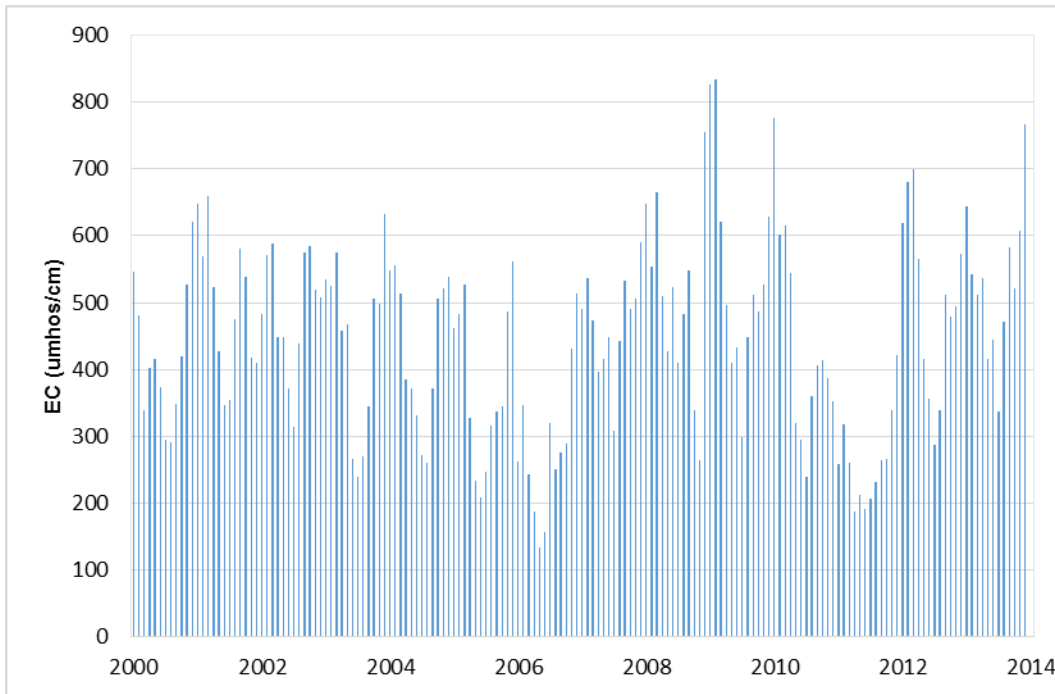
4

5 **Figure 6.7 Monthly Average Specific Conductance in Sacramento River at**  
6 **Emmaton (Reclamation 2013e)**



1

2 **Figure 6.8 Monthly Average Specific Conductance in Sacramento River at Rio Vista**  
3 **(Reclamation 2013e)**



4

5 **Figure 6.9 Monthly Average Specific Conductance at Delta Mendota Canal Intake**  
6 **(Reclamation 2013e)**

**Chapter 7**

1 **Groundwater Resources and**  
2 **Groundwater Quality**

3 **7.1 Introduction**

4 This chapter describes groundwater resources and groundwater quality in the  
5 study area, and potential changes that could occur as a result of implementing the  
6 alternatives evaluated in this Environmental Impact Statement (EIS).  
7 Implementation of the alternatives could affect groundwater resources through  
8 potential changes in operation of the Central Valley Project (CVP) and State  
9 Water Project (SWP) and ecosystem restoration.

10 **7.2 Regulatory Environment and Compliance**  
11 **Requirements**

12 Potential actions that could be implemented under the alternatives evaluated in  
13 this EIS could affect groundwater resources in the areas along the rivers impacted  
14 by changes in the operations of CVP or SWP reservoirs and in the vicinity of and  
15 lands served by CVP and SWP water supplies. Groundwater basins that may be  
16 affected by implementation of the alternatives are in the Trinity River Region,  
17 Central Valley Region, San Francisco Bay Area Region, Central Coast Region,  
18 and Southern California Region.

19 Actions located on public agency lands or implemented, funded, or approved by  
20 Federal and state agencies would need to be compliant with appropriate Federal  
21 and state agency policies and regulations, as summarized in Chapter 4, Approach  
22 to Environmental Analyses.

23 Several of the state policies and regulations described in Chapter 4 have resulted  
24 in specific institutional and operational conditions in California groundwater  
25 basins, including the basin adjudication process, California Statewide  
26 Groundwater Elevation Monitoring Program (CASGEM), California Sustainable  
27 Groundwater Management Act (SGMA), and local groundwater management  
28 ordinances, as summarized below.

29 **7.2.1 Groundwater Basin Adjudication**

30 Basin adjudications are determined through court decisions or pre-court mediation  
31 on litigation that determines the groundwater rights of all the groundwater users  
32 overlying the basins. The court identifies the extractors or well owners and the  
33 amount of groundwater those well owners are allowed to extract, and appoints a  
34 Watermaster whose role is to ensure that the basin is managed in accordance with  
35 the court's decree. The Watermaster must report periodically to the court. There  
36 are currently 23 adjudicated groundwater basins in California, most of which are

- 1 located in Southern California. Table 7.1 lists the adjudicated groundwater basins
- 2 located in the study area.

3 **Table 7.1 Adjudicated Groundwater Basins in the Study Area**

<b>Basin Name</b>	<b>Date of Final Court Decision</b>	<b>County</b>
Antelope Valley Groundwater Basin	Under way	Kern and Los Angeles
Beaumont – Upper Santa Ana Groundwater Basin	2004	Riverside
Brite Groundwater Basin	1970	Kern
Central Subbasin of the Coastal Plain of Los Angeles Basin	1965	Los Angeles
Chino Subbasin of the Upper Santa Ana Valley Basin	1978	Riverside and San Bernardino
Cucamonga Subbasin of the Upper Santa Ana Valley Basin	1978	San Bernardino
Cummings Valley Groundwater Basin	1972	Kern
Goleta Groundwater Basin	1989	Santa Barbara
San Jacinto Groundwater Basin	2013	Riverside
Los Osos Valley Groundwater Basin	Under way	San Luis Obispo
Mojave Basin Area (Lower Mojave River Valley, Middle Mojave River Valley, Upper Mojave River Valley, El Mirage Valley, and Lucerne Valley groundwater basins)	1996	San Bernardino
San Gabriel Valley Groundwater Basin – excluding Raymond Groundwater Basin	1973	Los Angeles
San Gabriel Valley Groundwater Basin – Puente Narrows	1985	Los Angeles
Raymond Groundwater Basin	1944	Los Angeles
Rialto-Colton Subbasin of the Upper Santa Ana Valley Basin	1961	San Bernardino
Santa Margarita River Watershed – Santa Margarita Valley, Temecula Valley, and Cahuilla Valley groundwater basins	1966*	Riverside and San Diego
Santa Maria Valley Groundwater Basin	2008	San Luis Obispo and Santa Barbara
Santa Paula Subbasin of the Santa Clara River Valley Groundwater Basin	1996	Ventura
Six Basins Area in upper Santa Ana Valley	1998	Los Angeles and San Bernardino
Tehachapi Valley West Basin and Tehachapi Valley East Basin	1973	Kern

Basin Name	Date of Final Court Decision	County
Upper Los Angeles River Area– San Fernando Valley Groundwater Basin	1979	Los Angeles
Warren Valley Groundwater Basin	1977	San Bernardino
West Coast Subbasin of the Coastal Plain of Los Angeles Basin	1961	Los Angeles
Western San Bernardino – Upper Santa Ana Groundwater Basin	1969	San Bernardino

1 Sources: DWR 2003a, 2014a; LOCSD 2013

2 Note:

3 \* Santa Margarita Watershed Adjudication addresses both groundwater and surface  
 4 water if water contributes to Santa Margarita River and its tributaries flows (SMRW 2014).  
 5 The agreements include interlocutory judgements for Murrieta-Temecula Groundwater  
 6 Basin that describes non-Indian water rights subject to court jurisdiction, land and water  
 7 rights not subject to court jurisdiction, reserved water rights for the Pechanga  
 8 Reservation, and appropriative storage and diversion rights in conjunction with use of  
 9 groundwater by the Vail Company.

10 **7.2.2 California Statewide Groundwater Elevation**  
 11 **Monitoring Program**

12 Senate Bill X7-6, enacted in November 2009, mandates a statewide groundwater  
 13 elevation monitoring program to track seasonal and long-term trends in  
 14 groundwater elevations in California’s groundwater basins defined in  
 15 Bulletin 118. This amendment to Division 6 of the Water Code, specifically  
 16 Part 2.11 Groundwater Monitoring, requires the collaboration between local  
 17 monitoring entities and California Department of Water Resources (DWR) to  
 18 collect groundwater elevation data. The law requires local agencies to monitor  
 19 and report the groundwater elevation in the basins. To achieve this goal, DWR  
 20 developed the CASGEM Program to establish a permanent, locally-managed  
 21 program of regular and systematic monitoring in all of the state’s alluvial  
 22 groundwater basins.

23 DWR is required to establish a priority schedule for monitoring groundwater  
 24 basins, and to report to the Legislature on the findings from these investigations  
 25 (Water Code section 10920 et. seq). The 2012 CASGEM Status Report to the  
 26 Legislature describes that more than 400 monitoring entities have been identified  
 27 and water level data are being submitted to DWR (DWR 2012). The  
 28 prioritization of basins is to identify, evaluate, and determine the need for  
 29 additional groundwater level monitoring. The prioritization approach includes the  
 30 following eight criteria.

- 31 • Overlying population in the groundwater basin
- 32 • Projected growth of the overlying population
- 33 • Number of public water supply wells



- 1 • Total number of water supply wells
  - 2 • Irrigated acreage overlying the groundwater basin
  - 3 • Reliance on groundwater as the primary source of water by the overlying
  - 4 land uses
  - 5 • Impacts on groundwater, including overdraft, subsidence, saline intrusion, and
  - 6 other water quality degradation
  - 7 • Any other information relevant to the groundwater conditions
- 8 Groundwater basins designations in the study area are described for each basin in
- 9 the following subsection of this chapter (DWR 2014e).

### 10 **7.2.3 Sustainable Groundwater Management Act**

11 In September 2014, the SGMA was enacted. The SGMA establishes a new

12 structure for locally managing California’s groundwater in addition to existing

13 groundwater management provisions established by Assembly Bill (AB)

14 3030 (1992), Senate Bill (SB) 1938 (2002), and AB 359 (2011), as well as

15 SBX7-6 (2009).

16 The SGMA includes the following key elements:

- 17 • Provides for the establishment of a Groundwater Sustainability Agency (GSA)
- 18 by one or more local agencies overlying a designated groundwater basin or
- 19 subbasin identified in DWR Bulletin 118-03
- 20 • Requires all DWR Bulletin 118 groundwater basins found to be of “high” or
- 21 “medium” priorities to prepare Groundwater Sustainability Plans (GSPs)
- 22 • Provides for the proposed revisions, by local agencies, to the boundaries of a
- 23 DWR Bulletin 118 basin, including the establishment of new subbasins
- 24 • Provides authority for DWR to adopt regulations to evaluate GSPs, and
- 25 review the GSPs for compliance every 5 years
- 26 • Requires DWR to establish best management practices and technical measures
- 27 for GSAs to develop and implement GSPs
- 28 • Provides regulatory authority to the State Water Resources Control Board
- 29 (SWRCB) for developing and implementing interim groundwater
- 30 management plans under certain circumstances (such as lack of compliance
- 31 with development of GSPs by GSAs)

32 The SGMA defines sustainable groundwater management as “the management

33 and use of groundwater in a manner that can be maintained during the planning

34 and implementation horizon without causing undesirable results.” Undesirable

35 results are defined as any of the following effects.

- 36 • Chronic lowering of groundwater levels (not including overdraft during a
- 37 drought if a basin is otherwise managed)
- 38 • Significant and unreasonable reduction of groundwater storage

- 1 • Significant and unreasonable seawater intrusion
- 2 • Significant and unreasonable degraded water quality, including the migration
- 3 of contaminant plumes that impair water supplies
- 4 • Significant and unreasonable land subsidence that substantially interferes with
- 5 surface land uses
- 6 • Depletions of interconnected surface water that have significant and
- 7 unreasonable adverse impacts on beneficial uses of the surface water

8 Based on basin priority definitions defined by DWR’s CASGEM program in June  
 9 2014 and confirmed in January 2015, the SGMA requires the formation of GSPs  
 10 by 2020 or 2022. GSPs for medium and high priority basins identified subject to  
 11 critical conditions of overdraft are required by 2022. All other high and medium  
 12 priority basins must complete a GSP by 2020. Updates to CASGEM-defined  
 13 June 2014 designated priorities are possible and can affect GSP deadline  
 14 requirements. Sustainable groundwater operations must be achieved within  
 15 20 years following completion of the GSPs.

16 **7.2.4 Regional and Local Groundwater Ordinances**

17 Many counties within the study area considered in this EIS have adopted or are  
 18 considering groundwater ordinances. The ordinances primarily address well  
 19 installation, groundwater extraction, and export of the groundwater to areas  
 20 outside the basin of origin. Local county groundwater ordinances vary by  
 21 authority, agency, or region but typically involve permitting for well installation,  
 22 and provisions to limit or prevent groundwater overdraft, to regulate transfers, and  
 23 to protect groundwater quality.

24 Table 7.2 provides a list of substantial county groundwater ordinances within the  
 25 study area that could affect groundwater supply availability.

26 **Table 7.2 County Groundwater Ordinances in the Study Area with a Summary of**  
 27 **Regulations**

County	Ordinance Number and Title	Description
Trinity	County Code Title 15: Buildings and Construction, Chapter 15.20: Water wells.	Well standards.
Trinity and Humboldt	Hoopa Valley Tribal Council Title 37: Pollution Discharge Prohibition Ordinance	Regulates surface water and groundwater operations.
Humboldt	County Code Title VI: Water and Sewage, Division 3: Wells.	Well standards.
	Hoopa Valley Tribe: Not identified at this time.	Not applicable.
Del Norte	County Code Title 7: Health and Welfare Chapter 32: Regulations of Wells and Preservation of Groundwater.	Well standards.

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<b>County</b>	<b>Ordinance Number and Title</b>	<b>Description</b>
Shasta	County Code Title 18: Environment 18.08: Groundwater Management.	Requires permit for groundwater extraction for use outside county.
Shasta	County Code Title 8: Health and Safety, 8.56: Water Wells.	Well standards.
Plumas	County Code Title 6: Sanitation and Health, Chapter 8: Water Wells.	Well standards. Groundwater management plans have been adopted in Plumas County, but not in the vicinity of the study area.
Tehama	County Code Title 9: Health and Safety, Chapter 9.40: Aquifer Protection.	Prohibits groundwater from being exported out of county. Requires permit to use groundwater from wells on a parcel on other parcels of land.
Tehama	County Code Title 9: Health and Safety, Chapter 9.42: Well Construction, Rehabilitation, Repair and Destruction.	Well standards.
Glenn	County Code Title 20: Water 20.030: Groundwater Coordinated Resource Management Plan.	Basin Management Objectives and monitoring network to detect changes in groundwater level, quality, land subsidence; and defines acceptable ranges of groundwater levels.
	County Code Title 20: Water, 20.080: Water Well Drilling Permits and Standards.	Well standards.
Colusa	County Code Chapter 43: Groundwater Management.	Requires permit for groundwater extraction for use outside county.
	County Code Chapter 35: Well Standards.	Well standards.
Butte	County Code Chapter 33A: Basin Management.	Basin Management Objectives for: groundwater quality and groundwater levels, and other protections to reduce land subsidence.
	County Code Chapter 23B: Water Wells.	Well standards.
Yuba	County Code Title VII: Health and Sanitation, Chapter 7.03: Water wells.	Well standards.

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<b>County</b>	<b>Ordinance Number and Title</b>	<b>Description</b>
Sutter	County Code Section 700: Health and Sanitation, Chapter 765: Water Wells.	Well standards.
Placer	County Code Chapter 13: Public Services, Article 13.08: Water Wells.	Well standards.
El Dorado	County Code Title 8: Health and Safety, Chapter 8.39: Well Standards.	Well standards. Groundwater management plans have been adopted in El Dorado County, but not in the vicinity of the study area.
Sacramento	County Code Title 6: Health and Sanitation, Chapter 6.28: Wells and Pumps.	Well standards.
Yolo	County Code Title 10: Environment Chapter 7: Groundwater.	Requires permit for groundwater extraction for use outside of the county.
	County Code Title 6: Sanitation and Health, Chapter 8: Water Quality, Article 10: Standards, Criteria, and Regulations of Wells.	Well standards.
Solano	County Code Chapter 13.6: Injection Wells.	Restricts operation of injection wells.
	County Code Chapter 13.10: Well Standards.	Well standards.
Napa	County Code Title 13: Waters, Sewers, and Public Services Chapter 13.15: Groundwater Conservation.	Regulates the use of groundwater.
	County Code Title 13: Waters, Sewers, and Public Services Chapter 13.12: Wells.	Well standards.
San Joaquin	County Code Title 5: Health and Sanitation, Division 4: Wells and Well Drilling.	Well standards.
	County Code Title 5: Health and Sanitation, Division 8: Groundwater.	Requires permit for groundwater use outside of the county.
Stanislaus	County Code Title 9: Health and Safety, Chapter 9.37: Groundwater Mining and Export Prevention.	Regulates groundwater use and prohibits export of water outside of the county (except as noted in the requirements).
	County Code Title 9: Health and Safety, Chapter 9.36: Water Wells.	Well standards.

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<b>County</b>	<b>Ordinance Number and Title</b>	<b>Description</b>
Madera	<p>County Code Title 13: Waters and Sewers, V Groundwater Exportation, Groundwater Banking, and Importation of Foreign Water, for Purposes of Groundwater Banking, to Areas of Madera County which are Outside of Local Water Agencies that Deliver Water to Lands Within their Boundaries.</p> <p>Chapter 13.1: Rules and Regulations Pertaining to Groundwater Banking— Importation of Foreign Water, for the Purpose of Groundwater Banking, to Areas of Madera County which are Outside of Local Water Agencies that Deliver Water to Lands within their Boundaries— Exportation of Groundwater Outside the County.</p>	<p>Regulates development of groundwater banking, including importation of groundwater to be stored in the groundwater bank, and exportation of groundwater for use outside of the county; and prohibits groundwater injection.</p>
	<p>County Code Title 13: Waters and Sewers, I: Water, Chapter 13.52: Well Standards.</p>	<p>Well standards.</p>
Merced	<p>County Code Title 9: General Health and Safety, Chapter 9.28: Wells.</p>	<p>Well standards.</p>
Fresno	<p>County Code Title 14: Waters and Sewers, Chapter 14.03: Groundwater Management.</p>	<p>Regulates groundwater use outside of the county.</p>
	<p>County Code Title 14: Waters and Sewers, Chapter 14.04: Well Regulations – General Provisions.</p>	<p>Well standards.</p>
	<p>County Code Title 14: Waters and Sewers Chapter 14.08: Well Construction, Pump Installation and Well Destruction Standards.</p>	<p>Well standards.</p>
Tulare	<p>County Code Part IV: Health, Safety, and Sanitation, Chapter 13: Well.</p>	<p>Well standards.</p>
Kings	<p>County Code Chapter 14A: Water Wells.</p>	<p>Well standards.</p>
Kern	<p>County Code Title 14: Utilities Chapter 14.08: Water Supply Systems, Article III: Well Standards.</p>	<p>Well standards.</p>
Contra Costa	<p>County Code Title 4: Health and Safety, Chapter 414: Waterways and Water Supply, Chapter 414-4: Water supply.</p>	<p>Well standards.</p>
Alameda	<p>County Code Title 6: Health and Safety, Chapter 6.88: Water Wells.</p>	<p>Well standards.</p>

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<b>County</b>	<b>Ordinance Number and Title</b>	<b>Description</b>
Santa Clara	Santa Clara Valley Water District Act (California Water Code Appendix, Chapter 60).	Santa Clara Valley Water District is the designated agency to manage water within Santa Clara County, including groundwater management to recharge the basin, conserve water, increase water supply, and prevent waste or diminution of the water supply.
	Santa Clara Valley Water District Well Ordinance 90-1.	Well standards.
San Benito	County Code Title 15: Public Works, Chapter 5.05: Water, Article I: Groundwater Aquifer Protections.	Regulates use of groundwater on non-contiguous parcels with separate owners than parcel with well, injection of groundwater, and operations that could adversely affect other groundwater users or the groundwater aquifer.
	County Code Title 15: Public Works, Chapter 5.05: Water, Article III: Well Standards.	Well standards.
San Luis Obispo	County Code Title 8: Health and Sanitation, Chapter 8.40: Construction, Repair, Modification and Destruction of Wells.	Well standards.
Santa Barbara	County Code Chapter 34A: Wells.	Well standards.
Ventura	County Code Division 4: Public Health, Chapter 8: Water, Article 1: Groundwater Conservation.	Well standards.
Los Angeles	County Code Title 11: Health and Safety, Chapter: 11.38 Water and Sewers, Part 2: Water and Water Wells.	Well standards.
Orange	County Code Title 4: Health and Sanitation and Animal Regulations, Division 5: Water Conservation, Article 3 Construction and Abandonment of Water Wells.	Well standards.

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County	Ordinance Number and Title	Description
San Diego	County Code Title 6: Health and Sanitation, Division 7: Water and Water Supplies, Chapter 4: Wells.	Well standards.
	County Code Title 6: Health and Sanitation, Division 7: Water and Water Supplies, Chapter 7: Groundwater.	Regulates actions for the protection, preservation, and maintenance of groundwater resources.
Riverside	County Code Title 13: Public Services, Chapter 13.20: Water Wells.	Well standards.
San Bernardino	County Code Title 3: Health and Sanitation, Division 3: Environmental Health, Chapter 6: Domestic Water Sources and Systems, Article 3: Water Wells.	Well standards.
	County Code Title 3: Health and Sanitation, Division 3: Environmental Health, Chapter 6: Domestic Water Sources and Systems, Article 5: Desert Groundwater Management.	Regulates groundwater basins not adjudicated by judicial decree; and wells not within the boundaries of the Mojave Water Agency and public water agencies within the Morongo Basin, incorporated areas, or Federal lands. This section does not apply to wells used for existing mining operations, small agricultural operations, small wells, or replacement wells of similar size to abandoned wells. This section does not apply to areas with a groundwater management plan and a memorandum of understanding with the county.

1 Sources: Trinity County 2014; Hoopa Valley Tribe 2008; Humboldt County 2014; Del  
2 Norte County 2014; Shasta County 2014 a, b; Plumas County 2014; Tehama County  
3 2014; Glenn County 2014; Colusa County 2014 a, b; Butte County 2014 a, b; Yuba  
4 County 2014; Sutter County 2014; Placer County 2014; El Dorado County 2014;  
5 Sacramento County 2014; Yolo County 2014; Solano County 2014; Napa County 2014;  
6 San Joaquin County 2014; Stanislaus County 2014; Madera County 2014; Merced  
7 County 2014; Fresno County 2014; Tulare County 2014; Kings County 2014; Kern  
8 County 2014; Contra Costa County 2014; Alameda County 2014; SCVWD 2014 a, b; San  
9 Benito County 2014; San Luis Obispo County 2014a; Santa Barbara County 2014;  
10 Ventura County 2014; Los Angeles County 2014a; Orange County 2014; San Diego  
11 County 2014; Riverside County 2014; San Bernardino County 2014

## 1 **7.3 Affected Environment**

2 This section describes groundwater resources that could be potentially affected by  
 3 the implementation of the alternatives considered in this EIS. Changes in  
 4 groundwater resources due to changes in CVP and SWP operations may occur in  
 5 the Trinity River, Central Valley, San Francisco Bay Area, Central Coast, and  
 6 Southern California regions.

7 Groundwater occurs throughout the study area. However, the groundwater  
 8 resources that could be directly or indirectly affected through implementation of  
 9 the alternatives analyzed in this EIS are related to groundwater basins which  
 10 include users of CVP and SWP water supplies that also use groundwater, and  
 11 areas along the rivers downstream of CVP or SWP reservoirs that use  
 12 groundwater supplies. Therefore, the following description of the affected  
 13 environment is limited to these areas and does not include groundwater basins or  
 14 subbasins that area not directly or indirectly affected by changes in CVP and  
 15 SWP operations.

### 16 **7.3.1 Overview of California Groundwater Resources**

17 As described in Chapter 5, Surface Water Resources and Water Supplies,  
 18 groundwater is a vital resource in California. Groundwater supplied about  
 19 37 percent of the state's average agricultural, municipal, and industrial water  
 20 needs between 1998 and 2010, and 40 percent or more during dry and critical  
 21 water years in that period (DWR 2013i). About 20 percent of the nation's  
 22 groundwater demand is supplied from the Central Valley aquifers, making it the  
 23 second-most-pumped aquifer system in the United States (USGS 2009). The  
 24 three Central Valley hydrologic regions (Tulare Lake, San Joaquin River, and  
 25 Sacramento River) account for about 75 percent of the state's average annual  
 26 groundwater use (DWR 2013i).

27 The DWR has delineated 515 distinct groundwater systems throughout the state,  
 28 as described in Bulletin 118-03 (DWR 2003a), that are considered to be the most  
 29 important groundwater basins. These basins and subbasins have various degrees  
 30 of supply reliability considering yield, storage capacity, and water quality, and are  
 31 typically alluvial, or non-consolidated (non-fractured rock) aquifers. Figure 7.1  
 32 shows the statewide occurrence of groundwater in the groundwater basins and  
 33 subbasins identified by DWR as Bulletin 118 basins. A majority of the  
 34 descriptions provided herein are summarized form DWR Bulletin 118 reports.

35 The importance of groundwater as a resource varies regionally. The Central  
 36 Coast has the most reliance on groundwater to meet its local uses, with more than  
 37 80 percent of the agricultural, municipal, and industrial water supplies by  
 38 groundwater in an average year. The central and southern San Joaquin Valley  
 39 (described as the Tulare Lake Area of the San Joaquin Valley Groundwater Basin  
 40 in this chapter) groundwater use, on average, meets about 50 percent of the total  
 41 water supplies. The Sacramento Valley and northern portion of the San Joaquin  
 42 Valley Groundwater Basin use groundwater to meet approximately 30 and  
 43 40 percent of the agricultural, municipal, and industrial water demand,



1 respectively. In the coastal areas of Southern California, groundwater use varies  
2 from less than 10 percent in western San Diego County to between 35 and  
3 50 percent of the agricultural, municipal, and industrial water supplies in counties  
4 along the coast western Ventura, Los Angeles, and Riverside counties and Orange  
5 County, on an annual average basis. In the inland areas of Southern California,  
6 groundwater use varies from approximately 45 to over 90 percent of the  
7 agricultural, municipal, and industrial water supplies (DWR 2013).

8 A comprehensive assessment of overdraft in all of the state's groundwater basins  
9 has not been conducted since Bulletin 118-80 was published in 1980, but  
10 overdraft is estimated at between 1 to 2 million acre-feet annually (DWR 2003a).  
11 In DWR's Bulletin 118-80 (DWR 1980), an assessment of critically overdrafted  
12 basins was conducted, as shown in Figure 7.2. This assessment identified 11  
13 basins in critical condition of overdraft. Based on SGMA requirements, the state  
14 must identify basins subject to critical conditions of overdraft in 2015, publish the  
15 final list in 2016, and use this list in the Bulletin 118 Interim Update 2017. This  
16 revised list is being finalized at the same time as this EIS document is finalized.  
17 This revised draft list added three basins in the EIS study area that are considered  
18 in critical conditions of overdraft (DWR 2015):

- 19 • Merced (5-22.04): Subsidence in El Nido area of 0.6 to 1.0 ft/year
- 20 • Delta-Mendota ((5-22.07): Significant, on-going and irreversible  
21 subsidence
- 22 • Westside (5-22.09): Significant, on-going and irreversible subsidence

23 In the past 20 years, specific groundwater studies have been conducted by  
24 regional water agencies or the U.S. Geological Survey (USGS) to update the  
25 statewide survey conducted by DWR in 1980 (USGS 2000a, 2006, 2008, 2009,  
26 2012, 2014). The results of many of those studies are discussed in the following  
27 subsections of this chapter.

### 28 **7.3.2 Trinity River Region**

29 The Trinity River Region includes the area along the Trinity River from Trinity  
30 Lake to the confluence with the Klamath River; and along the Klamath River  
31 from the confluence with the Trinity River to the Pacific Ocean.

32 Most usable groundwater in the Trinity River Region occurs in widely scattered  
33 alluvium filled valleys, such as those immediately adjacent to the Trinity River.  
34 These valleys contain only small quantities of recoverable groundwater, and,  
35 therefore, are not considered a major source. A number of shallow wells adjacent  
36 to the river provide water for domestic purposes (Reclamation et al. 2006a;  
37 NCRWQCB et al. 2009). Groundwater present in these alluvial valleys is in close  
38 hydraulic connection with the Trinity River and its tributaries. Both groundwater  
39 discharge to surface streams as well as leakage of steam flow to underlying  
40 aquifers are expected to occur at various locations.

41 The Bulletin 118-03 (DWR 2003a, 2004do, 2004dp) identified only two  
42 groundwater basins underlying the Trinity River Region in the Study Area, Hoopa

1 Valley and Lower Klamath River Valley groundwater basins, as shown in  
2 Figure 7.3. These groundwater basins are small, isolated, valley-fill aquifers that  
3 provide a very limited quantity of groundwater to satisfy local domestic,  
4 municipal, and agricultural needs. Groundwater pumped from these aquifer  
5 systems is used strictly for local supply.

6 As described in Chapter 5, Surface Water Resources and Water Supplies, several  
7 communities use infiltration galleries along the Trinity River and the tributaries to  
8 convey surface water to groundwater wells, including the Lewiston Community  
9 Services District, Lewiston Valley Water Company, and Lewiston Park Mutual  
10 Water Company (NCRWQCB et al. 2009).

11 Groundwater within the Hoopa Valley Indian Reservation occurs along alluvial  
12 terraces (Hoopa Valley Tribe 2008). The aquifers are approximately 10 to 80 feet  
13 deep. Some of the shallow wells are productive only during winter and early  
14 spring months.

15 The Lower Klamath River Valley Groundwater Basin extends over 7,030 acres in  
16 Del Norte and Humboldt counties, including areas along the Lower Klamath  
17 River (Reclamation 2010a). Groundwater along the Lower Klamath River occurs  
18 in alluvial fans near the confluences of major tributaries and along terrace and  
19 floodplain deposits adjacent to the river (Yurok Tribe 2012). The aquifers range  
20 in depth from 10 to 80 feet and are used by some members of the community.

21 The Hoopa Valley and Lower Klamath River Valley groundwater basins were  
22 designated by the CASGEM program as very low and low priorities, respectively.

23 Groundwater quality is suitable for many beneficial uses in the region. In other  
24 locations, the groundwater can include naturally occurring metals, including  
25 manganese, cadmium, zinc, and barium (Hoopa Valley Tribe 2008). Other  
26 groundwater quality issues include nitrate contamination (DWR 2013i).

27 Groundwater and surface water contamination is suspected at several former and  
28 existing mill sites that historically used wood treatment chemicals. Discharges of  
29 pentachlorophenol, polychlorodibenzodioxins, and polychlorodibenzofurans have  
30 likely occurred due to the poor containment practices typically used in historical  
31 wood treatment applications. Additional investigation, sampling and monitoring,  
32 and enforcement actions have been limited by the insufficient resources that exist  
33 to address this historical toxic chemical problem (NCRWQCB 2005).

34 **7.3.3 Central Valley Region**

35 The Central Valley Region extends from above Shasta Lake to the Tehachapi  
36 Mountains, and includes the Sacramento Valley, San Joaquin Valley, Delta, and  
37 Suisun Marsh.

38 Groundwater for the Central Valley Region is described in relation to the basins  
39 described by DWR in Bulletin 118-03 (DWR 2003a). The overall area includes  
40 the Sacramento Valley Basin which extends through the Sacramento Valley, and  
41 the San Joaquin Valley Groundwater Basin (including the Tulare Lake Area,  
42 which extends through the San Joaquin Valley). The Delta and Suisun Marsh  
43 area are located partially in the Sacramento Valley Basin and partially in the

1 San Joaquin Valley Groundwater Basin. The Delta and Suisun Marsh area is  
2 described separately because of its distinct characteristics as an estuary at the  
3 confluence of the Sacramento and the San Joaquin rivers.

4 **7.3.3.1 Sacramento Valley**

5 The Sacramento Valley includes the Redding Groundwater Basin and the  
6 Sacramento Valley Groundwater Basin. The Sacramento Valley Groundwater  
7 Basin is one of the largest groundwater basins in the state, and extends from  
8 Redding in the north to the Delta in the south (USGS 2009).

9 Approximately one-third of the Sacramento Valley's urban and agricultural water  
10 needs are met by groundwater (DWR 2003a). The portion of the water diverted  
11 for irrigation but not actually consumed by crops or other vegetation becomes  
12 recharge to the groundwater aquifer or flows back to surface waterways.

13 Overall, the Sacramento Groundwater Basin is approximately balanced with  
14 respect to annual recharge and pumping demand. However, there are several  
15 locations showing early signs of persistent drawdown, suggesting limitations due  
16 to increased groundwater use in dry years. Locations of persistent drawdown  
17 include: Glenn County, areas near Chico in Butte County, northern Sacramento  
18 County, and portions of Yolo County.

19 The water quality of groundwater in the Sacramento Valley is generally good, as  
20 described below for individual basins. Several areas have localized aquifers with  
21 high nitrate, total dissolved solids (TDS) or boron concentrations. High nitrate  
22 concentrations frequently occur due to residuals from agricultural operations or  
23 septic systems. High TDS, a measure of salinity, concentration can be an  
24 indicator of brackish or connate water when it occurs in high concentrations.  
25 High boron concentration usually is associated with naturally occurring deposits.

26 **7.3.3.1.1 Overview of Groundwater Basins in the Sacramento Valley**

27 The Sacramento Valley includes the Redding Groundwater Basin and the  
28 Sacramento Valley Groundwater Basin. The Redding Groundwater Basin is  
29 situated in the extreme northern end of the valley and is a separate, isolated  
30 groundwater basin, but due to similarities in geology and stratigraphy is discussed  
31 as part of the overall Sacramento Valley. It is bordered by the Coast Ranges on  
32 the west, and by the Cascade Range and Sierra Nevada mountains on the east.

33 The Sacramento Valley Groundwater Basin has been divided into 17 subbasins by  
34 DWR, as shown in Figure 7.4, based on groundwater characteristics, surface  
35 water features, and political boundaries (DWR 2003a). However, from a  
36 hydrologic standpoint, these individual groundwater subbasins have a high degree  
37 of hydraulic connection because the rivers do not always act as barriers to  
38 groundwater flow. Therefore, the Sacramento Valley Groundwater Basin  
39 functions primarily as a single laterally extensive alluvial aquifer, rather than  
40 numerous discrete, smaller groundwater subbasins.

41 For discussion purposes, and due to their common characteristics, the Sacramento  
42 Valley is further sub-divided into the Upper Sacramento Valley, the Lower

1 Sacramento Valley West of the Sacramento River, and the Lower Sacramento  
2 Valley East of the Sacramento River.

3 *General Hydrogeology of the Sacramento Valley*

4 Freshwater in the Sacramento Valley Groundwater Basin occurs within the  
5 continental deposits. Hydrogeologic units containing freshwater along the eastern  
6 portion of the basin, primarily occur in the Tuscan and Mehrten formations, and  
7 are derived from the Sierra Nevada. Toward the southeastern portion of the  
8 Sacramento Valley, the Mehrten formation is overlain by sediments of the  
9 Laguna, Riverbank, and Modesto formations, which also originated in the  
10 Sierra Nevada. The primary hydrogeologic unit in the western portion of the  
11 Sacramento Valley is the Tehama formation, which was derived from the Coast  
12 Ranges. In most of the Sacramento Valley, these deeper units are overlain by  
13 younger alluvial and floodplain deposits. Generally, groundwater flows inward  
14 from the edges of the basin toward the Sacramento River, then in a southerly  
15 direction parallel to the river. Depth to groundwater throughout most of the  
16 Sacramento Valley averages about 30 feet below the ground surface, with  
17 shallower depths along the Sacramento River and greater depths along the basin  
18 margins. Wells developed in the sediments of the valley provide excellent supply  
19 to irrigation, municipal, and domestic uses. The deepest elevation of the base of  
20 freshwater in the Sacramento Valley ranges between 400 feet and 3,350 feet  
21 below mean sea level (Berkstresser 1973). The location where the base of  
22 freshwater is the deepest occurs in the Delta near Rio Vista. Near the valley  
23 margins and the Sutter Buttes, the base of freshwater is relatively shallow;  
24 suggesting that the base of freshwater may coincide with bedrock or connate  
25 water trapped in shallower deposits close to the basin margins  
26 (Berkstresser 1973).

27 Today, groundwater levels are generally in balance valley-wide, with pumping  
28 matched by recharge from the various sources annually. Some locales show the  
29 early signs of persistent drawdown, especially in areas where water demands are  
30 met primarily, and in some locales exclusively, by groundwater. These areas  
31 include portions of the far west side of the Sacramento Valley in Glenn County,  
32 portions of Butte County near Chico, in portions of Yolo County, and in the  
33 northern Sacramento County area. The persistent areas of drawdown could be  
34 early signs that the limits of sustainable groundwater use have been reached in  
35 these areas. Due to the drought that started in 2011, surface water supplies have  
36 declined and new wells have been installed. Between January and October 2014,  
37 over 100 water supply wells were drilled in both Shasta and Butte counties  
38 (DWR 2014d).

39 Land subsidence in the Sacramento Valley has resulted from inelastic deformation  
40 (non-recoverable changes) of fine-grained sediments related to groundwater  
41 withdrawal. Areas of subsidence from groundwater level declines have been  
42 measured in the Sacramento Valley at several locations. Subsidence monitoring  
43 was established following several studies in the 1990s that indicated more than  
44 four feet of subsidence since 1954 in some areas, such as in Yolo County  
45 (Ikehara 1994). Initial data from the Yolo County extensometers indicated

1 subsidence in the Zamora area, which has subsequently been confirmed with a  
2 countywide global positioning system network installed in 1999 and monitored in  
3 2002 and 2005. Subsidence up to 0.4 feet occurred between 1999 and 2005 in the  
4 Zamora area (Frame Surveying and Mapping 2006). The Zamora area does not  
5 currently use CVP or SWP water supplies. However, this area was designated as  
6 part of the CVP Sacramento Valley Irrigation Canals service area in the  
7 Reclamation Act of 1950 and as amended in the Reclamation Act of 1980 and  
8 Central Valley Project Improvement Act.

### 9 **7.3.3.1.2 Upper Sacramento Valley**

10 The Upper Sacramento Valley includes the Redding Groundwater Basin and  
11 upper portions of the Sacramento Valley Groundwater Basin (DWR 2003a). The  
12 Redding Groundwater Basin extends from approximately Redding in Shasta  
13 County through the northern portions of Tehama County. The portions of the  
14 Sacramento Valley Groundwater Basin in the Upper Sacramento Valley are  
15 located primarily in Tehama County with small portions extending into Glenn  
16 County near Orland and Butte County near Chico in the south. The geology of  
17 this area is dominated by the Tuscan and Tehama Formations. The hydrology of  
18 this area is dominated by numerous smaller drainages that originate in the Sierra  
19 Nevada, Cascade, and Coast Ranges and drain to the Sacramento River (DWR  
20 2003a).

#### 21 *Hydrogeology and Groundwater Conditions*

22 The Redding Groundwater Basin comprises the northernmost part of the  
23 Sacramento Valley and is bordered by the Klamath Mountains to the north, the  
24 Coast Ranges to the west, the Cascade Mountains to the east, and the Red Bluff  
25 Arch to the south. This basin consists of a sediment-filled, symmetrical,  
26 southward-dipping trough formed by folding of the marine sedimentary basement  
27 rock. These deposits are overlain by a thick sequence of inter-bedded,  
28 continentally-derived, sedimentary, and volcanic deposits of Late Tertiary and  
29 Quaternary age. The primary fresh water-bearing deposits in the basin are the  
30 Pliocene age volcanic deposits of the Tuscan Formation and the Pliocene age  
31 continental deposits of the Tehama Formation (DWR 2003a, 2003b, 2004a,  
32 2004b, 2004c, 2004d, 2004e, 2004f).

33 The Tehama Formation consists of unconsolidated to moderately consolidated  
34 coarse and fine-grained sediments derived from the Coast Ranges to the west.  
35 The Tehama Formation is up to 4,000 feet thick and varies in depth from a few  
36 feet to several hundred feet below the land surface, with depth generally  
37 increasing to the east towards the Sacramento River (DWR 2003a, 2004a, 2004b,  
38 2004c, 2004d, 2004e, 2004f). The Tuscan formation is derived from the Cascade  
39 Range to the east and is primarily composed of volcanoclastic sediments.

40 The Redding Groundwater Basin includes six subbasins: Anderson, Rosewood,  
41 Bowman, Enterprise, Millville, and South Battle Creek (DWR 2003a, 2004a,  
42 2004b, 2004c, 2004d, 2004e, 2004f). The Anderson subbasin is one of the main  
43 groundwater units in the Redding Basin. Groundwater levels in the unconfined  
44 and confined portions of the aquifer system fluctuate annually by 2 to 4 feet

1 during normal precipitation years and up to 10 to 16 feet during drought years  
 2 (DWR 2003b). Between spring 2010 and spring 2014 in the Redding  
 3 Groundwater Basin, recent information indicates that groundwater levels declined  
 4 at multiple wells by up to 10 feet. The groundwater levels in some areas declined  
 5 up to 10 feet between Fall 2013 and Fall 2014 (DWR 2014c, 2014d).

6 Tehama County overlies three subbasins within the Redding Groundwater Basin  
 7 and seven subbasins in the Sacramento Valley Groundwater Basin. The  
 8 Rosewood, South Battle Creek, and Bowman subbasins in the Redding  
 9 Groundwater Basin are located in Tehama County. The Red Bluff, Corning,  
 10 Bend, Antelope, Dye Creek, Los Molinos, and Vina subbasins in the Sacramento  
 11 Valley Groundwater Basin are located in Tehama County (DWR 2004b, 2004c,  
 12 2004f, 2004g, 2004h, 2004i, 2004j, 2004k, 2004l, 2006a). The Corning subbasin  
 13 extends into northern Glenn County near Orland. The Vina subbasin extends into  
 14 northern Butte County near Chico. Groundwater levels in these subbasins show a  
 15 significant seasonal variation due to high groundwater use for irrigation during  
 16 the summer months. Groundwater levels showed significant declines in some  
 17 wells associated with the 1976 to 1977 and 1987 to 1992 drought periods.  
 18 Groundwater levels appeared to recover quickly during subsequent wet years.  
 19 Groundwater levels in the Corning area of Tehama County showed a general  
 20 decline before 1965 due to increased groundwater pumping for agricultural uses.  
 21 Following construction by the CVP of the Tehama-Colusa Canal and the Corning  
 22 Canal, surface water was delivered to these areas and there was a subsequent  
 23 upward trend in groundwater levels following initial operations (Tehama County  
 24 Flood Control and Water Conservation District 1996). Between spring 2010 and  
 25 spring 2014 in the Upper portion of the Sacramento Valley Groundwater Basin,  
 26 recent information indicates that groundwater levels declined at multiple wells  
 27 approximately 2.5 feet to 10 feet (DWR 2014c, 2014d). The groundwater levels  
 28 in some areas declined up to 10 feet between fall 2013 and fall 2014, and in some  
 29 areas more than 10 feet.

30 Groundwater quality in the Redding Groundwater Basin is generally good to  
 31 excellent for most uses. Some areas of poor quality due to high salinity from  
 32 marine sedimentary rock exist at the margins of the basin. Portions of the basin  
 33 are characterized by high boron, iron, manganese, and nitrates in localized areas  
 34 (DWR 2004a, 2004b, 2004c, 2004d, 2004e, 2004f). In general, groundwater in  
 35 the Sacramento Valley Groundwater Basin within Tehama County is of excellent  
 36 quality, with some localized areas with groundwater quality concerns related to  
 37 boron, calcium, chloride, magnesium, nitrate, phosphorous, and TDS (DWR  
 38 2004g, 2004h, 2004i, 2004j, 2004k, 2004l, 2006a). In the vicinity of Antelope,  
 39 east of Red Bluff, historical high nitrates in groundwater occur. Higher boron  
 40 levels have been detected in wells located in the eastern portion of Tehama  
 41 County. High salinity occurs near Salt Creek, which most likely originates from  
 42 the Tuscan Springs, which is a source of high boron and sulfates.

43 The Vina subbasin was designated by the CASGEM program as high priority.  
 44 The Anderson, Enterprise, Bowman, Red Bluff, Corning, Antelope, Dye Creek,  
 45 and Los Molinos subbasins were designated medium priority. The Rosewood,

1 Millville, South Battle Creek, and Bend subbasins were designated very low  
2 priority in the June 2014 CASGEM designation.

3 *Groundwater Use and Management*

4 Tehama County uses groundwater to meet approximately 65 percent of its total  
5 water needs (Tehama County Flood Control and Water Conservation District  
6 2008). Groundwater in the county provides water supply for agricultural,  
7 domestic, environmental, and industrial uses.

8 One of the main users of groundwater in this area is the Anderson-Cottonwood  
9 Irrigation District. Approximately 5 percent of the irrigated acres rely upon  
10 groundwater (DWR 2003b). Groundwater also is the primary water supply for  
11 residences and small scale agricultural operations.

12 **7.3.3.1.3 Lower Sacramento Valley (West of Sacramento River)**

13 The Lower Sacramento Valley area west of the Sacramento River includes  
14 three main groundwater subbasins: Colusa, Yolo, and Solano (DWR 2003a,  
15 2004m, 2004n, 2006b).

16 *Hydrogeology and Groundwater Conditions*

17 *Colusa Subbasin*

18 The Colusa subbasin is bordered by the Coast Ranges to the west, Stony Creek to  
19 the north, Sacramento River to the east, and Cache Creek to the south. The  
20 Colusa subbasin extends primarily in western Glenn and Colusa counties. This  
21 subbasin is composed of continental deposits of late Tertiary age, including the  
22 Tehama and the Tuscan Formations, to Quaternary age, including alluvial and  
23 floodplain deposits as well as Modesto and Riverbank Formations. The Tehama  
24 Formation represents the main water bearing formation for the Colusa subbasin  
25 (DWR 2003b, 2006b). Groundwater levels are fairly stable in this subbasin,  
26 except during droughts, such as in 1976 and 1977 and 1987 to 1992 (DWR  
27 2013a). Groundwater levels in the Colusa subbasin declined in the 2008 drought,  
28 and increased during the wetter periods of 2010 and 2011 to the pre-drought 2008  
29 levels (DWR 2014c, 2014d). Historically, groundwater levels fluctuate by  
30 approximately 5 feet seasonally during normal and dry years (DWR 2006b,  
31 2013a). Recent information indicates that groundwater levels declined at multiple  
32 wells in the Colusa subbasin approximately 10 to 20 feet between spring 2010 and  
33 spring 2014 in southwestern Colusa subbasin (DWR 2014c, 2014d). The  
34 groundwater levels in some areas declined up to 10 feet between fall 2013 and fall  
35 2014, and in some areas more than 10 feet.

36 Groundwater quality for the Colusa subbasin is characterized by moderate to high  
37 TDS; with localized areas of high nitrate and manganese concentrations near the  
38 town of Colusa (DWR 2013a, 2006b). High TDS and boron concentrations have  
39 been observed near Knights Landing. High nitrate levels have been observed near  
40 Arbuckle, Knights Landing, and Willows.

41 The Colusa subbasin was designated by the CASGEM program as medium  
42 priority.

1        *Yolo Subbasin*

2        The Yolo subbasin lies to the south of the Colusa subbasin primarily within Yolo  
3        County. The primary water bearing formations for the Yolo subbasin are the  
4        same as those for the Colusa subbasin. Younger alluvium from flood basin  
5        deposits and stream channel deposits lie above the saturated zone and tend to  
6        provide significant well yields. In general, groundwater levels are stable in this  
7        subbasin, except during periods of drought, and in certain localized pumping  
8        depressions in the vicinity of Davis, Woodland, and Dunnigan and Zamora areas  
9        (DWR 2004m, 2013a). However, between spring 2010 and spring 2014 in the  
10       Yolo subbasin, recent information indicates that groundwater levels declined at  
11       multiple wells at least 10 feet and in some areas up to 20 feet (DWR 2014c,  
12       2014d). The groundwater levels in some areas declined up to 10 feet between fall  
13       2013 and fall 2014, and in some areas more than 10 feet.

14       Groundwater quality is generally good for beneficial uses except for localized  
15       impairments including elevated concentrations of boron in groundwater along  
16       Cache Creek and in the Cache Creek Settling Basin area, elevated levels of  
17       selenium present in the groundwater supplies for the City of Davis, and localized  
18       areas of nitrate contamination (DWR 2004m, 2013a). The cities of Davis and  
19       Woodland, which heavily rely on groundwater supply, lost nine municipal wells  
20       since 2011 due to high nitrate concentrations (YCFWCWCD 2012). Sources of  
21       high nitrate concentrations near these cities have been determined to be primarily  
22       from agricultural and wastewater operations. High salinity levels have also been  
23       reported in some areas that may be related to groundwater use for irrigation which  
24       tends to increase salt concentrations in groundwater.

25       In Yolo County, as much as 4 feet of groundwater withdrawal-related subsidence  
26       has occurred since the 1950s. Groundwater withdrawal-related subsidence has  
27       damaged or reduced the integrity of highways, levees, irrigation canals, and wells  
28       in Yolo County, particularly in the vicinities of Zamora, Knights Landing, and  
29       Woodland (Water Resources Association of Yolo County 2007).

30       The Yolo subbasin was designated by the CASGEM program as high priority.

31       *Solano Subbasin*

32       The Solano subbasin includes most of Solano County, southeastern Yolo County,  
33       and southwestern Sacramento County. In the Solano subbasin, general  
34       groundwater flow directions are from the northwest to the southeast  
35       (DWR 2004n, 2013a). Increasing agricultural and urban development in the  
36       1940s in the Solano subbasin has caused significant groundwater level declines.  
37       Today, groundwater levels are relatively stable but show significant declines  
38       during drought cycles. Groundwater level data also suggest that these declines  
39       tend to recover quickly during subsequent wet years. Between spring 2010 and  
40       spring 2014 in the Solano subbasin, recent information indicates that groundwater  
41       levels declined at multiple wells by at least 10 feet (DWR 2014c, 2014d).

42       Groundwater quality in the Solano subbasin is generally good and is deemed  
43       appropriate for domestic and agricultural use (DWR 2004n, 2013a). However,



1 TDS concentrations are moderately high in the central and southern areas of the  
2 basin with localized areas of high calcium and magnesium.

3 The Solano subbasin was designated by the CASGEM program as medium  
4 priority.

#### 5 *Groundwater Use and Management*

6 Many irrigators on the west side of the Sacramento Valley relied primarily on  
7 groundwater prior to completion of the CVP Tehama-Colusa Canal facilities  
8 which conveyed surface water to portions of Colusa County.

9 In the Colusa subbasin, although surface water is the primary source of water to  
10 meet water supply needs, groundwater is also used to assist in meeting  
11 agricultural, domestic, municipal, and industrial water needs, primarily in areas  
12 outside of established water districts. The Tehama Colusa Canal Authority  
13 service area is also an area of groundwater use in the Colusa subbasin. Although  
14 the Tehama-Colusa Canal Authority delivers surface water to agricultural users  
15 when the CVP water supplies are restricted due to hydrologic conditions, water  
16 users rely upon groundwater to supplement limited surface water supplies.

17 Groundwater is the source of water for municipal and domestic uses in Yolo  
18 County except for the City of West Sacramento, as described in Chapter 5,  
19 Surface Water Resources and Water Supplies. Recently, in normal years,  
20 approximately 40 percent of the irrigation users in Yolo County rely on  
21 groundwater (Yolo County 2009). For the East Yolo South area of the County  
22 (eastern Yolo subbasin), a 2006 study estimated that groundwater supplies  
23 about 80 to 85 percent of the total annual water demand in the county  
24 (YCFCWCD 2012).

25 Within Yolo and Sacramento counties portions of the Solano subbasin,  
26 groundwater is primarily used for domestic and irrigation uses. Within Solano  
27 County, groundwater is used exclusively by most rural residential landowners and  
28 the cities of Rio Vista and Dixon (Solano County 2008). The City of Vacaville  
29 uses groundwater to provide approximately 30 percent of the water supply. Other  
30 communities rely upon surface water, as described in Chapter 5, Surface Water  
31 Resources and Water Supplies. Irrigation users within the Solano Irrigation  
32 District rely upon surface water. All other irrigation users rely upon groundwater.

#### 33 **7.3.3.1.4 Lower Sacramento Valley (East of Sacramento River)**

34 The Lower Sacramento Valley area is located to the east of the Sacramento River,  
35 and includes seven groundwater subbasins: West Butte, East Butte, North Yuba,  
36 South Yuba, Sutter, North American, and South American (DWR 2003a, 2004o,  
37 2004p, 2004q, 2006c, 2006d, 2006e, 2006f).

#### 38 *Hydrogeology and Groundwater Conditions*

39 The aquifer system throughout the Lower Sacramento Valley east of the  
40 Sacramento River is composed of Tertiary to late Quaternary age deposits. The  
41 confined portion of the aquifer system includes the Tertiary-age Tuscan and  
42 Laguna formations. The Tuscan formation consists of volcanic mudflows, tuff

1 breccia, tuffaceous sandstone, and volcanic ash deposits. The Laguna formation  
 2 consists of moderately consolidated and poorly to well cemented interbedded  
 3 alluvial sand, gravel, and silt with a low permeability, overall. The Quaternary  
 4 portion of the aquifer system, typically unconfined, is largely composed of  
 5 unconsolidated gravel, sand, silt, and clay stream channel and alluvial fan  
 6 deposits. South and east of the Sutter Buttes, the deposits contain Pleistocene  
 7 alluvium, which is composed of loosely compacted silts, sands, and gravels that  
 8 are moderately permeable; however, nearly impermeable hardpans and claypans  
 9 also exist in this deposit, which restrict the vertical movement of groundwater  
 10 (DWR 2003a, 2004o, 2004p, 2004q, 2006c, 2006d, 2006e, 2006f).

11 *West and East Butte Subbasins*

12 The West Butte subbasin is located within Butte, Glenn, and Sutter counties. In  
 13 the West Butte subbasin, groundwater levels declined during the 1976 to 1977  
 14 and 1987 to 1992 droughts, followed by a recovery in groundwater levels to  
 15 pre-drought conditions of the early 1980s and 1990s (DWR 2004o, 2013a). A  
 16 comparison of spring-to-spring groundwater levels from the 1950s and 1960s, to  
 17 levels in the early 2000s, indicates about a 10-foot decline in groundwater levels  
 18 in portions of this subbasin. Several groundwater depressions exist in the Chico  
 19 area, due to year-round groundwater extraction for municipal uses. Between  
 20 spring 2010 and spring 2014 in the West Butte subbasin, recent information  
 21 indicates that groundwater levels declined at multiple wells at least 10 feet and in  
 22 some areas up to 20 feet near Chico (DWR 2014c, 2014d). The groundwater  
 23 levels in some areas declined up to 10 feet between fall 2013 and fall 2014.

24 The East Butte subbasin is located with Butte and Sutter counties. In the northern  
 25 portion of the East Butte subbasin, annual groundwater fluctuations in the  
 26 confined and semi-confined aquifer system ranges from 15 to 30 feet during  
 27 normal years (DWR 2004p, 2013a). In the southern part of Butte County,  
 28 groundwater fluctuations for wells constructed in the confined and semi-confined  
 29 aquifer system average 4 feet during normal years and up to 5 feet during drought  
 30 years. Between spring 2010 and spring 2014 in the East Butte subbasin, recent  
 31 information indicates that groundwater levels either increased or declined at  
 32 multiple wells by approximately 2 to 3 feet near Oroville (DWR 2014c, 2014d).

33 High nitrates occur near the Chico area in the West Butte subbasin. There are  
 34 localized areas in the subbasin with high boron, calcium, electrical conductivity  
 35 (EC), and TDS concentrations (DWR 2004 o, 2013a). There are several  
 36 groundwater areas near Chico that historically had high perchloroethylene  
 37 concentrations from industrial sites. Following implementation of groundwater  
 38 treatment, the chemicals have not been detected (Butte County 2010).

39 There are localized high concentrations of calcium, salinity, iron, manganese,  
 40 magnesium, and TDS throughout the East Butte subbasin (DWR 2004p, 2013a).

41 The West Butte subbasin was designated by the CASGEM program as high  
 42 priority. The East Butte subbasin was designated as medium priority.

1        *North and South Yuba Subbasins*

2        The North Yuba subbasin is located within Butte and Yuba counties. The South  
3        Yuba subbasin is located within Yuba County. In the North Yuba and South  
4        Yuba subbasins areas along the Feather River, the groundwater levels have been  
5        generally stable since at least 1960, with some seasonal fluctuations between  
6        spring and summer conditions. Groundwater levels in the central parts of the two  
7        subbasins declined until about 1980, when surface water deliveries were extended  
8        to these areas and groundwater levels started to rise. Hydrographs in the central  
9        portions of the North and South Yuba subbasins also show the effect of  
10       groundwater substitution transfers (during 1991, 1994, 2001, 2002, 2008, and  
11       2009), in the form of reduced groundwater levels followed by recovery to  
12       pre-transfer levels (YCWA 2010). Between spring 2010 and spring 2014 in the  
13       North Yuba and South Yuba subbasins, recent information indicates that  
14       groundwater levels declined at multiple wells by 10 to 20 feet, especially near  
15       Yuba City (DWR 2014c, 2014d). The groundwater levels in some areas declined  
16       up to 10 feet between fall 2013 and fall 2014.

17       Historical water quality data show that in most areas of the North and South Yuba  
18       subbasins, trends of increasing concentrations of calcium, bicarbonate, chloride,  
19       alkalinity, and TDS occur. In general, groundwater salinity increases with  
20       distance from the Yuba River. No groundwater quality impairments were  
21       documented at the DWR monitoring wells in the North Yuba subbasin  
22       (DWR 2006c). High salinity occurred in the Wheatland area of the South Yuba  
23       subbasin within the South Yuba Water District and Brophy Irrigation District  
24       (DWR 2006d; YCWA 2010).

25       The North Yuba and South Yuba subbasins were designated by the CASGEM  
26       program as medium priority.

27       *Sutter Subbasin*

28       The Sutter subbasin is located in Sutter County. In the Sutter subbasin,  
29       groundwater levels have remained relatively constant. The water table is very  
30       shallow and most groundwater levels in the subbasin tend to be within about  
31       10 feet of ground surface (DWR 2006e, 2013a). Between the spring 2010 and  
32       spring 2014 in the Sutter subbasin, recent information indicates that groundwater  
33       levels declined at multiple wells by up to 10 feet (DWR 2014c, 2014d). The  
34       groundwater levels in some areas declined up to 10 feet between fall 2013 and  
35       fall 2014, and in some areas more than 10 feet.

36       Groundwater quality in the western portion of the Sutter subbasin includes areas  
37       with high concentrations of arsenic, boron, calcium magnesium bicarbonate,  
38       chloride, fluoride, iron, manganese, sodium, and TDS. In the southern portion of  
39       the subbasin, groundwater in the upper aquifer system tends to be high in salinity  
40       (DWR 2003b, 2006e).

41       The Sutter subbasin was designated by the CASGEM program as medium  
42       priority.

1        *North American Subbasin*

2        The North American subbasin underlies portions of Sutter, Placer, and  
3        Sacramento Counties, including several dense urban areas. Since at least the  
4        1950s, concentrated groundwater extraction occurred east of downtown  
5        Sacramento, which resulted in a regionally extensive cone of depression.  
6        Drawdown in the wells in this areas have been in excess of 70 feet over the past  
7        60 years (SGA 2008). Water purveyors have constructed facilities to import  
8        surface water to allow groundwater levels to recover from the historic levels of  
9        drawdown. In general, since around the mid-1990s to the late 2000s, water levels  
10       remained stable in the southern portion of the subbasin and in some cases  
11       groundwater levels are continuing to increase slightly in response to increases in  
12       conjunctive use and reductions in pumping near McClellan Air Force Base  
13       (SGA 2014). Groundwater levels in Sutter and northern Placer Counties  
14       generally have remained stable, although some wells in southern Sutter County  
15       have experienced declines (DWR 2006f, 2013a). Overall, groundwater levels are  
16       higher along the eastern portion of the North American subbasin and decline  
17       towards the western portion (Roseville et al. 2007). There is a groundwater  
18       depression in the southern Placer-Sutter counties area near the border with  
19       Sacramento County. Between the spring 2010 and spring 2014 in the North  
20       American subbasin, recent information indicates that groundwater levels declined  
21       at multiple wells by up to 10 feet (DWR 2014c, 2014d). The groundwater levels  
22       were relatively constant between fall 2013 and fall 2014.

23       The area along the Sacramento River extending from Sacramento International  
24       Airport northward to the Bear River contains high levels of arsenic, bicarbonate,  
25       chloride, manganese, sodium, and TDS (DWR 2006f, 2013a). In an area between  
26       Reclamation District 1001 and the Sutter Bypass, high TDS concentrations occur.  
27       There have been three sites within the subbasin with significant groundwater  
28       contamination issues: the former McClellan Air Force Base, the Union Pacific  
29       Railroad Rail Yard in Roseville, and the Aerojet Superfund Site. Mitigation  
30       operations have been initiated for all of these sites. In the deeper portions of the  
31       aquifer, the groundwater geochemistry indicates the occurrence of connate water  
32       from the marine sediments underlying the freshwater aquifer, which mixes with  
33       the fresh water. Water quality concerns due to this type of geology include  
34       elevated levels of arsenic, bicarbonate, boron, chloride, fluoride, iron, manganese,  
35       nitrate, sodium, and TDS (DWR 2003b).

36       The North American subbasin was designated by the CASGEM program as high  
37       priority.

38       *South American Subbasin*

39       The South American subbasin is located within Sacramento County.  
40       Groundwater levels in the South American subbasin have fluctuated over the past  
41       40 years, with the lowest levels occurring during periods of drought. From 1987  
42       to 1995, water levels declined by about 10 to 15 feet and then recovered to levels  
43       close to the mid-80s by 2000. Over the past 60 years, a general lowering of  
44       groundwater levels was caused by intensive use of groundwater in the region.  
45       Areas affected by municipal pumping show a lower groundwater level recovery

1 than other areas (DWR 2004q, 2013a). A large cone of depression is centered in  
2 the southwestern portion of the subbasin. Between the spring 2010 and spring  
3 2014 in the South American subbasin, recent information indicates that  
4 groundwater levels declined at multiple wells by up to 10 feet (DWR 2014c, 2014d).  
5 The groundwater levels were relatively constant between fall 2013 and fall 2014.  
6 The groundwater quality is characterized by low to moderate TDS concentrations  
7 (DWR 2004q, 2013a). Seven sites historically had significant groundwater  
8 contamination, including three Superfund sites near the Sacramento metropolitan  
9 area. These sites are in various stages of cleanup.  
10 The South American subbasin was designated by the CASGEM program as high  
11 priority.

#### 12 *Groundwater Use and Management*

13 In this area, groundwater is used for agricultural, domestic, municipal, and  
14 industrial purposes. Most of the groundwater extraction occurs via privately  
15 owned domestic and agricultural wells.

#### 16 *West and East Butte Subbasins*

17 The primary water source in Butte County is surface water (approximately  
18 70 percent, by volume), and groundwater use accounts for about 30 percent of  
19 total county water use. In Butte County, most of the irrigation users rely upon  
20 surface water and approximately 75 percent of the residential water users rely  
21 upon groundwater (Butte County 2004, 2010).

22 The cities of Chico and Hamilton City are served by groundwater provided by  
23 California Water Service Company (California Water Service Company 2011g).

#### 24 *North and South Yuba Subbasins*

25 The Yuba County Water Agency actively manages surface water and groundwater  
26 conjunctively to prevent groundwater overdraft in the North and South Yuba  
27 subbasins. The majority of water demand in these subbasins is crop water use  
28 from irrigated agriculture (YCWA 2010).

#### 29 *Sutter Subbasin*

30 Agricultural water use in Sutter County is composed, on average, of  
31 approximately 60 percent surface water, 20 percent groundwater, and 20 percent  
32 of land irrigated by both surface water and groundwater. Permanent crops are  
33 predominantly irrigated with groundwater. Groundwater is also used for small  
34 communities and rural domestic uses (Sutter County 2011).

#### 35 *North American Subbasin*

36 Several agencies manage water resources in the North American subbasin: South  
37 Sutter Water District, Placer County Water Agency, Natomas Central Mutual  
38 Water Company, and several urban water purveyors which are part of the  
39 Sacramento Groundwater Authority (SGA), a joint powers authority (SGA 2014).  
40 The northern portion of this subbasin is rural and agricultural, while the southern  
41 portion is urbanized, including the Sacramento Metropolitan area. Many of the  
42 urban agencies in Placer County rely upon surface water for normal operations,

1 and have developed or are planning on developing groundwater for emergency  
 2 situations (Roseville et al. 2007). In the urban area encompassed by SGA, some  
 3 agencies rely entirely on groundwater for their water supply (SGA 2014).

4 Local planning efforts have been implemented in a local groundwater planning  
 5 area known as the American River Basin region. This area encompasses  
 6 Sacramento County and the lower watershed portions of Placer and El Dorado  
 7 counties, and overlies the productive North American and South American  
 8 subbasins. Groundwater is a regionally significant source of water supply, and is  
 9 used as a primary source for many agencies in the region. However, in recent  
 10 years, regional conjunctive use programs have allowed for the optimization of  
 11 water supplies and a decrease in groundwater use has been observed in the past  
 12 5 years (RWA 2013).

13 Since 2000, groundwater extraction decreased in the northeastern portion of the  
 14 North American subbasin as additional surface water supplies were made  
 15 available under conjunctive use operations implemented following the Water  
 16 Forum Agreement in 2000. In 2007, groundwater extraction increased because  
 17 additional surface water was not available due to dry surface water supply  
 18 conditions (SGA 2008, 2011).

19 *South American Subbasin*

20 The South American subbasin lies entirely within Sacramento County and is  
 21 overlain by a majority of urban and densely populated areas. Many of the water  
 22 users in this subbasin use surface water.

23 The main water purveyors that use South American subbasin groundwater include  
 24 the Elk Grove Water District, California-American Water Company, Golden State  
 25 Water Company, and the Sacramento County Water Agency. The entities serve  
 26 the communities of Antelope, Arden, Lincoln Oaks, Parkway, Rosemont, and  
 27 portions of the City of Rancho Cordova (California-American Water Company  
 28 2011; EGWD 2011; Golden State Water Company 2011; Sacramento County  
 29 Water Agency 2011). The majority of groundwater pumping is for agricultural  
 30 uses (SCGA 2010). The South American subbasin also includes portions of the  
 31 area known as the American River Basin, as described above under the North  
 32 American subbasin section.

33 **7.3.3.2 Delta**

34 The Delta overlies the western portion of the area where the Sacramento River  
 35 and San Joaquin River groundwater basins converge, as shown in Figure 7.5.  
 36 The Delta includes the Solano subbasin and the South American subbasin in the  
 37 Sacramento Valley Groundwater Basin (as described above); the Tracy subbasin,  
 38 the Eastern San Joaquin subbasin, and the Cosumnes subbasin in the San Joaquin  
 39 Valley Groundwater Basin (as described in subsequent sections of this chapter for  
 40 the San Joaquin); and the Suisun-Fairfield Valley Basin (as described in  
 41 subsequent sections of this chapter for the San Francisco Bay Area Region).

1 **7.3.3.2.1 Hydrogeology and Groundwater Conditions**

2 In some areas of the western and central Delta floodplain, floodplain deposits  
3 contain organic material (peat) that range in thickness from 0 to 150 feet. Below  
4 the surficial floodplain deposits, unconsolidated non-marine sediments occur, at  
5 depths of a few hundred feet near the Coast Range to nearly 3,000 feet near the  
6 eastern margin of the Sacramento Valley Groundwater Basin. These non-marine  
7 sediments form the major water-bearing formations in the Delta.

8 In general, shallow groundwater conditions and extensive groundwater-surface  
9 water interaction characterize the Delta. Spring runoff generated by melting snow  
10 in the Sierra Nevada increases flows in the Sacramento and San Joaquin rivers  
11 and their tributaries and cause groundwater levels near the rivers to rise. Because  
12 the Delta is a large floodplain and the shallow groundwater is hydraulically  
13 connected to the surface water, changes in river stages affect groundwater levels  
14 and vice versa. Groundwater levels in the central Delta are very shallow, and land  
15 subsidence on several islands has resulted in groundwater levels close to the  
16 ground surface. Maintaining groundwater levels below crop rooting zones is  
17 critical for successful agriculture, especially for islands that lie below sea level.  
18 Many farmers rely on an intricate network of drainage ditches and pumps to  
19 maintain groundwater levels of about 3 to 6 feet below ground surface. The  
20 accumulated agricultural drainage is discharged into adjoining surface water  
21 bodies (USGS 2000a). Without this drainage system, many of the islands would  
22 be subject to extremely high groundwater, bogs, or localized flooding.

23 Groundwater generally flows from the Sierra Nevada in the east toward the  
24 low-lying lands of the Delta to the west. However, a number of pumping  
25 depressions have reversed this trend, and groundwater inflow from the Delta  
26 toward these pumping areas has been observed, primarily in the Stockton area.

27 Subsidence in the Delta is well-documented and a major source of concern for  
28 farming operations. The oxidation of peat soils is the primary mechanism of  
29 subsidence in the Delta, and some areas are located below sea level. Another  
30 mechanism for subsidence is wind erosion. There is a possibility that certain  
31 areas in the Delta could continue to subside 2 to 4 more feet over the next  
32 35 years (DWR 2013i).

33 **7.3.3.2.2 Groundwater Use and Management**

34 Groundwater is used throughout the Delta for domestic and irrigation water  
35 supplies. Irrigation supplies are provided by wells and plant uptake in the root  
36 zone. An accurate accounting of groundwater used in the region is not available  
37 because wells are not metered and there is no method to measure root-zone  
38 irrigation.

39 Groundwater is used for potable water supplies by the Delta communities of  
40 Clarksburg, Courtland, Freeport, Hood, Isleton, Rio Vista, Ryde, and Walnut  
41 Grove. In the rural portions of the Delta, private groundwater wells provide  
42 residential and agricultural water supplies (Sacramento County 2010; Yolo  
43 County 2009; SCWA et al. 2005; Solano County 2008; San Joaquin County 2009;

1 Contra Costa County 2005). In some portions of the Delta, groundwater use is  
2 limited because of low well yields and poor water quality. Shallow groundwater  
3 in the western Delta may be saline due to hydraulic connection with western Delta  
4 waterways that are influenced by sea water intrusion. Shallow groundwater levels  
5 can be detrimental if the groundwater encroaches into the crop root zones.  
6 Therefore, groundwater pumping frequently is used to drain shallow groundwater  
7 and surface water from agricultural fields.

8 **7.3.3.3 Suisun Marsh**

9 To the west, the Suisun Marsh overlies the Suisun–Fairfield Valley subbasin. The  
10 Suisun-Fairfield Groundwater Basin is adjacent to, but hydrogeologically distinct  
11 from, the Sacramento River Groundwater Basin, and is adjacent to Suisun Bay.  
12 This basin is bounded by the Coast Ranges to the north and west and the  
13 Sacramento River Groundwater Basin in the east, as shown in Figure 7.5. It is  
14 separated from the Sacramento River Groundwater Basin by the English Hills.

15 **7.3.3.3.1 Hydrogeology and Groundwater Conditions**

16 In the Suisun-Fairfield Valley Groundwater Basin, freshwater occurs within the  
17 alluvial deposits that overlie the Sonoma volcanics (Travis AFB 1997;  
18 USGS 1960).

19 The overall direction of groundwater flow in the Suisun-Fairfield Valley  
20 Groundwater Basin is from the uplands toward Suisun Marsh (USGS 1960;  
21 Reclamation et al. 2011). Depth to groundwater varies seasonally, with higher  
22 groundwater levels occurring during the rainy season (Solano County 2008).  
23 Prior to implementation of the Solano Project that conveys water into Solano  
24 County from Lake Berryessa as part of the Solano Project and the SWP North  
25 Bay Aqueduct, groundwater depressions were occurring near Fairfield.  
26 Following importation of surface water from the Solano Project and the North  
27 Bay Aqueduct, surface water was used more extensively to reduce the  
28 groundwater overdraft (Solano County 2008; Travis AFB 1997). Few  
29 groundwater monitoring sites exist in the basin, and most are near ongoing  
30 groundwater investigations. Data from these groundwater investigations suggest  
31 that groundwater levels in the basin are generally stable.

32 Groundwater quality issues within the Suisun-Fairfield Valley Groundwater Basin  
33 include high boron, TDS, and volatile organic compound concentrations near  
34 Travis Air Force Base (USGS 1960, 2008). Volatile organic compound plumes at  
35 Travis Air Force Base are largely contained on base, but volatile organic  
36 compound constituents have migrated up to 0.5-mile off base at three sites.  
37 Containment and remediation is occurring at each of these sites (Travis  
38 AFB 2005).

39 The Suisun-Fairfield Valley Groundwater Basin was designated by the CASGEM  
40 program as very low priority.



1 **7.3.3.3.2 Groundwater Use and Management**

2 Information on groundwater supplies in the Suisun-Fairfield Valley Groundwater  
3 Basin is limited. Groundwater was the primary water source for the Suisun-  
4 Fairfield Valley Groundwater Basin, including the cities of Fairfield and Suisun  
5 City, through the 1950s. This groundwater production resulted in local areas of  
6 depressed groundwater levels. As surface water became available, groundwater  
7 use declined. Studies have shown that the basin provides low well yields and  
8 therefore is probably not used as a major water supply (Reclamation et al. 2011).  
9 Many private well owners in the Suisun-Fairfield Valley Groundwater Basin use  
10 groundwater for irrigation. However, due to the brackish quality of the  
11 groundwater, surface water is used for potable water supplies  
12 (Reclamation et al. 2011).

13 **7.3.3.4 San Joaquin Valley**

14 The San Joaquin Valley Groundwater Basin extends from the Sacramento-San  
15 Joaquin Delta in the north to the Tehachapi Mountains in the South. Groundwater  
16 is estimated to provide over 47 percent of the overall water supply in the  
17 San Joaquin Valley, including 70 percent of municipal uses and 43 percent of  
18 irrigation supplies from 2005 through 2010 (DWR 2013i). The San Joaquin  
19 Valley has an average annual precipitation between 5 to 18 inches. Due to the  
20 low amounts of average annual precipitation, limited surface water supply and  
21 extensive agricultural water use, there are areas of significant overdraft that exist  
22 in the San Joaquin Valley Groundwater Basin. Eight subbasins in the San Joaquin  
23 Valley Groundwater Basin were identified in a state of critical overdraft:  
24 Chowchilla, Eastern San Joaquin, Madera, Kings, Kaweah, Tule, Tulare Lake,  
25 and Kern (DWR 1980). Three of these subbasins are on the eastern side of the  
26 San Joaquin River: Eastern San Joaquin, Chowchilla, and Madera. Recent studies  
27 have indicated that overdraft continues to exist in these subbasins (DWR 2013i).  
28 By 1970, over 5,200 square miles of irrigable land had subsided by a minimum of  
29 1 foot. The maximum subsidence occurred near Mendota at almost 30 feet  
30 (9 meters) (Reclamation 2013a). Due to the drought that started in 2011, surface  
31 water supplies have declined and new wells have been constructed. Between  
32 January and October 2014, over 100 wells were drilled in both Kern and Kings  
33 counties, almost 200 in Stanislaus County, almost 250 in Merced County, and  
34 over 350 in both Fresno and Tulare counties (DWR 2014d).

35 The elevation of the base of freshwater in the western and central San Joaquin  
36 Valley ranges from 600 to 800 feet below mean sea level (WWD 2013). This  
37 area has experienced subsidence of up to 28 feet between 1926 and 1970  
38 (USGS 2009). The water quality of the semi-perched aquifer on the western side  
39 of the San Joaquin Valley is impaired with high salinity, selenium, and boron  
40 concentrations. These constituents are from both naturally occurring deposits in  
41 the Coast Ranges to the west and agricultural activities. The chemicals become  
42 trapped in the soil matrix due to the low permeability clay layers close to the  
43 surface. There are also localized areas with high concentrations of naturally  
44 occurring arsenic or selenium.

1 Portions of the San Joaquin Valley Groundwater Basin in the Cosumnes, Tracy,  
2 and Eastern San Joaquin subbasins were designated by the State Water Resources  
3 Control Board in 2000 as Hydrogeologically Vulnerable Areas and Groundwater  
4 Protection Areas based on hydrogeologic permeability. These areas could be  
5 more vulnerable to groundwater quality impairment if applied surface water,  
6 including recycled water, contained high concentrations of constituents of concern  
7 to the beneficial users of the groundwater (CVRWQCB 2014b).

8 **7.3.3.4.1 Northern Portions of the San Joaquin Valley Groundwater Basin**

9 Extending south into the Central Valley from the Delta to the southern extent  
10 marked by the San Joaquin River, DWR has delineated nine subbasins within the  
11 northern portion of the San Joaquin Valley Groundwater Basin based on  
12 groundwater divides, barriers, surface water features, and political boundaries  
13 (DWR 2003a), as shown in Figure 7.6. The Cosumnes, Eastern San Joaquin, and  
14 Tracy subbasins partially underlie the Delta. The Delta-Mendota, Modesto,  
15 Turlock, Merced, Chowchilla, and Madera subbasins are located between the  
16 Delta and the San Joaquin River.

17 The northern portion of the San Joaquin Valley Groundwater Basin is marked by  
18 laterally extensive deposits of thick fine-grained materials deposited in lacustrine  
19 and marsh depositional systems. These units, which can be tens to hundreds of  
20 feet thick, create vertically differentiated aquifer systems within the subbasins.  
21 The Corcoran Clay (or E-Clay), occurs in the Tulare Formation and separates the  
22 alluvial water-bearing formations into confined and unconfined aquifers. The  
23 direction of groundwater flow generally coincides with the primary direction of  
24 surface water flows in the area, which is to the northwest toward the Delta  
25 (DWR 2003a, 2004r, 2004s, 2004t, 2004u, 2006g, 2006h, 2006k). Groundwater  
26 levels fluctuate seasonally and a strong correlation exists between depressed  
27 groundwater levels and periods of drought, when more groundwater is pumped in  
28 the area to support agricultural operations.

29 Water users in the northern portion of the San Joaquin Valley Groundwater Basin  
30 rely upon groundwater, which is used conjunctively with surface water for  
31 agricultural, industrial, and municipal supplies (DWR 2003a). Groundwater is  
32 estimated to account for about 38 percent of the overall water supply in the  
33 northern portion of the San Joaquin Valley Groundwater Basin (DWR 2013i).  
34 Annual groundwater pumping in the northern portion of the San Joaquin Valley  
35 Groundwater Basin accounts for about 19 percent of all groundwater pumped in  
36 the state of California. Groundwater use in the northern portion of the San  
37 Joaquin Valley Groundwater Basin is estimated to average 3.2 million acre-feet  
38 per year between 2005 and 2010.

39 According to the Draft California Water Plan 2013 Update (DWR 2013i), three  
40 planning areas within the northern portion of the San Joaquin Valley Groundwater  
41 Basin rely heavily on groundwater pumping: the Eastern Valley Floor Planning  
42 Area, the Lower Valley Eastside Planning Area, and the Valley West Side  
43 Planning Area. Each of these areas has limited local surface water supplies and

1 uses extensive groundwater pumping for their agricultural water supply  
2 (DWR 2013i).

3 The northern portion of the San Joaquin Valley Groundwater Basin discussion is  
4 divided into two sub-regions: West of the San Joaquin River, and East of the  
5 San Joaquin River, as described below.

6 *West of the San Joaquin River*

7 The Tracy and the Delta-Mendota subbasins are located on the west side of the  
8 San Joaquin River.

9 *Hydrogeology and Groundwater Conditions*

10 Along the western portion of the San Joaquin Valley, the Tulare formation  
11 comprises the primary freshwater aquifer. The Tulare Formation originated as  
12 reworked sediments from the Coast Ranges re-deposited in the San Joaquin  
13 Valley as alluvial fan, flood basin, deltaic (pertaining to a delta) or lacustrine, and  
14 marsh deposits (USGS 1986).

15 *Tracy Subbasin*

16 The Tracy subbasin underlies eastern Contra Costa County and western  
17 San Joaquin County. A large portion of the subbasin is located within the Delta.  
18 In the Tracy subbasin, groundwater generally flows from south to north and  
19 discharges into the San Joaquin River. According to DWR and the San Joaquin  
20 County Flood Control and Water Conservation District, groundwater levels in the  
21 Tracy subbasin have been relatively stable over the past 10 years, apart from  
22 seasonal variations resulting from recharge and pumping (DWR 2006g, 2013b).  
23 Recent information indicates that between the spring 2010 and spring 2014,  
24 groundwater levels declined at some wells in the Tracy subbasin by up to 10 feet  
25 (DWR 2014c, 2014d). The groundwater levels in some areas declined up to  
26 10 feet between fall 2013 and fall 2014, and in some areas more than 10 feet.

27 In the Tracy subbasin, areas of poor water quality exist throughout the area.  
28 Elevated chloride concentrations are found along the western side of the subbasin  
29 near the City of Tracy and along the San Joaquin River. Overall, Delta  
30 groundwater wells in the Tracy subbasin are characterized by high levels of  
31 chloride, TDS, arsenic, and boron (DWR 2006g, 2013b; USGS 2006). The  
32 Central Valley Regional Water Quality Board recently adopted general waste  
33 discharge requirements to protect groundwater, as well as surface water, within  
34 the San Joaquin County and Delta areas, including the Tracy subbasin  
35 (CVRWQCB 2014b). Supporting information recognizes the potential for  
36 groundwater impairment due to the water quality of applied water to crops if the  
37 applied water quality contains high concentrations of constituents of concern.

38 The Tracy subbasin was designated by the CASGEM program as medium  
39 priority.

40 *Delta-Mendota Subbasin*

41 The Delta-Mendota subbasin underlies portions of Stanislaus, Merced, Madera,  
42 and Fresno counties. The geologic units present in the Delta-Mendota subbasin  
43 consist of the Tulare Formation, terrace deposits, alluvium, and flood-basin

1 deposits. Groundwater occurs in three water-bearing zones: the lower zone  
 2 contains confined fresh water in the lower section of the Tulare Formation; the  
 3 upper zone contains confined, semi-confined, and unconfined water in the upper  
 4 section of the Tulare formation; and a shallow zone that contains unconfined  
 5 water (DWR 2006h, 2013b). The groundwater is characterized by moderate to  
 6 extremely high salinity with localized areas of high iron, fluoride, nitrate, and  
 7 boron (DWR 2006h, 2013b).

8 In the Delta-Mendota subbasin, groundwater levels have generally declined by as  
 9 much as 20 feet in the northern portion of the basin near Patterson between 1958  
 10 and 2006. Surface water imports in the early 1970s resulted in decreased  
 11 pumping, and a steady recovery of groundwater levels. However, the lack of  
 12 imported surface water availability during the drought periods of 1976 to 77, 1986  
 13 to 1992, and 2007 to 2009 resulted in increases in groundwater pumping, and  
 14 associated declines in groundwater levels to near-historic lows (USGS 2012).  
 15 Recent information indicates that between the spring 2010 and spring 2014,  
 16 groundwater levels declined at some wells in the Delta-Mendota subbasin by up  
 17 to 20 feet (DWR 2014c, 2014d).

18 In areas adjacent to the Delta-Mendota Canal in this subbasin, extensive  
 19 groundwater withdrawal has caused land subsidence of up to 10 feet in some  
 20 areas. Land subsidence can cause structural damage to the Delta-Mendota Canal  
 21 which has caused operational issues for CVP water delivery. Historical wide-  
 22 spread soil compaction and land subsidence between 1926 and 1970 has caused  
 23 reduced freeboard and flow capacity of the Delta-Mendota Canal, the California  
 24 Aqueduct, other canals, and roadways in the area. To better understand  
 25 subsidence issues near the Delta-Mendota Canal and improve groundwater  
 26 management in the area, the U.S. Geological Survey (USGS) provided and  
 27 evaluated information on groundwater conditions and the potential for additional  
 28 land subsidence in the San Joaquin Valley (USGS 2013a). Results show that at  
 29 least 1.8 feet of subsidence occurred near the San Joaquin River and the Eastside  
 30 Bypass from 2008 to 2010 period, affecting the southern part of the Delta-  
 31 Mendota Canal by about 0.8 inches of subsidence during the same period. It was  
 32 estimated that subsidence rates doubled in 2008 in some areas. The subsidence  
 33 measured was primarily inelastic (or permanent, not reversible, due to the  
 34 compaction of fine-grained material). The area of maximum active subsidence is  
 35 shown to be located southwest of Mendota and extends into the Merced subbasin  
 36 to the south of El Nido. Land subsidence in this area is expected to continue to  
 37 occur due to uncertainties and limitations (especially climate-related changes) in  
 38 surface water supplies to meet irrigation demand and the continuous need to  
 39 supplement water supply with groundwater pumping.

40 *Groundwater Use and Management*

41 In this area, groundwater is used for agricultural, domestic, municipal, and  
 42 industrial purposes.

1            *Tracy Subbasin*

2    The primary water source in Contra Costa County is surface water. Groundwater  
3    is used by individual homes and businesses and the communities of Brentwood,  
4    Bethel Island, Knightsen, Byron and Discovery Bay (Contra Costa County 2005).  
5    The Diablo Water District groundwater blending facility provides water to users  
6    in the City of Oakley by blending groundwater and treated water from Contra  
7    Costa Water District (DWD 2011).  
8    Contra Costa Water District has an agreement with the East Contra Costa  
9    Irrigation District to purchase surplus irrigation water for municipal and industrial  
10   purposes in East Contra Costa Irrigation District’s service area (CCWD 2011).  
11   The agreement includes an option to implement an exchange of surface water for  
12   groundwater that can be used in the Contra Costa Water District service area  
13   when the CVP allocations are less than full contract amounts. This groundwater  
14   exchange water was implemented during the 2007 to 2009 drought.  
15   Groundwater and surface water are used within western San Joaquin County for  
16   agricultural operations and for the cities of Stockton, Lathrop, and Tracy  
17   (San Joaquin 2009). In the 1980s, about 30 percent of the water supplies in  
18   San Joaquin County were based on groundwater (including the Tracy, Cosumnes,  
19   and Eastern San Joaquin subbasins). By 2007, groundwater was used to supply  
20   over 60 percent of water demand in the county.

21           *Delta-Mendota Subbasin*

22   Groundwater is used for agricultural and domestic water supplies in the  
23   Delta-Mendota subbasin (Reclamation and DWR 2011). Groundwater is  
24   primarily used for domestic and industrial water supplies in Stanislaus County,  
25   including for the City of Patterson (Stanislaus County 2010; Patterson 2014). In  
26   the Delta-Mendota subbasin within Merced County, approximately 3 percent of  
27   groundwater withdrawals are used for municipal and industrial purposes  
28   (including uses in the city of Gustine, Los Banos, and Santa Nella), and  
29   97 percent of the groundwater withdrawals are used for agricultural purposes  
30   (Merced County 2012). Most of the portions of Madera County within the  
31   Delta-Mendota subbasin use groundwater for domestic and agricultural uses  
32   (Madera County 2002, 2008). In portions of Western Fresno County within the  
33   Delta-Mendota subbasin, domestic water users rely upon groundwater (including  
34   the cities of Mendota and Firebaugh), and agricultural water users rely upon  
35   surface water and/or groundwater (Mendota 2009; Firebaugh 2015;  
36   Fresno County 2000).

37           *East of the San Joaquin River*

38   The east side of the San Joaquin River is underlain by seven groundwater  
39   subbasins: the Cosumnes, Eastern San Joaquin, Modesto, Turlock, Merced,  
40   Chowchilla, and Madera subbasins. Three of these subbasins are in a critical state  
41   of overdraft: the Chowchilla, Eastern San Joaquin, and Madera (DWR 2013i).

1        *Hydrogeology and Groundwater Conditions*

2 Several of the hydrogeologic units present in the southern Sacramento Valley  
3 extend south into the San Joaquin Valley. Along the eastern boundary of the  
4 Central Valley, the Ione, Mehrten, Riverbank, and Modesto formations are  
5 primarily composed of sediments originating from the Sierra Nevada.  
6 Historically, surface water and groundwater were hydraulically connected in most  
7 areas of the San Joaquin River and its tributaries. This resulted in a significant  
8 quantity of groundwater actively discharging into streams in most of this  
9 watershed. However this condition changed as increased groundwater pumping  
10 in the area lowered groundwater levels and reversed the hydraulic gradient  
11 between the surface water and groundwater systems, resulting in surface water  
12 recharging the underlying aquifer system through streambed seepage. Long-term  
13 groundwater production throughout this basin has lowered groundwater levels  
14 faster than natural recharge rates. Areas where this overdraft has occurred include  
15 eastern San Joaquin County, Merced County, and western Madera County. This  
16 occurs along the San Joaquin River where the riverbed is highly permeable and  
17 river water readily seeps into the underlying aquifer. This condition reduces  
18 groundwater and surface water outflows to the Delta, lowers the water table, and  
19 may increase the potential for land subsidence (USFWS 2012).

20 Generally, the groundwater in the San Joaquin River subbasins east of the San  
21 Joaquin River is of suitable quality for most urban and agricultural uses with only  
22 local impairments. There are localized areas with high concentrations of boron,  
23 chloride, iron, nitrate, TDS, and organic compounds (DWR 2003a, 2004r, 2004s,  
24 2004t, 2004u, 2006i, 2006j, 2006k). The use of groundwater for agricultural  
25 supply is impaired in western Stanislaus and Merced counties due to elevated  
26 boron concentrations. Groundwater use for drinking water supply is also  
27 impaired in the Tracy, Modesto-Turlock, Merced, and Madera areas due to  
28 elevated nitrate concentrations (USFWS 2012).

29 Dibromochloropropane (DBCP), a soil fumigant that was extensively used on  
30 grapes and cotton before it was banned, is prevalent in groundwater near Merced  
31 and Stockton and in the Merced, Modesto, Turlock, Cosumnes, and Eastern San  
32 Joaquin subbasins (CVRWQCB 2011; DWR 2004r; USFWS 2012). Many areas  
33 with high concentrations of DBCP have undergone groundwater remediation, and  
34 the DBCP concentrations are declining.

35 Declining groundwater levels in the subbasins east of the San Joaquin River have  
36 resulted in an area approximately 16-miles long with high salinity due to saltwater  
37 intrusion from the Delta (USFWS 2012).

38        *Cosumnes Subbasin*

39 The Cosumnes subbasin underlies western Amador County, northwestern  
40 Calaveras County, southeastern Sacramento County, and northeastern San  
41 Joaquin County. Groundwater levels in the Cosumnes subbasin have fluctuated  
42 significantly over the past 40 years, with the lowest levels occurring during  
43 periods of drought. From 1987 to 1995, water levels declined by about 10 to  
44 15 feet and then recovered by that same amount through 2000. Areas affected by

1 municipal pumping show a lower magnitude of groundwater level recovery  
2 during this period than in other areas of the subbasin (DWR 2006i, 2013b).  
3 Within the portion of Sacramento County in the Cosumnes subbasin, it is  
4 estimated that the recent average annual decline in groundwater levels has been  
5 approximately 1 foot, with a lower rate of decline in more recent years (South  
6 Area Water Council 2011). Recent information indicates that between the spring  
7 2010 and spring 2014, groundwater levels declined at some wells in the  
8 Cosumnes subbasin by up to 10 feet (DWR 2014c, 2014d).

9 The Cosumnes subbasin contains groundwater of very good quality, with  
10 localized high concentrations of calcium bicarbonate and pesticides  
11 (DWR 2006i, 2013b).

12 The Cosumnes subbasin was designated by the CASGEM program as medium  
13 priority.

#### 14 *Eastern San Joaquin Subbasin*

15 The Eastern San Joaquin subbasin underlies western Calaveras County, a large  
16 portion of San Joaquin County, and a portion of Stanislaus County. Groundwater  
17 levels in the Eastern San Joaquin subbasin have continuously declined in the past  
18 40 years due to groundwater overdraft. Cones of depression are present near  
19 major pumping centers such as the City of Stockton and the City of Lodi  
20 (DWR 2006j, 2013b). Groundwater level declines of up to 100 feet have been  
21 observed in some wells. In the 1990s, groundwater levels were so low that many  
22 wells were inoperable and many groundwater users were obligated to construct  
23 new deeper wells (NSJCGBA 2004). Recent information indicates that between  
24 the spring 2010 and spring 2014, groundwater levels declined at some wells in the  
25 Eastern San Joaquin subbasin by up to 20 feet (DWR 2014c, 2014d).

26 In the Eastern San Joaquin subbasin, the groundwater is characterized with low to  
27 high salinity levels and localized areas of high calcium or magnesium  
28 bicarbonate, salinity, nitrates, pesticides, and organic constituents (DWR 2006j,  
29 2013b). The high groundwater salinity is attributed to poor-quality groundwater  
30 intrusion from the Delta caused by the pumping-induced decline in groundwater  
31 levels, especially in the groundwater underlying the Stockton area since the 1970s  
32 (SJCFCWCD 2008). High chloride concentrations have also been observed in the  
33 Eastern San Joaquin subbasin. Ongoing studies are evaluating the sources of  
34 chloride in groundwater along a line extending from Manteca to north of  
35 Stockton. Initial concern was that long-term overdraft conditions in the eastern  
36 portion of the subbasin were enabling more saline water from the Delta to migrate  
37 inland. Other possible sources include upward movement of deeper saline  
38 formation water and agricultural practices (USGS 2006). In addition, large areas  
39 of groundwater with elevated nitrate concentrations have been observed in several  
40 portions of the subbasin, such as areas southeast of Lodi and south of Stockton  
41 and east of Manteca, and in areas extending towards the San Joaquin-Stanislaus  
42 County line (USFWS 2012).

43 The Eastern San Joaquin subbasin was designated by the CASGEM program as  
44 high priority.

1                    *Modesto Subbasin*

2    The Modesto subbasin underlies northern Stanislaus County. In the Modesto  
3    subbasin, water levels have declined nearly 15 feet on average between 1970 and  
4    2000 (DWR 2004r, 2013b), with the major declines occurring in the eastern  
5    portion of the subbasin. Recent information indicates that between the spring  
6    2010 and spring 2014, groundwater levels declined at some wells in the Modesto  
7    subbasin by up to 20 feet (DWR 2014c, 2014d).

8    The groundwater is characterized by low to high TDS concentrations with  
9    localized areas of boron, chlorides, DBCP, iron, manganese, and nitrate  
10    concentrations (DWR 2004r, 2013b; Stanislaus County 2010).

11    The Modesto subbasin was designated by the CASGEM program as high priority.

12                    *Turlock Subbasin*

13    The Turlock subbasin underlies portions of Stanislaus and Merced counties. In  
14    the Turlock subbasin, water levels declined nearly 7 feet on average from 1970  
15    through 2000 (DWR 2006k, 2013b). Comparison of groundwater contours from  
16    1958 and 2006 shows that historically, groundwater flows occurred from east to  
17    west, toward the San Joaquin River. Groundwater pumping centers to the east of  
18    the City of Turlock have drawn the groundwater toward these cones of  
19    depression, allowing less water to flow toward the San Joaquin River, and  
20    diminishing the discharge of groundwater to the river. Recent information  
21    indicates that between the spring 2010 and spring 2014, groundwater levels  
22    declined at some wells in the Turlock subbasin by up to 20 feet (DWR 2014c,  
23    2014d). The storage capacity of the Turlock subbasin is estimated at about  
24    15,800,000 acre-feet (DWR 2006k, 2013b).

25    The groundwater quality is characterized with low to high concentrations of TDS  
26    and localized high concentrations of boron, chlorides, DBCP, nitrates, and TDS  
27    (DWR 2013b).

28    The Turlock subbasin was designated by the CASGEM program as high priority.

29                    *Merced Subbasin*

30    The Merced subbasin underlies most of Merced County. In the Merced subbasin,  
31    water levels have declined nearly 30 feet on average from 1970 through 2000.  
32    Water level declines have been more severe in the eastern portion of the subbasin  
33    (DWR 2004s, 2013b). The estimated specific yield of the groundwater subbasin  
34    is 9 percent. Recent information indicates that between the spring 2010 and  
35    spring 2014, groundwater levels declined at some wells in the Merced subbasin  
36    by up to 20 feet (DWR 2014c, 2014d).

37    The groundwater quality is characterized by low to high TDS concentrations and  
38    localized areas with high concentrations of chloride, DBCP, iron, and nitrate  
39    (DWR 2004s, 2013b; USFWS 2012).

40    The Merced subbasin was designated by the CASGEM program as high priority.



1                    *Chowchilla Subbasin*

2    The Chowchilla subbasin underlies southwestern Merced County and  
3    northwestern Madera County. In the Chowchilla subbasin, water levels declined  
4    nearly 40 feet on average from 1970 to 2000. Water level declines were more  
5    severe in the eastern portion of the subbasin from 1980 to present, but the western  
6    portion of the subbasin showed the strongest declines before 1980 (DWR 2004t,  
7    2013b). Groundwater recharge in this subbasin is primarily from irrigation water  
8    percolation. Recent information indicates that between the spring 2010 and  
9    spring 2014, groundwater levels declined at some wells in the western Chowchilla  
10   subbasin by up to 10 feet (DWR 2014c, 2014d).

11   There are localized areas with high concentrations of chloride, iron, nitrate, and  
12   hardness (DWR 2004t, 2013b). Organic chemicals were detected in some wells  
13   in the Chowchilla subbasin between 1983 and 2003 (CVRWQCB 2011).

14   The Chowchilla subbasin was designated by the CASGEM program as high  
15   priority.

16                    *Madera Subbasin*

17   The Madera subbasin underlies most of Madera County. In the Madera subbasin,  
18   water levels have declined nearly 40 feet on average from 1970 through 2000.  
19   Water level declines have been more severe in the eastern portion of the subbasin  
20   from 1980 to the present, but the western subbasin showed the strongest declines  
21   before this period (DWR 2004u, 2013b). Recent information indicates that  
22   between the spring 2010 and spring 2014, groundwater levels declined at some  
23   wells in the western Chowchilla subbasin by up to 10 feet (DWR 2014c, 2014d).

24   Groundwater in the Madera subbasin is characterized by low to high TDS and  
25   localized areas with high concentrations of chlorides, iron, nitrates, and hardness  
26   (DWR 2004u, 2013b). Occurrences of organic chemicals have been observed  
27   including DBCP and pesticides (CVRWQCB 2011; DWR 2004u, 2013b).

28   The Madera subbasin was designated by the CASGEM program as high priority.

29                    *Groundwater Use and Management*

30   In this area, groundwater is used for agricultural, domestic, municipal, and  
31   industrial purposes.

32                    *Cosumnes Subbasin*

33   Currently, urban and agricultural water users on the valley floor are reliant on  
34   groundwater for water supply. Water demands in the Cosumnes Subbasin area  
35   are supported by nearly 95 percent groundwater (South Area Water Council  
36   2011). Groundwater and surface water are used for agricultural and domestic  
37   water supplies in the Cosumnes subbasin (CVRWQCB 2011). Groundwater is  
38   used by many agricultural water users and the community of Galt  
39   (CVRWQCB 2011; South Area Water Council 2011).

40   The Central Valley Regional Water Quality Board recently adopted general waste  
41   discharge requirements to protect groundwater, as well as surface water, within  
42   the San Joaquin County and Delta areas, including the Cosumnes subbasin. The

1 new requirements do not address protection of groundwater related to use of  
2 recycled water on crops because those operations would require separate  
3 discharge permits from the Central Valley Regional Water Quality Board and are  
4 not anticipated to be widely used in this area due to availability of recycled water  
5 near farms. However, the supporting information recognizes the potential for  
6 groundwater impairment due to the water quality of applied water to crops if the  
7 applied water quality contains high concentrations of constituents of concern  
8 (CVRWQCB 2014b).

9 *Eastern San Joaquin Subbasin*

10 Groundwater and surface water are used for agricultural and domestic water  
11 supplies in the Eastern San Joaquin subbasin (CVRWQCB 2011). Groundwater  
12 is the major source of water supply for agricultural areas in eastern San Joaquin  
13 County (NSJCGBA 2007). Groundwater is used by many agricultural water users  
14 and the communities of Escalon, Lodi, Manteca, Ripon, and Stockton  
15 (NSJCGBA 2004, 2007). The cities of Manteca and Stockton use both groundwater  
16 and surface water, while Lodi, Escalon, and Ripon primarily use groundwater for  
17 their municipal needs.

18 The City of Stockton uses both surface water and groundwater for its municipal  
19 and industrial water needs. Due to overdraft of the aquifer beneath Stockton, the  
20 city has limited annual groundwater extraction. All of these demands on the finite  
21 groundwater resources available in the basin historically have resulted in annual  
22 groundwater withdrawals in excess of the natural recharge volume in the East San  
23 Joaquin subbasin (DWR 2003a, 2006j). This extensive use of groundwater to  
24 meet local demand results in localized overdraft conditions within the subbasin.

25 The Northeastern San Joaquin County Groundwater Banking Authority is a joint-  
26 powers authority that develops local projects to strengthen water supply reliability  
27 in Eastern San Joaquin County. The Northeastern San Joaquin County  
28 Groundwater Banking Authority facilitated the development and adoption of the  
29 Eastern San Joaquin Groundwater Basin Groundwater Management Plan and  
30 completed an Integrated Regional Water Management Plan (IRWMP). This plan  
31 outlines the requirements for an integrated conjunctive use program that takes into  
32 account the various surface water and groundwater facilities in eastern San  
33 Joaquin County and promotes better groundwater management to meet future  
34 basin demands (NSJCGBA 2004). Conjunctive use refers to the use and  
35 management of the groundwater resource in coordination with surface water  
36 supplies by users overlying the basin. Potential projects that could be  
37 implemented to improve groundwater conditions in the area include urban and  
38 agricultural water use efficiency projects, recycled municipal water projects,  
39 groundwater banking operations, new surface water storage opportunities,  
40 improved conveyance facilities, and utilizing new sources of surface water  
41 (NSJCGBA 2007). Pursuant to the IRWMP, a program-level Environmental  
42 Impact Report identified potential changes to the environmental and mitigation  
43 measures to reduce identified significant adverse impacts (NSJCGBA 2011).

44 The Farmington Groundwater Recharge Program led by Stockton East Water  
45 District, in conjunction with the U.S. Army Corp of Engineers, and other local

1 water agencies, was developed to utilize flood-season and excess irrigation water  
2 supplies in the Eastern San Joaquin groundwater subbasin to recharge the  
3 groundwater aquifer. This program supports replenishment of a critically  
4 overdrafted groundwater basin by recharging an average of 35,000 acre-feet of  
5 water annually into the Eastern San Joaquin subbasin. The program includes  
6 recharge of surface water on 800 to 1,200 acres of land using direct field-  
7 flooding. In addition, the program increases surface water deliveries in-lieu of  
8 groundwater pumping to reduce overdraft (Farmington Program 2012).

9 A joint conjunctive use and groundwater banking project was evaluated by the  
10 East San Joaquin Parties Water Authority and East Bay Municipal Utility District,  
11 named the Mokelumne Aquifer Recharge and Storage Project (NSJCGBA 2004).  
12 The goal of this project was to store surface water underground in wet years, and  
13 in dry years, East Bay Municipal Utility District would extract and export the  
14 recovered water supply (NSJCGBA 2004, 2009). Several studies have concluded  
15 that the test area is suitable for recharge and recovery of groundwater; however,  
16 more testing needs to be done to further evaluate the feasibility of this project.

17 The Central Valley Regional Water Quality Control Board recently adopted  
18 general waste discharge requirements to protect groundwater, as well as surface  
19 water, within the San Joaquin County and Delta areas. The new requirements do  
20 not address protection of groundwater related to use of recycled water on crops  
21 because those operations would require separate discharge permits from the  
22 Central Valley Regional Water Quality Board and are not anticipated to be widely  
23 used in this area due to availability of recycled water near farms. However, the  
24 supporting information recognizes the potential for groundwater impairment due  
25 to the water quality of applied water to crops if the applied water quality contains  
26 high concentrations of constituents of concern (CVRWQCB 2014b).

#### 27 *Modesto Subbasin*

28 Groundwater is used for agricultural and domestic water supplies in the Modesto  
29 subbasin (Reclamation and DWR 2011). Groundwater is used by many  
30 agricultural water users and the community of Modesto (DWR 2004r; Stanislaus  
31 County 2010).

#### 32 *Turlock Subbasin*

33 Groundwater is used for agricultural and domestic water supplies in the Turlock  
34 subbasin (Reclamation and DWR 2011). Groundwater is used by many  
35 agricultural water users and the community of Turlock in Stanislaus County and  
36 the communities of Delhi and Hilmar in Merced County (DWR 2006k; Stanislaus  
37 County 2010; Merced County 2012).

#### 38 *Merced Subbasin*

39 Groundwater is used for agricultural and domestic water supplies in the Merced  
40 subbasin (Reclamation and DWR 2011). Groundwater is used by many  
41 agricultural water users and the communities of Atwater, El Nido, Le Grand,  
42 Livingston, Merced, Planada, and Winton (DWR 2004s; Merced County 2012).

1                    *Chowchilla Subbasin*

2 Groundwater is used for agricultural and domestic water supplies in the  
 3 Chowchilla subbasin (Reclamation and DWR 2011). Groundwater is used by  
 4 many agricultural water users and the community of Chowchilla (DWR 2006k;  
 5 Madera County 2002).

6                    *Madera Subbasin*

7 Groundwater is used for agricultural and domestic water supplies in the Madera  
 8 subbasin (Reclamation and DWR 2011). Groundwater is used by many  
 9 agricultural water users and the community of Madera (DWR 2006k; Madera  
 10 County 2002, 2008).

11 **7.3.3.4.2 Tulare Lake Area of the San Joaquin Valley Groundwater Basin**

12 The Tulare Lake Area overlies seven groundwater subbasins of the San Joaquin  
 13 Valley Groundwater Basin, as defined by DWR (DWR 2003a): the Westside,  
 14 Kings, Tulare Lake, Kaweah, Tule, Pleasant Valley, and Kern subbasins, as  
 15 shown in Figure 7.7. The Kern and Pleasant Valley subbasins have distinct  
 16 hydrogeology and groundwater management from the other subbasins, and  
 17 therefore are described separately.

18 *Northern Tulare Lake Area: Westside, Kings, Tulare Lake, Kaweah, Tule,*  
 19 *Pleasant Valley, and Kern Subbasins*

20                    *Hydrogeology and Groundwater Conditions*

21                    *Hydrogeology*

22 The aquifer system in the Tulare Lake Area consists of younger and older  
 23 alluvium, flood-basin deposits, lacustrine and marsh deposits and unconsolidated  
 24 continental deposits. These deposits are configured within most parts of the basin  
 25 to form an unconfined to semi-confined upper aquifer and a confined lower  
 26 aquifer. These aquifers are separated by the Corcoran Clay (E-Clay) member of  
 27 the Tulare Formation, which occurs at depths between 200 and 850 feet within the  
 28 central and western portions of the basin, specifically in the Westside and Tulare  
 29 Lake subbasins and in the western Kings, Kaweah, and Tule subbasins.  
 30 Fine-grained lacustrine deposits up to 3,600 feet thick also are present in the  
 31 Tulare Lake region (DWR 2003a, 2004v, 2004w, 2006l, 2006m, 2006n, 2006o,  
 32 2006p).

33 Prior to extensive use of groundwater in the basin, groundwater generally flowed  
 34 toward Tulare Lake. Due to depressed groundwater levels and interception of  
 35 surface water, the Tulare Lake Area is dry except during extreme flood events;  
 36 and recharge of the Tulare Lake Area is limited.

37 Groundwater withdrawals in the Tulare Lake Area account for approximately  
 38 38 percent of the total groundwater withdrawals in the state of California  
 39 (DWR 2013i). The CVP and SWP surface water supplies are used by many  
 40 agricultural water users and several communities in the Tulare Lake Area to  
 41 reduce reliance on groundwater and allow for groundwater recharge. In drier  
 42 years when the CVP and SWP water supplies are limited, extensive groundwater  
 43 pumping occurs to meet the water demands. In drier years, water users in the

1 Westside, Kings, Tulare Lake, and Kaweah subbasins may use groundwater for  
2 up to 75 percent of their water supply (DWR 2013i).

3 Areal recharge from precipitation provides most of the groundwater recharge, and  
4 seepage from stream channels provides the remaining groundwater recharge.  
5 Most of the recharge occurs as mountain-front recharge in the coarse-grained  
6 upper alluvial fans where streams enter the basin (USGS 2009). Prior to  
7 development of the Tulare Lake Area, surface water and groundwater exchange  
8 occurred throughout the basin in response to hydrologic conditions. When rapid  
9 agricultural growth and groundwater development occurred, the primary  
10 interaction of surface water with groundwater occurred as stream flow loss to  
11 underlying aquifers. In areas of severe overdraft in the Tulare Lake Area of the  
12 San Joaquin Valley Groundwater Basin, complete disconnection between  
13 groundwater and overlying surface water systems has occurred. In some areas  
14 with disconnected hydrology where streambeds are used as conveyance elements  
15 for irrigation purposes and to recharge groundwater, the streams become losing  
16 streams. Recent information indicates that between the spring 2010 and spring  
17 2014, groundwater levels declined at some wells in this area by up to 10 feet  
18 (DWR 2014c, 2014d). The groundwater levels in some areas declined up to  
19 10 feet between fall 2013 and fall 2014, and in some areas more than 10 feet.

#### 20 *Groundwater Quality*

21 In the northern Tulare Lake Area (including the Westside, Tulare Lake, Kings,  
22 Kaweah, and Tule subbasins), groundwater in the upper unconfined/semi-  
23 confined aquifer is characterized by high calcium and magnesium sulfate as well  
24 as high TDS (DWR 2006l, 2006m, 2006n, 2013c). The lower confined aquifer is  
25 approximately 300 feet below the ground surface and above the Corcoran Clay,  
26 and is characterized by high sodium sulfates and less dissolved solids than the  
27 upper aquifer.

28 Groundwater quality in the northern Tulare Lake Area is poor in portions of the  
29 upper aquifer, due to agricultural drainage issues and naturally occurring high  
30 salinity soils. Groundwater in the Westside subbasin is of poor quality due to  
31 historical agricultural drainage. The high clay content of the soils that comprise  
32 the upper aquifer restricts the movement of groundwater in the aquifer, further  
33 contributing to water quality impacts from root zone drainage. Studies have  
34 shown that the quality of the upper 20 to 200 feet of the saturated groundwater  
35 zone have been affected by crop irrigation and drainage issues (Reclamation  
36 2006). The eastward movement of saline groundwater from the Westside  
37 subbasin also adversely affects the groundwater quality in adjacent subbasins,  
38 such as in the vicinity of the City of Mendota and Fresno Slough  
39 (Reclamation 2006).

40 The Westside and Kings subbasins also have localized areas with high boron  
41 concentrations (CVRWQCB 2011). The Kings and Tulare Lake subbasins have  
42 localized areas with high arsenic and hydrogen sulfide. In the Kaweah subbasin  
43 and the northern portion of the Tule subbasin, groundwater is of the calcium  
44 bicarbonate type with high TDS and localized areas with high nitrate  
45 concentrations (DWR 2004v, 2004w, 2013c). In the Kaweah subbasin,

1 groundwater is characterized by moderate to high TDS concentrations  
2 (DWR 2004v, 2013c). In the Tule subbasin, low to moderate TDS concentrations  
3 occur in the most of the subbasin with high concentrations in areas with poor  
4 drainage (DWR 2004w, 2013c). On the western side of the subbasin there is  
5 shallow saline water. The eastern side of the subbasin has areas of high nitrates  
6 (DWR 2013c, 2004b). The Westside and Kings subbasins also have localized  
7 areas with high boron concentrations (CVRWQCB 2011). The Kings and Tulare  
8 Lake subbasins have localized areas with high arsenic and hydrogen sulfide. In  
9 the Kaweah subbasin and the northern portion of the Tule subbasin, groundwater  
10 is of the calcium bicarbonate type with high TDS and localized areas with high  
11 nitrate concentrations (DWR 2004v, 2004w, 2013c). Portions of the Kings  
12 subbasin are characterized by high nitrate concentrations due to historical  
13 agricultural practices (CVRWQCB 2011; DWR 2006n, 2013c). High DBCP and  
14 other pesticides concentrations occur in localized areas within the Westside,  
15 Kings, Tulare Lake, Kaweah, and Tule subbasins (CVRWQCB 2011).

16 A recent study evaluated high nitrate concentrations in groundwater and related  
17 public health issues in four community water systems with recorded violations  
18 related to nitrates in drinking water (Pacific Institute 2011). The communities  
19 served by the water systems were evaluated to assess the quality of groundwater  
20 provided by their water distribution systems and potential costs to the  
21 communities. Overall, this significant degradation of groundwater quality  
22 throughout the area has implications on public health and economic sustainability  
23 of the region. The findings of the report indicated that improved notification  
24 procedures, new funding mechanisms, and improved regulations and incentives  
25 are needed to provide safe drinking water, as described in Chapter 18, Public  
26 Health. The four water systems included Beverly Grand Mutual Water Company  
27 (Tule subbasin), Lemon Cove Water Company (east of Tule subbasin), El Monte  
28 Village Mobile Home Park (Kings subbasin), and Soult's Mutual Water Company  
29 (Kings subbasin) in Tulare County.

30 High groundwater salinity occurs in many locations in the Tulare Lake Area.  
31 Salts are imported into the Tulare Lake Area through irrigation with Delta water  
32 and salts added through application of fertilizers, and other salt containing  
33 materials. Except in very wet years, the Tulare Lake Area has no natural  
34 drainage, so imported salts accumulate in the groundwater unless captured and  
35 sequestered. This salt accumulation causes groundwater quality degradation for  
36 potable and agricultural uses.

37 To the high nitrate and salinity problems, the Central Valley Salinity  
38 Alternatives for Long-Term Sustainability (CV-Salts) was formed as a strategic  
39 initiative to address accumulation of salts and nitrates throughout the region in a  
40 comprehensive, consistent and sustainable manner (CVRWQCB 2015; SWRCB  
41 2015). The Central Valley Regional Water Quality Control Board and the State  
42 Water Resources Control Board in cooperation with stakeholders and the Central  
43 Valley Salinity Coalition collaborate to review and update the Water Quality  
44 Control Plans for the Sacramento Valley and San Joaquin Valley groundwater  
45 basins and the Delta Plan for salinity management, as described in Chapter 6,

1 Surface Water Quality. The goals of this program are to address groundwater  
2 nitrate legacy conditions and current loadings, direct impacts of high nitrates on  
3 drinking water supplies from diverse sources, and economic costs for water  
4 treatment or alternate supplies. A final Salinity and Nitrate Management Plan is  
5 scheduled to be completed in May 2016.

6 *Overall Groundwater Conditions*

7 The Westside, Kings, Tulare Lake, Kaweah, Tule, and Kern subbasins were  
8 designated by the CASGEM program as high priority. The Pleasant Valley  
9 subbasin was designated as low priority.

10 *Groundwater Use and Management*

11 The northern Tulare Lake Area uses groundwater for its many water needs.  
12 Groundwater is used conjunctively with surface water, where possible, when  
13 surface water supplies are not sufficient to meet the region's demand for  
14 agricultural, industrial, and municipal uses (DWR 2003a). For example, the cities  
15 of Fresno and Visalia are almost entirely dependent on groundwater for their  
16 water supplies. Most groundwater subbasins in the Tulare Lake Area are in a  
17 state of overdraft as a consequence of groundwater pumping that exceeds the  
18 basin's safe yield (the amount of natural and induced recharge available to  
19 replenish the basin). As a result, the aquifers in these groundwater basins contain  
20 a significant amount of potential storage space that can be filled with additional  
21 recharged water. However, cities in the northern Tulare Lake Area are  
22 considering other water sources and/or groundwater banking programs.

23 *Westside Subbasin*

24 The Westside subbasin is located within western Fresno County and northwestern  
25 Kings County. The majority of lands within the Westside subbasin are within the  
26 Westlands Water District which uses CVP surface water, water transferred from  
27 other agencies, and groundwater. Groundwater levels in the Westside subbasin  
28 have fluctuated over the past 46 years in response to the availability of surface  
29 water deliveries from the CVP (WWD 2013). The lowest recorded average  
30 groundwater level below the Corcoran Clay between 1950 and 1968 (prior to  
31 delivery of CVP water to the subbasin) was 156 feet below mean sea level, which  
32 occurred in 1967. Groundwater elevations increased after 1968 to 89 feet above  
33 mean sea level in 1987.

34 Groundwater levels are closely related to the availability of surface water. In the  
35 1977 drought when CVP water supplies were substantially reduced, groundwater  
36 withdrawals decreased the groundwater elevation by 97 feet in 1 year  
37 (WWD 2013). In 1991 and 1992 (during the 1987 to 1992 drought), the  
38 groundwater elevation declined to 62 feet below mean sea level. In 1996, the  
39 Westlands Water District adopted a groundwater management plan to preserve  
40 and enhance reliable groundwater resources; provide long-term availability of  
41 high quality groundwater; maintain local control of groundwater in the district;  
42 and minimize the cost and impact of groundwater use (WWD 2013a). The  
43 groundwater levels recovered following the drought that ended in 1992.  
44 However, in 2010, the CVP allocation was 45 percent of the contract amount, and

1 the average groundwater elevation was 9 feet above mean sea level (WWD 2011).  
2 In 2012, the CVP allocation was 40 percent of the contract amount, and the  
3 average groundwater elevation decreased to 1 foot above mean sea level (WWD  
4 2013). Recent information indicates that between the spring 2013 and spring  
5 2014, groundwater levels have declined at some wells in the Westside subbasin  
6 by up to 40 feet within the 1-year period (DWR 2014c, 2014d).

7 Subsidence has occurred in the Westside subbasin as a result of the high rate of  
8 historic groundwater pumping resulting in reduced groundwater levels and the  
9 compaction of fine grained soils. In some areas, the land surface elevation has  
10 decreased substantially. It is estimated that extensive groundwater pumping prior  
11 to delivery of CVP water resulted in compaction of water bearing sediments and  
12 land subsidence of 1 to 24 feet between 1926 and 1972 (WWD 2013). The  
13 Westland Water District has referenced that the Department of Water Resources  
14 estimated the amount of subsidence since 1983 to be almost 2 feet in some areas  
15 of the District with most of that subsidence occurring since 1989 (WWD 2013).  
16 The USGS monitoring between 2003 and 2010 indicated no subsidence in the  
17 Westside subbasin area during the same time period while at least 1.8 feet of  
18 subsidence occurred in the Delta-Mendota subbasin area near the southern part of  
19 the Delta-Mendota Canal (USGS 2013a).

20 *Kings Subbasin*

21 The Kings subbasin includes most of central and eastern Fresno County, and  
22 northern Kings and Tulare County (DWR 2006n, 2013c). Two major  
23 groundwater depressions occur near the Fresno-Clovis urban area and  
24 approximately 20 miles southwest of Fresno in the Raisin City Water District  
25 (DWR 2013c). On average, the majority of this subbasin has experienced  
26 generalized declines in groundwater levels of approximately 20 feet between 2003  
27 and 2011 (KRCD 2012a). The Kings subbasin is in overdraft condition and  
28 overdraft continues to be a major long-term problem due to increasing water  
29 demand and reduced surface water supply reliability. Recent information  
30 indicates that between the spring 2010 and spring 2014, groundwater levels  
31 declined at some wells in the Kings subbasin by up to 20 feet (DWR 2014c,  
32 2014d).

33 Groundwater is used for a portion of agricultural water demands and for most of  
34 the domestic and industrial water demands in Fresno County, including for water  
35 users in the communities of Fresno, Clovis, Sanger, Fowler, Selma, Kingsburg,  
36 Reedley, Dinuba, Orange Cove, Raisin City, and Riverdale (CVRWQCB 2011;  
37 Fresno County 2000; KRCD 2012a).

38 The City of Fresno, which previously used groundwater for the municipal water  
39 supplies, has developed a surface water supply program. The groundwater is  
40 recharged through direct recharge and from applied agricultural water, and  
41 groundwater inflows from the adjacent foothills (City of Fresno 2015).

42 Several water agencies are coordinating efforts in the Kings subbasin to mitigate  
43 the extensive historical declines in groundwater levels resulting from pumping  
44 withdrawals. Current Kings subbasin groundwater recharge efforts include a total



1 of 4,000 acres of dedicated recharge ponds (CGRA 2012). One of the biggest  
2 groundwater recharge efforts in the Kings subbasin area is the McMullin On-farm  
3 Flood Capture and Recharge Project near Raisin City (KRCD 2013).

4 *Tulare Lake Subbasin*

5 The Tulare Lake subbasin includes most of Kings County (DWR 2006m, 2013c).  
6 In the Tulare Lake subbasin, water levels have declined nearly 17 feet on average  
7 from 1970 through 2000. Fluctuations in water levels have been most  
8 exaggerated in the Tulare Lakebed area of the subbasin, which has experienced  
9 both the steepest declines and the steepest rises over time. Groundwater overdraft  
10 conditions also prevail in this subbasin, similar to the Kings subbasin. Recent  
11 information indicates that between the spring 2010 and spring 2014, groundwater  
12 levels declined at some wells in the Tulare Lake subbasin by up to 20 feet  
13 (DWR 2014c, 2014d).

14 Groundwater is used for a portion of agricultural water demands and for most of  
15 the domestic and industrial water demands in Kings County, including the  
16 communities of Corcoran, Hanford, Lemoore, and Kettleman Hills  
17 (CVRWQCB 2011; KRCD 2012a).

18 *Kaweah Subbasin*

19 The Kaweah subbasin includes a portion of eastern Kings County and  
20 northwestern Tulare County. Water levels in this subbasin declined about 12 feet  
21 on average from 1970 through 2000 (DWR 2004v, 2013c). The basin is subject  
22 to large fluctuations in water levels since the 1970s to as low as 35 feet lower than  
23 the 1970 water level in 1995 to 25 feet higher in 1988. These fluctuations  
24 correspond to successive dry years (declines) and wet years (rebounds),  
25 respectively. Recent information indicates that between the spring 2010 and  
26 spring 2014, groundwater levels declined at some wells in the Kaweah subbasin  
27 by up to 20 feet (DWR 2014c, 2014d). The Kaweah Delta Water Conservation  
28 District operates recharge facilities to supplement groundwater recharge that  
29 occurs along the natural stream channels (KDWCD 2006). Water is released  
30 from the Terminus Reservoir on the Kaweah River to flow into over 40 recharge  
31 basins throughout the basin. Use of CVP water from the Friant-Kern Canal by  
32 Tulare Irrigation District and Ivanhoe Irrigation District reduces the need for  
33 groundwater withdrawals when the CVP water is available.

34 Groundwater is used for a portion of agricultural water demands and for most of  
35 the domestic and industrial water demands in the subbasin, including for water  
36 users in the communities of Visalia, Tulare, and Lindsay (CVRWQCB 2011;  
37 Tulare County 2010).

38 *Tule Subbasin*

39 The Tule subbasin includes southwestern Tulare County. Water levels in this  
40 subbasin increased by about 4 feet on average from 1970 through 2000  
41 (DWR 2004w, 2013c). Water levels have fluctuated during dry and wet years  
42 between 16 feet below the 1970 water level in 1995 to 20 feet above the 1970  
43 water level in 1988. Recent information indicates that between the spring 2010  
44 and spring 2014, groundwater levels declined at some wells in the Tule subbasin

1 by up to 20 feet (DWR 2014c, 2014d). The Deer Creek and Tule River Authority  
2 implemented a groundwater management plan in 2006 in the Tule Subbasin  
3 (DCTRA 2012). The plan participants include Lower Tule River Irrigation  
4 District, Pixley Irrigation District, Porterville Irrigation District, Terra Bella  
5 Irrigation District, Saucelito Irrigation District, Tea Pot Dome Irrigation District,  
6 Vandalia Irrigation District, Tipton Community Services District, Poplar  
7 Community Services District (primarily the City of Porterville), and Woodville  
8 Public Utility District. Many of these agencies have CVP water service contracts  
9 and some of these agencies have surface water rights. Groundwater recharge  
10 occurs in more than 25 groundwater recharge basins and along the Tule River and  
11 Deer Creek channels.

12 *Southern Tulare Lake Area: Kern County Subbasin*

13 The Kern County subbasin is located between the Tule and Tulare Lake  
14 groundwater subbasins on the north, the Sierra Nevada and Tehachapi Mountains  
15 granitic rock on the east, and the marine sediments of the Coast Ranges on the  
16 west. The major water suppliers within the Kern County subbasin include Kern  
17 County Water Agency and the City of Bakersfield.

18 *Hydrogeology and Groundwater Conditions*

19 The unconfined aquifer in the Kern County Groundwater subbasin is composed  
20 primarily of sediments that were deposited during the tertiary and quaternary age.  
21 The Tulare Formation, located in the western portion of the subbasin, includes the  
22 Corcoran Clay unit which occurs at depths of 300 to 650 feet and overlies the  
23 confined aquifer (DWR 2006o, 2013c).

24 Net groundwater level changes in the Kern County subbasin varied in different  
25 portions of the subbasin between 1970 and 2000 (DWR 2006o, 2013c). Since the  
26 late 1970s, the groundwater levels have ranged from an increase of over 30 feet in  
27 the southeastern portion of the subbasin to a decrease of up to 25 feet near  
28 Bakersfield and 50 feet near McFarland/Shafter. Recent information indicates  
29 that between the spring 2013 and spring 2014, groundwater levels declined at  
30 some wells in the Kern County subbasin by up to 40 feet (DWR 2014c, 2014d).  
31 The groundwater levels in some areas declined up to 10 feet between fall 2013  
32 and fall 2014, and in some areas more than 10 feet.

33 Complete hydraulic disconnection between the groundwater and overlying surface  
34 water systems has occurred in the Kern County area. Kern River, a losing stream,  
35 is used as a conveyance element for irrigation purposes and to recharge  
36 groundwater.

37 Groundwater quality in the region is generally characterized by calcium  
38 bicarbonate in the shallow aquifers, and the groundwater quality is generally  
39 suitable for most uses. Lower aquifers have higher sodium concentrations  
40 (DWR 2006o, 2013c). Salinity is a significant groundwater quality issue in the  
41 region. Salt from imported CVP and SWP water accumulates annually in  
42 groundwater because the Tulare Lake is a closed system without any natural  
43 outlets (KCWA 2011).

1 Shallow groundwater with high salinity occurs in the western and southern  
2 portions of the Kern County subbasin and is related to drainage problems for  
3 irrigated agriculture (DWR 2006o, 2013c). An agricultural drainage study  
4 showed that shallow groundwater occurs between 0 and 30 feet below the ground  
5 surface in the southern portion of the Kern County subbasin (DWR 2013j). The  
6 shallow groundwater is characterized by high TDS, sodium chloride, selenium,  
7 and sulfates (DWR 2013j). Areas with high nitrate and pesticide concentrations  
8 occur in localized areas due to historic agricultural practices including irrigation  
9 and dairy wastes (CVRWQCB 2011; DWR 2006o). Elevated arsenic  
10 concentrations tend to occur in isolated areas associated with lakebed deposits.  
11 Selenium and chromium also naturally occur in portions of the subbasin  
12 (KCWA 2011).

13 *Groundwater Use and Management*

14 The Kern County subbasin is located in western Kern County. The majority of  
15 the lands within the Kern County subbasin are within Kern County Water Agency  
16 or the City of Bakersfield. Water supplies in the subbasin include local surface  
17 water, CVP and SWP water supplies, and groundwater. The subbasin includes a  
18 portion of the land evaluated in the Tulare Lake Basin Portion of the Kern Region  
19 IRWMP. It is estimated that over the long-term, approximately 39 percent of  
20 water supplies in this area are met by groundwater (KCWA 2011). Groundwater  
21 can provide up to 60 percent of the total water supply in drier years.

22 Much of the groundwater is withdrawn by individuals or farmers who do not  
23 maintain groundwater extraction records. Historically, groundwater extractions  
24 were estimated based upon electricity use, changes in groundwater storage, or  
25 changes in crop patterns and/or water requirements (DWR 2004o, 2013c;  
26 KCWA 2011).

27 Most of the groundwater is used by agriculture and the communities of  
28 Bakersfield, Rosedale, Shafter, Delano, Taft, and Wasco (KCWA 2011). The  
29 City of Bakersfield and surrounding unincorporated areas use surface water and  
30 groundwater. The groundwater supplies in 2010 include water provided by  
31 California Water Service Company; East Niles Community Services District;  
32 Kern County Water Agency Improvement District No. 4 and North of the River  
33 Municipal Water District; and Vaughn Water Company (California Water Service  
34 Company 2011a; ENCSD 2011; KCWA 2011; KCWA and NORMWD 2011;  
35 Vaughn Water Company, Inc. 2011). The water entities along with adjacent  
36 water agencies manage the groundwater basin levels through ongoing recharge  
37 projects and conjunctive use projects.

38 *Conjunctive Use and Groundwater Banking*

39 Conjunctive use is an important component of water management in the Kern  
40 County subbasin. Many groundwater banking facilities supplement water  
41 supplies delivered to customers in dry years, when insufficient surface water  
42 supplies are available to meet demands.

43 More than 30,000 acres of groundwater recharge ponds are estimated to exist in  
44 the Kern County subbasin area (KCWA 2011). Infrastructure used for

1 groundwater banking includes recharge basins, recharge canals, recovery wells,  
2 and conveyance pipelines. In addition, connections to regional conveyance  
3 infrastructure conveys water from the local water supplies, including the Kern  
4 River; Friant-Kern Canal; the Cross Valley Canal; and California Aqueduct to the  
5 recharge areas. Groundwater banking programs have developed various interties  
6 to the regional conveyance systems, such as the Semitropic Water Storage District  
7 Intake Canal and the Kern Water Bank Canal (KCWA 2011).

8 The major groundwater banking programs in Kern County include the Kern  
9 Water Bank operated by the Kern Water Bank Authority; the Semitropic  
10 Groundwater Bank, operated by the Semitropic Water Storage District; a  
11 groundwater bank operated by the North Kern Water Storage District; a  
12 groundwater bank operated by the City of Bakersfield; and a groundwater bank  
13 operated by Rosedale-Rio Bravo Water Storage District.

14 The Kern Water Bank Authority is located west of Bakersfield and covers nearly  
15 30 square miles of the Kern County subbasin. The Kern Water Bank includes  
16 recharge ponds where water from local surface streams and the SWP infiltrates  
17 into the aquifer (KCWA n.d.; KWBA 2011). Eighty-four recovery wells are used  
18 to pump groundwater out of the aquifer in dry years when additional water is  
19 needed for irrigation since the program began operations in 1995 (KCWA 2011).

20 The Semitropic Water Storage District is located west of Wasco and covers more  
21 than 220,000 acres (SWSD 2011a). The Semitropic Water Storage District Stored  
22 Water Recovery Unit (a subunit of the overall Semitropic Water Storage District  
23 Water Bank) partnered with the Antelope Valley Water Bank, located close to  
24 Rosamond in the Kern County portion of the Antelope Valley, to form the  
25 Semitropic-Rosamond Water Bank Authority (SWSD 2011b). The major banking  
26 partners of Semitropic Water Storage District include (SWSD 2014):

- 27 • Metropolitan Water District of Southern California
- 28 • Santa Clara Valley Water District
- 29 • Alameda County Water District
- 30 • Zone 7 Water Agency
- 31 • Poso Creek Water Company
- 32 • Newhall Land & Farming Company
- 33 • San Diego County Water Authority
- 34 • Homer, LLC
- 35 • City of Tracy
- 36 • Harris Farms

37 Other banking programs include (KCWA and NORMWD 2011; KCWA  
38 2011, n.d.):

- 39 • Arvin-Edison Water Storage District Banking

- 1 • Buena Vista Water Storage District Banking
- 2 • Cawelo Water District Banking
- 3 • City of Bakersfield 2800 Acres Recharge Facility
- 4 • Kern County Water Agency Improvement District No. 4 Pioneer Project and
- 5 Allen Road Complex Well Field
- 6 • Kern Delta Water District Banking
- 7 • Kern Tulare and Rag Gulch Water Districts Banking
- 8 • Rosedale-Rio Bravo Water Storage District Banking (developed with Kern
- 9 County Water Agency Improvement District No. 4)

10 *Western Tulare Lake Area: Pleasant Valley Subbasin*

11 The Pleasant Valley subbasin is located within the western portions of Fresno and  
12 Kings Counties.

13 *Hydrogeology and Groundwater Conditions*

14 Tertiary continental and marine sediments of the Coast Ranges and Kettleman  
15 Hills form the western boundary of the Pleasant Valley subbasin (DWR 2006p,  
16 2013c). Alluvium of the San Joaquin Valley extends into the subbasin from the  
17 north, east, and south. Ephemeral streams from the Coast Ranges and Kettleman  
18 Hills flow into the subbasin. Groundwater recharge occurs primarily along these  
19 and other streams within the subbasin.

20 In the Pleasant Valley subbasin, groundwater levels are generally continuing a  
21 historical trend of decline. DWR measurements indicated a decline of 5 to 25 feet  
22 during the 1990s (DWR 2006p, 2013c).

23 Water quality in the Pleasant Valley subbasin is characterized by high TDS  
24 (CVRWQCB 2011; DWR 2006p, 2013c). Localized areas of high concentrations  
25 of boron, calcium, chlorides, magnesium, pesticides, sodium, bicarbonates, and  
26 sulfates occur in the groundwater.

27 The Pleasant Valley subbasin was designated by the CASGEM program as low  
28 priority.

29 *Groundwater Use and Management*

30 Groundwater is used to meet agricultural and municipal water demands in the  
31 Pleasant Valley subbasin (DWR 2006p, 2013c). Due to limited recharge  
32 capabilities in the subbasin, surface water is used either completely or  
33 conjunctively in western Fresno and Kings Counties. The communities of Avenal  
34 and Coalinga use CVP surface water due to groundwater quality, as described in  
35 Chapter 5, Surface Water Resources and Water Supplies (Reclamation 2012).

36 **7.3.4 San Francisco Bay Area Region**

37 The San Francisco Bay Area Region includes portions of Contra Costa, Alameda,  
38 Santa Clara, and San Benito counties that are within the CVP and SWP service

1 areas. The SWP water users in Napa County do not use groundwater. Therefore,  
 2 groundwater resources for Napa County are not described in this EIS.

3 There are several groundwater basins in the San Francisco Bay Area Region;  
 4 however, only some of the basins are within the CVP and SWP service areas  
 5 evaluated in this EIS. The portions of the San Francisco Bay Area Region within  
 6 the CVP and/or SWP service areas include the Pittsburg Plain, Clayton Valley,  
 7 Ygnacio Valley, Arroyo Del Hambre Valley, San Ramon Valley, Livermore  
 8 Valley, Castro Valley, and Santa Clara Valley groundwater basins within the San  
 9 Francisco Bay Hydrologic Region; and Gilroy-Hollister Valley Groundwater  
 10 Basin within the Central Coast Hydrologic Region.

11 Groundwater represents approximately 15 percent of the agricultural, municipal,  
 12 and industrial water supplies in the San Francisco Bay Area (DWR 2013i).  
 13 Conjunctive use programs have been implemented by several agencies to  
 14 optimize the use of groundwater and surface water sources.

15 Groundwater quality in the San Francisco Bay Area is generally suitable for most  
 16 agricultural and municipal uses, but concerns exist about groundwater  
 17 contamination from industrial and agricultural chemical spills, leaky underground  
 18 and above ground storage tanks, landfill leachate, and poorer-quality surface  
 19 water bodies. There were over 800 groundwater cleanup projects in the area with  
 20 the majority resulting from leaky fuel tanks (DWR 2013i). Portions of the San  
 21 Francisco Bay Area Region along the shorelines include aquifers that are  
 22 susceptible to seawater intrusion.

23 In the southern San Francisco Bay Area Region, groundwater and surface water  
 24 are connected through in-stream and off-stream artificial recharge projects, in  
 25 which surface water is delivered to water bodies that permit the infiltration of  
 26 water to recharge underlying aquifers. Surface waters recharge aquifers in other  
 27 regions of the San Francisco Bay Area Region along streambeds, especially in  
 28 areas with depressed groundwater levels that have resulted from extensive  
 29 groundwater pumping.

30 This section describes groundwater in subbasins within CVP and/or SWP water  
 31 service areas, including Pittsburg Plain, Clayton Valley, Arroyo Del Hambre  
 32 Valley, Ygnacio Valley, and San Ramon Valley subbasins in Contra Costa  
 33 County; East Bay Plain and Livermore Valley subbasins in Contra Costa and  
 34 Alameda counties; Castro Valley subbasin in Alameda County; Santa Clara and  
 35 Llagas Area subbasins in Santa Clara County; and Bolsa, Hollister, and San Juan  
 36 Bautista Area subbasins in San Benito County, as shown in Figure 7.8.

37 **7.3.4.1 San Francisco Bay Hydrologic Region**

38 **7.3.4.1.1 Hydrogeology and Groundwater Conditions**

39 Each of these groundwater basins in the San Francisco Bay Hydrologic Region  
 40 contains unique hydrogeologic characteristics. However, generally the water  
 41 bearing materials consist of alluvial, unconsolidated sand, sand and gravel, and  
 42 clay (DWR 2004x, 2004y, 2004z, 2004aa, 2004ab, 2004ac, 2004ad, 2004ae,

1 2006q, 2006r, 2013d). Aquifers in these basins are hydrologically connected to  
2 surface water bodies, such as the San Joaquin River, Suisun Bay, local streams,  
3 and San Francisco Bay.

4 The movement of groundwater is locally influenced by features such as faults and  
5 structural depressions and operating production wells; however, groundwater  
6 generally flows toward the nearby bays. Groundwater levels in the area exhibit  
7 seasonal variation and have been historically depressed from significant  
8 groundwater use. However, as groundwater use decreased over the last few  
9 decades following implementation of surface water projects, groundwater levels  
10 have risen significantly. Over the entire period of record, groundwater levels  
11 have shown only a slight decline and are stable in more recent years.

12 *Pittsburg Plain, Clayton Valley, Ygnacio Valley, and Arroyo Del Hambre Valley*  
13 *Groundwater Basins*

14 The Pittsburg Plain, Clayton Valley, Ygnacio Valley, and Arroyo Del Hambre  
15 Valley groundwater basins represent the majority of groundwater storage in  
16 northern Contra Costa County. Except for portions of the Pittsburg Plain, most of  
17 these groundwater basins are not located within the Delta.

18 These basins extend inland from Suisun Bay towards Mt. Diablo. The Pittsburg  
19 Plain Groundwater Basin is composed of Pleistocene deposits of consolidated and  
20 unconsolidated clay sediments; overlain by alluvial soft water-saturated muds,  
21 peat, and loose sands (DWR 2004x, 2013d). The Clayton Valley and Ygnacio  
22 Valley groundwater basins are composed of unconsolidated alluvium and semi-  
23 consolidated alluvium interbedded with clay, sand, and gravel lenses. Along  
24 Suisun Bay, the water bearing formations are composed of alluvial soft water-  
25 saturated muds, peat, and loose sands (DWR 2004y, 2004z, 2004aa, 2013d).

26 Groundwater levels are relatively stable because the groundwater is recharged  
27 from streams (DWR 2004x, 2004y, 2004z, 2004aa, 2013d). The streams include  
28 Kirker and Willow creeks in the Pittsburg Plain Groundwater Basin; Marsh Creek  
29 in the Clayton Valley Groundwater Basin; Walnut and Grayson creeks in the  
30 Ygnacio Valley Groundwater Basin; and Alhambra Creek in the Arroyo Del  
31 Hambre Valley Groundwater Basin. There are no recent data for these basins  
32 related to groundwater levels or storage capacities.

33 The groundwater in this area is characterized by moderate to high TDS  
34 (DWR 2004x, 2004y, 2004z, 2004aa, 2013d). High nitrate concentrations occur  
35 in some rural areas of these basins (Contra Costa County 2005).

36 The Pittsburg Plain, Clayton Valley, Ygnacio Valley, and Arroyo Del Hambre  
37 Valley groundwater basins were designated by the CASGEM program as very  
38 low priority.

39 *San Ramon Valley Groundwater Basin*

40 The San Ramon Valley Groundwater Basin is located in southern Contra Costa  
41 County and extends from the Alamo area southward under the Town of Danville  
42 and City of San Ramon to the county boundary.

1 The basin is a closed basin characterized by alluvial fan deposits of sand, gravel,  
2 silt, and clay sediments (DWR 2004ab, 2013d). Multiple faults within the basin  
3 affect groundwater movement.

4 There are no recent data for this basin related to groundwater levels, storage  
5 capacities, or quality (DWR 2004ab, 2013d).

6 The San Ramon Valley Groundwater Basin was designated by the CASGEM  
7 program as very low priority.

8 *Livermore Valley Groundwater Basin*

9 The Livermore Valley Groundwater Basin extends under northeastern Alameda  
10 County and southern Contra Costa County. The Livermore Valley Groundwater  
11 Basin contains groundwater-bearing materials originating from continental  
12 deposits from alluvial fans, outwash plains, and lakes (DWR 2006q, 2013d).

13 The Main Basin is the aquifer that includes the highest yielding aquifers and  
14 highest quality groundwater (Zone 7 2012). The Main Basin generally is divided  
15 into the Upper Aquifer Zone and Lower Aquifer Zone which are separated by a  
16 relatively continuous silty clay lens. Water from the Upper Aquifer Zone moves  
17 into the Lower Aquifer Zone when groundwater levels in the upper zone are high.

18 Well yields are mostly adequate and in some areas can produce large quantities of  
19 groundwater for all types of wells (DWR 2006q, 2013d). The movement of  
20 groundwater is locally impeded by structural features such as faults that act as  
21 barriers to groundwater flow, resulting in varying water levels in the basin.  
22 Groundwater follows a westerly flow pattern, similar to the surface water streams,  
23 along the structural central axis of the valley toward municipal pumping centers  
24 (Zone 7 2005).

25 Groundwater levels in the main portion of the Livermore Valley Groundwater  
26 Basin started declining in the early 1900s when groundwater pumping removed  
27 large quantities of groundwater (Zone 7 2005, 2010, 2013). This trend continued  
28 until the late 1960s when Zone 7 Water Agency began importing SWP water.  
29 Subsequently, Zone 7 Water Agency developed surface water projects to capture  
30 local runoff. Local runoff and SWP water is stored in Lake Del Valle and used to  
31 recharge groundwater within the Livermore Valley. The importation of additional  
32 surface water alleviated the pressure on the aquifer, and groundwater levels  
33 started to rise in the 1970s. However, historical lows were reached during periods  
34 of drought. During the recent dry period, groundwater levels declined 7 to 17 feet  
35 throughout the aquifers used by Zone 7 Water Agency between 2011 and 2012.

36 The Livermore Valley Groundwater Basin is characterized by localized areas of  
37 high boron, nitrate, and TDS (DWR 2006q, 2013; Zone 7 2012). High boron  
38 levels can be attributed to marine sediments adjacent to the basin.

39 Nitrate concentrations generally are within potable water criteria; however, high  
40 nitrate concentrations occur in some locations of the upper aquifer (Zone 7 2012).  
41 The source of nitrates appears to be related to agricultural activities, wastewater  
42 disposal, and natural sources from decaying vegetation.



1 Salinity of the aquifer depends upon the quality of the water used for recharge  
2 operations. Salinity has increased over the past 30 years (Zone 7 2012) especially  
3 in the western portion of the Main Basin. Aquifers in the central and eastern  
4 portions of the Livermore Valley Groundwater Basin are generally recharged  
5 through streambeds and are characterized by lower salinity due to the high  
6 recharge rate.

7 The Livermore Valley Groundwater Basin was designated by the CASGEM  
8 program as medium priority.

9 *Castro Valley Groundwater Basin*

10 The Castro Valley Groundwater Basin is located in the Castro Valley area of  
11 Alameda County between San Lorenzo Creek on the east and the Hayward Fault  
12 on the west (Castro Valley 2012).

13 The basin is composed of alluvial deposits of sand, gravel, silt, and clay sediments  
14 (DWR 2004ac, 2013d). Previous studies indicated that the maximum yield was  
15 about 140,000 gallons per day (Castro Valley 2012).

16 The groundwater is characterized by bicarbonates with calcium and sodium.  
17 Localized contamination has occurred in this shallow aquifer related to  
18 agricultural activities and underground storage tanks (Castro Valley 2012).

19 The Castro Valley Groundwater Basin was designated by the CASGEM program  
20 as very low priority.

21 *Santa Clara Valley Groundwater Basin*

22 The Santa Clara Valley Groundwater Basin includes three subbasins in areas that  
23 are within the CVP and/or SWP service areas. The three subbasins include the  
24 East Bay Plain subbasin in Contra Costa and Alameda counties, Niles Cone  
25 subbasin in Alameda County, and Santa Clara subbasin in Santa Clara County.

26 *East Bay Plain Subbasin*

27 The East Bay Plain subbasin is an alluvial plain that extends from San Pablo Bay  
28 southward to the Niles Cone subbasin, and extends under San Francisco Bay  
29 (DWR 2004ad, 2013d; EBMUD 2013). The alluvium consists of unconsolidated  
30 sediments of mud, silts, sands, and clays. Multiple faults within the subbasin  
31 affect groundwater movement. Groundwater levels declined to approximately  
32 250 feet below the ground surface until the mid-1960s when groundwater levels  
33 began to increase. By 2000, groundwater levels were close to the ground surface.  
34 The groundwater quality is characterized as calcium and sodium bicarbonate with  
35 moderate to high TDS. Higher TDS concentrations occur near San Francisco Bay  
36 where localized sea water intrusion has occurred. High nitrate concentrations  
37 occur in localized areas due to historic agricultural activities.

38 The East Bay Plain subbasin was designated by the CASGEM program as  
39 medium priority.

40 *Niles Cone Subbasin*

41 The Niles Cone subbasin is mainly comprised of the alluvial fan along Alameda  
42 Creek. The Hayward Fault crosses the Niles Cone subbasin and further separates

1 the subbasin into the Below Hayward Fault (west of the Hayward Fault) and  
 2 Above Hayward Fault (east of the Hayward Fault) subbasins (ACWD 2012;  
 3 DWR 2006r, 2013d).

4 The Niles Cone subbasin was in overdraft condition through the early 1960s.  
 5 After 1962, groundwater levels increased as SWP water was delivered to the area  
 6 and used to recharge the groundwater subbasin (DWR 2006r, 2013d).

7 The main groundwater quality impairment in the Niles Cone subbasin is saltwater  
 8 intrusion caused by groundwater pumping (ACWD 2012; DWR 2006r, 2013d).  
 9 In the 1950s the migration of saline water extended into the Above Hayward Fault  
 10 subbasin, and migrated into deeper aquifers. Alameda County Water District has  
 11 developed aquifer reclamation programs to help control the movement of saline  
 12 water and restore the quality of groundwater in the affected aquifers, as described  
 13 below.

14 Niles Cone subbasin was designated by the CASGEM program as medium  
 15 priority.

16 *Santa Clara Subbasin*

17 The Santa Clara subbasin is located within Santa Clara County along a structural  
 18 trough that parallels the Coast Ranges and extends from the Diablo Range and  
 19 Santa Cruz Mountains. The water bearing formations of the Santa Clara subbasin  
 20 include unconsolidated to semi-consolidated gravel, sand, silt and clay  
 21 (DWR 2004ac, 2013d). The upper alluvial fan in the northern portion of the  
 22 subbasin is characterized by coarse-grained sediments (SCVWD 2010). Towards  
 23 the central portion of the subbasin, thick silty clay lenses are inter-bedded with  
 24 thin sand and gravel lenses. The northern and central portions of the subbasin are  
 25 locally referred to as the Santa Clara Plain (SCVWD 2011). The southern portion  
 26 of the subbasin consists of extensive alluvial deposits of unconsolidated and semi-  
 27 consolidated sediments and is referred to as the Coyote Valley (SCVWD 2010).  
 28 The central portions and areas along the edges of the Santa Clara Plain subbasin  
 29 consist of unconfined aquifers that provide recharge to the basin (SCVWD 2010,  
 30 2011). The Shallow Aquifer consists of water-bearing sediments that are less  
 31 than 150 feet deep. The Principal Aquifer provides most of the groundwater  
 32 supply for the Santa Clara Valley and is separated from the Shallow Aquifer by a  
 33 confining lens in some areas of the Santa Clara Plain. The groundwater recharge  
 34 primarily occurs due to percolation of water on the soil from precipitation or  
 35 artificial recharge operations (as described below), seepage from stream beds, and  
 36 subsurface inflow from surrounding hills.

37 In the Coyote subbasin, the groundwater aquifer is primarily unconfined with  
 38 areas of perched groundwater above discontinuous clay deposits (SCVWD 2010,  
 39 2011). Groundwater recharge occurs along the streambeds. When the  
 40 groundwater levels are high in the Coyote subbasin, groundwater seeps into the  
 41 streams.

42 The movement of groundwater in the Santa Clara subbasin is locally influenced  
 43 by groundwater recharge activities, proximity to streams, and operating

1 production wells (SCVWD 2010). Regionally, groundwater in the Santa Clara  
2 Subbasin generally flows northwest toward the San Francisco Bay.

3 The Santa Clara subbasin has historically experienced decreasing groundwater  
4 level trends. Between 1900 and 1960, water level declines of more than 200 feet  
5 from groundwater pumping have induced unrecoverable land subsidence of nearly  
6 13 feet (SCVWD 2011). Importation of surface water using CVP, SWP, and San  
7 Francisco Public Utilities District water supplies; and the development of an  
8 artificial recharge program have resulted in rising groundwater levels since the  
9 late 1960s. The groundwater levels in some portions of this subbasin declined up  
10 to 10 feet between fall 2013 and fall 2014, and in some areas more than 10 feet.

11 The groundwater quality in the Santa Clara subbasin is good to excellent and  
12 suitable for most beneficial uses. The groundwater meets all drinking water  
13 standards and can be used without additional treatment (SCVWD 2001, 2010).  
14 Some areas affected by historical saltwater intrusion exist in the northern portion  
15 of the Santa Clara subbasin in the Shallow Aquifer. Recent groundwater  
16 monitoring has indicated that seawater intrusion appears to be stabilizing  
17 (SCVWD 2012a). High nitrate concentrations occur in the Coyote Valley.

18 Santa Clara subbasin was designated by the CASGEM program as medium  
19 priority.

#### 20 **7.3.4.1.2 Groundwater Use and Management**

21 Use of groundwater in the San Francisco Bay Hydrologic Region varies  
22 extensively. In the basins within Contra Costa County (Pittsburg Plain, Clayton  
23 Valley, Ygnacio Valley, Arroyo Del Hambre Valley, and San Ramon Valley),  
24 local wells are used for small agricultural activities and landscape irrigation by  
25 individual land owners. In the Livermore Valley Groundwater Basin,  
26 groundwater is used for a major portion of the water supply.

#### 27 *Pittsburg Plain, Clayton Valley, Ygnacio Valley, and Arroyo Del Hambre Valley* 28 *Groundwater Basins*

29 Groundwater use is limited within northern Contra Costa County within the  
30 Pittsburg Plain, Clayton Valley, Ygnacio Valley, and Arroyo Del Hambre Valley  
31 groundwater basins. This area is located within the Contra Costa Water District  
32 or East Bay Municipal Utilities District service areas. These districts provide  
33 surface water to most water users in this area.

34 Within the Contra Costa Water District service area, groundwater use is limited  
35 (CCWD 2011). The use of existing Contra Costa Water District wells at the  
36 Mallard Well Fields is limited because of the threat of contamination from  
37 adjacent industrial areas.

38 The City of Pittsburg operates two municipal wells from the Pittsburg Plain  
39 Groundwater Basin (Pittsburg 2011).

40 The City of Martinez operates up to two wells in the Arroyo Del Hambre Valley  
41 Groundwater Basin to provide irrigation water to a municipal park  
42 (Martinez 2011).

1 *San Ramon Valley Groundwater Basin*

2 Groundwater use is limited within the San Ramon Valley Groundwater Basin  
3 located in southern Contra Costa County. Local wells are used for small  
4 agricultural activities and landscape irrigation by individual land owners. This  
5 area is located within the East Bay Municipal Utilities District service area. The  
6 district provides surface water to most water users in this area.

7 *Livermore Valley Groundwater Basin*

8 In the Livermore Valley Groundwater Basin, Zone 7 Water Agency administers  
9 oversight of the groundwater basins used for water supply and provides water to  
10 California Water Service Company, Dublin San Ramon Services District, City of  
11 Livermore, and City of Pleasanton. Zone 7 Water Agency only withdraws  
12 groundwater that has been recharged using surface water supplies (Zone 7 2010).  
13 The California Water Service Company, Dublin San Ramon Services District, and  
14 City of Pleasanton also withdraw groundwater (California Water Service  
15 Company 2011h; DSRSD 2011; City of Livermore 2011; City of  
16 Pleasanton 2011).

17 Zone 7 Water Agency manages the groundwater levels and quality in the  
18 Livermore Valley Groundwater Basin to maintain groundwater levels that would  
19 avoid subsidence and provide emergency reserves for the worst credible drought  
20 (DWR 2006q, 2013d).

21 Zone 7 Water Agency artificially recharges the Livermore Valley Groundwater  
22 Basin with local surface water supplies and SWP water by releasing the surface  
23 waters into the Arroyo Mocho and Arroyo Valle (Zone 7 2005, 2010). The  
24 infiltrated water is then pumped from the groundwater basin for various uses,  
25 mostly during the summer and during drought periods when local surface water  
26 supplies are diminished and the available SWP water supplies are less than the  
27 entitlement value Zone 7 Water Agency, City of Livermore, City of Pleasanton,  
28 Dublin San Ramon Services District, and California Water Service Company are  
29 permitted to withdraw groundwater from this subbasin.

30 In 2009, the Zone 7 Water Agency began operation of the Mocho Groundwater  
31 Demineralization Plant (Zone 7 2010). This plant is a wellhead treatment plant  
32 that produces potable water using reverse osmosis to remove TDS and hardness  
33 from the Main Basin.

34 *Castro Valley Groundwater Basin*

35 Groundwater use is limited within the Castro Valley Groundwater Basin. Local  
36 wells are used for small agricultural activities and landscape irrigation by  
37 individual land owners (Castro Valley 2012). This area is located within the East  
38 Bay Municipal Utilities District service area. The district provides surface water  
39 to most water users in this area.

40 *Santa Clara Valley Groundwater Basin*

41 The Santa Clara Valley Groundwater Basin includes the East Bay Plain, Niles  
42 Cone, and Santa Clara subbasins.

1        *East Bay Plain Subbasin*

2 Groundwater use is limited within the East Bay Plains subbasin. Local wells are  
3 used for small agricultural activities and landscape irrigation by individual land  
4 owners (DWR 2004ad, 2013d; EBMUD 2013). Well fields that served the  
5 communities were initially constructed in the late 1800s and early 1900s, and  
6 were closed by 1930. This area is located within the East Bay Municipal Utilities  
7 District service area. The district provides surface water to most water users in  
8 this area. East Bay Municipal Utilities District initiated the Bayside Groundwater  
9 Project in 2009 to store surface water in wet years for use during droughts.

10        *Niles Cone Subbasin*

11 Alameda County Water District is the primary water agency that relies upon the  
12 Niles Cone subbasin. This Alameda County Water District uses fresh  
13 groundwater from the Niles Cone subbasin and desalinated brackish groundwater  
14 in addition to local and imported surface water supplies. The Niles Cone subbasin  
15 is primarily recharged in the Alameda Creek watershed by percolation of local  
16 runoff and SWP water (ACWD 2011, 2012). In wetter years, when local water  
17 supplies are abundant, Alameda County Water District diverts some of the SWP  
18 allocation to the Semitropic Water Storage District in Kern County through a  
19 water banking agreement (as described above for the Kern County subbasin).  
20 This agreement allows Alameda County Water District to subsequently recover  
21 this water during drier years through an exchange agreement with Semitropic  
22 Water Storage District (ACWD 2012).

23 Alameda County Water District provides retail water supplies to the cities of  
24 Fremont, Newark, and Union City. The district has implemented treatment of  
25 brackish groundwater to allow previously unused groundwater to be used as a  
26 potable water source (ACWD 2011, 2012). In 2003, the Alameda County Water  
27 District Newark Desalination Facility began to remove salts and other constituents  
28 from the Niles Cone subbasin groundwater that is subject to seawater intrusion  
29 using a reverse-osmosis process. The aquifer reclamation program also includes  
30 withdrawing water to prevent a plume of brackish water in the Centerville-  
31 Fremont Aquifer from further migrating toward the Alameda County Water  
32 District Mowry Wellfield. Future groundwater desalination facilities are being  
33 evaluated by the district.

34        *Santa Clara Subbasin*

35 Local water agencies and individual landowners use groundwater in the Santa  
36 Clara subbasin. The Santa Clara subbasin is primarily recharged from percolation  
37 of local runoff and water supplied by the CVP and/or SWP that is discharged to  
38 streambeds and recharge facilities (SCVWD 2011).

39 Treated water is provided by the Santa Clara Valley Water District to retail water  
40 agencies in order to promote conjunctive use of groundwater. The water entities  
41 in the Santa Clara subbasin that use treated surface water include the cities of  
42 Milpitas, Mountain View, Palo Alto, San Jose, Santa Clara, and Sunnyvale;  
43 California Water Service (Los Altos), Purissima Water District, and San Jose

1 Water Company. Several of these entities also use surface water from San  
2 Francisco Public Utilities Commission as part of their overall water supply.  
3 In the Santa Clara subbasin, groundwater is withdrawn by local water suppliers  
4 and private well owners to meet municipal, domestic, agricultural, and industrial  
5 water needs (SCVWD 2011). Groundwater provides approximately 40 to  
6 50 percent of total water supply in Santa Clara County in average water year  
7 conditions (SCVWD 2010). Within the Santa Clara subbasin, the users of the  
8 most groundwater include San Jose Water Company, City of Santa Clara, Great  
9 Oaks Water Company, California Water Service, and individual land owners  
10 primarily in the southern portion of the subbasin (SCVWD 2012a).

11 The Santa Clara Valley Water District is responsible for groundwater  
12 management in the Santa Clara subbasin, and operates a robust and flexible  
13 conjunctive use program that uses a variety of surface water sources: local  
14 supplies, imported SWP and CVP supplies, and imported transfer options.  
15 Surface water is also supplied to some water users by the San Francisco Public  
16 Utilities Commission (SCVWD 2001, 2010). The district operates an extensive  
17 system of in-stream and off-stream artificial recharge facilities to replenish the  
18 groundwater basin and provide more flexibility to manage water supplies.  
19 Eighteen major recharge systems allow local reservoir water and imported water  
20 to be released in over 30 local creeks and 71 percolation ponds that provide 393  
21 acres for artificial recharge to the groundwater basin. Recharge in this subbasin  
22 occurs along streambeds and off-stream managed basins. Most of the recharge  
23 facilities are located in the Santa Clara subbasin. Two major recharge facilities,  
24 the Lower Llagas and Upper Llagas recharge systems, are located in the Llagas  
25 subbasin of the Gilroy-Hollister Groundwater Basin, as described below  
26 (SCVWD 2011, 2012a). The amount of water artificially recharged throughout  
27 the entire district depends upon the availability of local, CVP, and/or SWP surface  
28 water supplies.

29 **7.3.4.2 Central Coast Hydrologic Region: Gilroy-Hollister Valley**  
30 **Groundwater Basin**

31 Portions of the Gilroy-Hollister Valley Groundwater Basin within the CVP and/or  
32 SWP water service areas include the Llagas Area, Hollister Area, and San Juan  
33 Bautista Area subbasins.

34 **7.3.4.2.1 Hydrogeology and Groundwater Conditions**

35 Each of these groundwater basins in the Gilroy-Hollister Valley Groundwater  
36 Basin contains unique hydrogeologic characteristics. However, generally the  
37 water bearing materials consist of alluvial, unconsolidated sand, sand and gravel,  
38 and clay. Within four subbasins in the study area of this EIS, groundwater flows  
39 towards the Pajaro River which flows to Monterey Bay (DWR 2004af, 2004ag,  
40 2004ah, 2004ai, 2013d).

41 *Llagas Area Subbasin*

42 The water bearing formations of the Llagas subbasin include continental deposits  
43 of unconsolidated to semi-consolidated gravel, sand, silt and clay (DWR 2004af,

1 2013d; SCVWD 2010, 2011). Alluvium along the edges and the center portions  
2 of the subbasin are underlain by dense clayey soils. Younger alluvium does not  
3 have a well-defined clay subsoil.

4 As described above for the Santa Clara subbasin in the Santa Clara Valley  
5 Groundwater Basin, Santa Clara Valley Water District manages groundwater in  
6 the Llagas Area subbasin. Groundwater withdrawals in the Llagas subbasin have  
7 been relatively stable in recent years; and groundwater elevation has been stable  
8 since the late 1990s (SCVWD 2012a).

9 The groundwater quality in the Llagas subbasin is of good to excellent mineral  
10 composition and suitable for most beneficial uses (SCVWD 2010, 2012a). High  
11 nitrate concentrations occur in localized areas throughout the subbasin due to  
12 historical agricultural practices and wastewater effluent disposal. Santa Clara  
13 Valley Water District implemented a Nitrate Management Program in 1997 and  
14 nitrate concentrations are beginning to decline.

15 *Bolsa Area, Hollister Area, and San Juan Bautista Subbasins*

16 The Bolsa Area, Hollister Area, and San Juan Bautista Area subbasins extend  
17 over northern San Benito County. The subbasins are comprised of a sedimentary  
18 sequence that contains the principal aquifers underlying the Hollister and San  
19 Juan Valleys. The water bearing formation includes clay, silt, sand, and gravel  
20 (DWR 2004ag, 2004ah, 2004ai, 2013e).

21 The main water bearing formation in this area is composed of alluvium in the  
22 Bolsa Area and Hollister Area subbasins (San Benito County Water District  
23 2012). The water bearing formations in the northern San Juan Bautista Area  
24 consist of alluvium (San Benito County Water District 2012). Groundwater  
25 movement within the aquifers is affected by the numerous faults, including the  
26 San Andreas and Calaveras Faults. Groundwater aquifers in this area include  
27 both unconfined and confined aquifer conditions with surficial clay deposits in the  
28 northern portions of these subbasins.

29 Groundwater in these subbasins is characterized by artesian conditions when  
30 groundwater levels are high, such as in the early 1900s (San Benito County Water  
31 District 2012). After the mid-1940s, groundwater levels declined with increased  
32 withdrawals. One of the lowest levels occurred in the late 1970s when the  
33 groundwater elevation was approximately 150 feet lower than the high water level  
34 conditions. In 2012, groundwater elevations ranged from 80 feet above mean sea  
35 level in the Bolsa Area subbasin to 700 feet above mean sea level in the San Juan  
36 Bautista Area subbasin.

37 The Bolsa Area, Hollister Area, and San Juan Bautista Area subbasins have  
38 localized areas with high concentrations of boron, chloride, hardness, metals,  
39 nitrate, sulfate, potassium, and TDS (San Benito County Water District 2012).  
40 The most substantial constituents include high TDS concentrations in the  
41 southeastern Bolsa Area subbasin, Hollister Area subbasin, and northern San Juan  
42 Bautista Area subbasin. High nitrate concentrations occur in the northern San  
43 Juan Bautista Area subbasin.

1 *Overall Groundwater Conditions*

2 The Llagas Area subbasin was designated by the CASGEM program as high  
3 priority. The Hollister Area and San Juan Bautista Area subbasins were  
4 designated as medium priority.

5 **7.3.4.2.2 Groundwater Use and Management**

6 *Llagas Area Subbasin*

7 As described in Chapter 5, Surface Water Resources and Water Supplies,  
8 groundwater is the primary water supply for local water agencies and individual  
9 landowners in the Llagas Area subbasin. The subbasin is primarily recharged  
10 from percolation of local runoff and water supplied by the CVP that is discharged  
11 to recharge facilities managed by Santa Clara Valley Water District, as described  
12 above for the Santa Clara subbasin in the Santa Clara Valley Groundwater Basin  
13 (SCVWD 2011). The two major recharge facilities in the Llagas Area subbasin  
14 include the Lower Llagas and Upper Llagas recharge systems (SCVWD 2010).

15 The primary municipal water suppliers are the cities of Gilroy and Morgan Hill.  
16 Groundwater is used by these local water suppliers and private well owners to  
17 meet municipal, domestic, agricultural, and industrial water needs  
18 (SCVWD 2011).

19 *Bolsa Area, Hollister Area, and San Juan Bautista Subbasins*

20 Local water agencies and individual landowners use groundwater in the Bolsa  
21 Area, Hollister Area, and San Juan Bautista subbasins. The subbasins are  
22 primarily recharged from percolation of local runoff in streambeds, including  
23 water from Hernandez and Paicines Reservoirs that is released to Tres Pinos  
24 Creek (San Benito County Water District 2012).

25 San Benito County Water District provides CVP water to the cities of Hollister  
26 and San Juan Bautista, Sunnyslope County Water District, residential areas  
27 surrounding Hollister and Tres Pinos, and agricultural areas in northern San  
28 Benito County to reduce groundwater use by these areas (San Benito County  
29 Water District 2012). Most other water users in the subbasins rely upon  
30 groundwater and/or local surface water stored in Hernandez and Paicines  
31 Reservoirs.

32 In 2011, groundwater supplies provided 49 percent of the water used for  
33 agriculture, municipal, domestic, and industrial supply in the areas of the subbasin  
34 supplied by CVP water (San Benito County Water District 2012).

35 **7.3.5 Central Coast Region**

36 The Central Coast Region includes portions of San Luis Obispo and Santa  
37 Barbara counties served by the SWP. The Central Coast Region encompasses the  
38 southern planning area of the Central Coast Hydrologic Region (DWR 2009a).

39 The SWP water is provided to the Central Coast Region by the Central Coast  
40 Water Authority (CCWA 2013a). The facilities divert water from the SWP  
41 California Aqueduct at Devil's Den and convey the water to the 43 million gallon  
42 per day water treatment plant at Polonto Pass. The treated water is conveyed to



1 municipal water users in San Luis Obispo and Santa Barbara counties to reduce  
2 groundwater overdraft in these areas.

3 Portions of the Central Coast Region that use SWP water are included in the  
4 Central Coast Hydrologic Region which includes 50 delineated groundwater  
5 basins, as defined by DWR (DWR 2003a). The basins vary from large extensive  
6 alluvial aquifers to small inland valleys and coastal terraces. Groundwater in the  
7 large alluvial aquifers exists in thick unconfined and confined basins.

8 Groundwater is generally used for urban and agricultural use in the Central Coast  
9 Region.

### 10 **7.3.5.1 Hydrogeology and Groundwater Conditions**

11 The areas within the SWP service area in the Central Coast Region include the  
12 Morro Valley and Chorro Valley groundwater basins in San Luis Obispo County;  
13 Santa Maria River Valley Groundwater Basin in San Luis Obispo and Santa  
14 Barbara counties; and San Antonio Creek Valley, Santa Ynez River Valley,  
15 Goleta, Foothill, Santa Barbara, Montecito, and Carpinteria groundwater basins in  
16 Santa Barbara County, as shown in Figure 7.9.

#### 17 **7.3.5.1.1 Morro Valley and Chorro Valley Groundwater Basins**

18 In the portions of San Luis Obispo County within the SWP service area near  
19 Morro Bay, groundwater is provided by Morro Valley and Chorro Valley  
20 groundwater basins. The water bearing formations are alluvium that consists of  
21 clays, silts, sands, and gravel that extend into the Pacific Ocean (DWR 2004aj,  
22 2004ak, 2013e). The alluvium is recharged by seepage from streambeds and  
23 precipitation and irrigation water applied to the soils.

24 The groundwater has moderate TDS (DWR 2004aj, 2004ak, 2013e). Localized  
25 areas have high nitrate concentrations (Morro Bay 2011). Localized areas with  
26 organic contamination are also present; however, actions have been implemented  
27 to reduce the concentrations. Seawater intrusion occurs in localized areas near the  
28 Pacific Ocean.

29 The Morro Valley and Chorro Valley groundwater basins were designated by the  
30 CASGEM program as high priority.

#### 31 **7.3.5.1.2 Santa Maria River Valley Groundwater Basin**

32 The Santa Maria River Valley Groundwater Basin is located in San Luis Obispo  
33 and Santa Barbara counties. The water bearing formation is primarily unconfined  
34 alluvium with localized confined areas near the coast (DWR 2004 al, 2013e;  
35 SMVMA 2012). Recharge occurs along the streambeds. Groundwater levels in  
36 the Basin have fluctuated over the past 100 years with declining groundwater  
37 levels until the mid-1970s, recovery through the mid-1980s, and declining levels  
38 through the mid-1990s. Following importation of SWP water, groundwater levels  
39 increased to historic high levels. However, in the last decade, groundwater levels  
40 have gradually declined which could be partially due to reductions in Twitchell  
41 Reservoir releases for groundwater recharge since 2000. Groundwater levels  
42 have been maintained at levels above 15 feet above mean sea level in shallow and

1 deep aquifers near the coast to avoid seawater intrusion. Groundwater recharge  
2 occurs along streambeds. Water released from Twitchell and Lopez reservoirs  
3 increase groundwater recharge rates (SMVMA 2012).

4 Groundwater quality issues in the Santa Maria Valley Groundwater Basin include  
5 hardness, nitrates, salinity, sulfate and volatile organic compounds (DWR 2004a,  
6 2013e; San Luis Obispo County 2011; SMVMA 2012). TDS concentrations are  
7 moderate to high. There are localized areas in the basin with high sulfate  
8 concentrations. Volatile organic compound contamination was a major issue for  
9 two wells used by the City of San Luis Obispo in the late 1980s. High nitrate  
10 concentrations occur in the shallow aquifer due to historic agricultural practices.  
11 Higher salinity levels occur in the shallow aquifer near the coast than within the  
12 inland areas or in the deep aquifer.

13 The Santa Maria River Valley Groundwater Basin was designated by the  
14 CASGEM program as high priority.

15 **7.3.5.1.3 San Antonio Creek Valley Groundwater Basins**

16 San Antonio Creek Valley Groundwater Basin is located along the Pacific Ocean  
17 within San Luis Obispo and Santa Barbara counties. The water bearing  
18 formations are characterized by unconsolidated alluvial and terrace deposits of  
19 sand, clay, silt, and gravel (DWR 2004dq, 2013e). Groundwater flows towards  
20 the Pacific Ocean. A groundwater barrier to the east of the Pacific Ocean creates  
21 the Barka Slough. Groundwater has declined in some areas of the basin over the  
22 past 60 years. Groundwater quality issues include areas with high salinity near  
23 the Pacific Ocean.

24 The San Antonio Creek Valley Groundwater Basin was designated by the  
25 CASGEM program as medium priority.

26 **7.3.5.1.4 Santa Ynez River Valley Groundwater Basins**

27 Several groundwater basins in Santa Barbara County are in a state of overdraft,  
28 including the Santa Ynez River Valley Groundwater Basin. The Santa Ynez  
29 Groundwater Basin is located along the Pacific Ocean in southwestern Santa  
30 Barbara County. The water bearing formations are characterized by  
31 unconsolidated alluvial and terrace deposits of gravel, sand, silt, and clay  
32 (DWR 2004an, 2013e). Groundwater flows towards the Santa Ynez River, and  
33 then towards the Pacific Ocean. Groundwater recharge occurs along the stream  
34 beds.

35 Groundwater quality is generally good for municipal and agricultural uses. There  
36 are localized areas with high TDS near the Pacific Ocean due to seawater  
37 intrusion (DWR 2004an, 2013e).

38 The Santa Ynez River Valley Groundwater Basin was designated by the  
39 CASGEM program as medium priority.

1 **7.3.5.1.5 Goleta, Foothill, Santa Barbara, Montecito, and Carpinteria**  
2 **Groundwater Basins**

3 The Goleta, Foothill, Santa Barbara, Montecito, and Carpinteria groundwater  
4 basins are located in southwestern Santa Barbara County along the Pacific Ocean  
5 and near the boundary with Ventura County. The water bearing formations in the  
6 Goleta, Foothill, Santa Barbara, and Montecito groundwater basins are  
7 unconsolidated alluvium of clay, silt, sand, and/or gravel that overlays the  
8 generally confined Santa Barbara Formation of marine sand, silt, and clay  
9 (DWR 2004an, 2004ao, 2004ap, 2004aq, 2013e).

10 In the Carpinteria Groundwater Basin, the alluvium extends under the agricultural  
11 plain (DWR 2004ar, 2013e). A confined aquifer occurs under a thick clay bed in  
12 the lower part of the alluvium. This basin includes the Santa Barbara Formation;  
13 as well as the Carpinteria Formation, of unconsolidated to poorly consolidated  
14 sand with gravel and cobble; and the Casitas Formation, of poorly to moderately  
15 consolidated clay, silt, sand, and gravel.

16 Several faults restrict groundwater flow throughout these basins. Recharge occurs  
17 along streambeds and from subsurface inflow into the basin from upland areas.  
18 Water released from Lake Cachuma increases groundwater recharge rates.

19 The groundwater levels in portions of these groundwater basins declined up to  
20 10 feet between fall 2013 and fall 2014, and in some areas more than 10 feet  
21 (DWR 2014d).

22 Groundwater quality is generally good for municipal and agricultural uses. There  
23 are localized areas with high TDS near the Pacific Ocean due to seawater  
24 intrusion (DWR 2004an, 2004ao, 2004ap, 2004aq, 2004ar, 2013e; GWD and  
25 LCMWC 2010). High concentrations of nitrate, iron, and manganese occur in  
26 localized areas in the Goleta Groundwater Basin. Localized areas of high nitrate  
27 and sulfate concentrations occur within the Foothill Groundwater Basin. High  
28 concentrations of calcium, magnesium, bicarbonate, and sulfate occur in localized  
29 areas of the Santa Barbara Groundwater Basin. High concentrations of iron and  
30 manganese occur in localized areas of the Montecito Groundwater Basin.

31 Localized areas with high nitrates occur within the Carpinteria Groundwater  
32 Basin. Other basins are in equilibrium due to management of the basin through  
33 conjunctive use by local water districts (Santa Barbara County 2007). The Goleta  
34 Groundwater Basin generally is near or above historical groundwater conditions  
35 (Goleta Groundwater Basin and La Cumbre Mutual Water Company 2010), with  
36 the northern and western portions of the basin having groundwater levels near the  
37 ground surface. High groundwater levels may result in degradation to building  
38 foundations and agricultural crops (water levels within the crop root zone).

39 The Goleta Groundwater Basin was designated by the CASGEM program as  
40 medium priority. Goleta, Foothill, Santa Barbara, Montecito, and Carpinteria  
41 groundwater basins were designated as very low priority.

1 **7.3.5.2 Groundwater Use and Management**

2 Groundwater is an important source of water supply for the population of the  
3 Central Coast; it is the region’s primary water source.

4 **7.3.5.2.1 Morro Valley and Chorro Valley Groundwater Basins**

5 As described in Chapter 5, Surface Water Resources and Water Supplies, the City  
6 of Morro Bay uses groundwater from Morro Valley and Chorro Valley  
7 groundwater basins. These basins have been designated by the State Water  
8 Resources Control Board as riparian underflow basins. The City of Morro Bay  
9 and other users of these basins have received water rights permits which limits the  
10 rate and volume of groundwater withdrawals (Morro Bay 2011).

11 **7.3.5.2.2 Santa Maria River Valley Groundwater Basin**

12 The Santa Maria River Valley Groundwater Basin is the primary water supply for  
13 irrigation in southwestern San Luis Obispo County and northwestern Santa  
14 Barbara County. Groundwater also is a major portion of the water supplies for  
15 the communities of Pismo Beach, Grover Beach, Arroyo Grande, Oceano,  
16 Nipomo, and several smaller communities in San Luis Obispo County; and  
17 Guadalupe, Santa Maria, and Orcutt in Santa Barbara County (City of Grover  
18 Beach 2011). In many cases, groundwater is the total water supply for these  
19 communities including Nipomo Community Services District (NCSD 2011).

20 The groundwater basin was adjudicated as defined by a settlement agreement, or  
21 stipulation, in 2005 that was filed in 2008. The stipulation defined the safe yield  
22 of the basin and measures to protect groundwater supplies (Pismo Beach 2011,  
23 Arroyo Grande 2012, NCSD 2011, Santa Maria 2011). The stipulation provided  
24 for the Northern Cities Management Area, Nipomo Mesa Management Area, and  
25 Santa Maria Valley Management Area. The groundwater adjudication considers  
26 groundwater recharge from precipitation and applied irrigation water; and water  
27 released from Reclamation’s Twitchell Reservoir and San Luis Obispo Flood  
28 Control and Water Conservation District’s Lopez Reservoir that recharge the  
29 basin from the downstream stream beds.

30 The cities of Pismo Beach, Grover Beach, Arroyo Grande; Oceano Community  
31 Services District; San Luis Obispo County; and San Luis Obispo Flood Control  
32 and Water Conservation District have formed the Northern Cities Management  
33 Area to manage and protect groundwater supplies in accordance with the  
34 adjudication stipulation (Pismo Beach 2011, Arroyo Grande 2012, NCSD 2011).  
35 Historical monitoring reporting indicates that the groundwater levels have varied  
36 from 20 feet above to 20 feet below mean sea level. When groundwater levels are  
37 below mean sea level, there is a potential for sea water intrusion. In 2008,  
38 groundwater levels in this area were approximately 10 feet below mean sea level.  
39 In 2010, groundwater levels had recovered and ranged from 0 to 20 feet above  
40 mean sea level. Overdraft conditions occurred more frequently prior to the  
41 groundwater adjudication and completion of the Central Coast Water Authority  
42 project that provides SWP water supplies to the area. There is a deep aquifer

1 under the City of Arroyo Grande (Pismo Formation) that provides groundwater  
2 not addressed in the adjudicated Santa Maria Groundwater Basin.

3 Agricultural water users and the communities of Guadalupe, Orcutt, and Santa  
4 Maria use groundwater in the Santa Maria Valley Management Area of the Santa  
5 Maria Groundwater Basin (SMVMA 2012). Historically, groundwater was used  
6 to provide almost 50 percent of the water supply to the City of Santa Maria.  
7 Recently, groundwater supplies have become 10 to 20 percent of the total water  
8 supply to the city (Santa Maria 2011). Groundwater provides most of the water  
9 supplies in Orcutt (Golden State Water Company 2011a).

#### 10 **7.3.5.2.3 San Antonio Creek Valley Groundwater Basin**

11 Groundwater is used for agricultural and domestic water supplies in the San  
12 Antonio Creek Valley Groundwater Basin, including the Los Alamos area  
13 (DWR 2004dq, 2013e).

#### 14 **7.3.5.2.4 Santa Ynez River Valley Groundwater Basin**

15 Groundwater is used for agricultural and domestic water supplies in the Santa  
16 Ynez River Valley Groundwater Basin. As described in Chapter 5, Surface Water  
17 Resources and Water Supplies, groundwater is used by all agricultural water users  
18 and the communities of Buellton, Lompoc, Solvang, Mission Hills, Vandenberg  
19 Village, and Santa Ynez (DWR 2004am, 2013e; Santa Barbara County 2007).

#### 20 **7.3.5.2.5 Goleta, Foothill, Santa Barbara, Montecito, and Carpinteria** 21 **Groundwater Basins**

22 Groundwater is used agricultural and domestic water supplies in the Goleta,  
23 Foothill, Santa Barbara, Montecito, and Carpinteria groundwater basins within  
24 Santa Barbara County. Goleta Water District and La Cumbre Mutual Water  
25 Company are the major communities that use groundwater in the Goleta  
26 Groundwater Basin (DWR 2004an; GWD 2011; GWD and LCMWC 2010). This  
27 basin is operated under an adjudication settlement in 1989 and a voter-passed  
28 groundwater management plan. Historically, Goleta Water District provided up  
29 to 14 percent of the water supply by groundwater. As described in Chapter 5,  
30 Surface Water Resources and Water Supplies, Goleta Water District has increased  
31 use of surface water from Lake Cachuma and the SWP; and decreased long-term  
32 average use of groundwater to about 5 percent of the total water supply.

33 Portions of the La Cumbre Mutual Water Company and City of Santa Barbara use  
34 groundwater from the Foothill Groundwater Basin. The City of Santa Barbara  
35 also relies upon groundwater from the Santa Barbara Groundwater Basin. The  
36 City of Santa Barbara manages groundwater in accordance with the Pueblo Water  
37 Rights (Santa Barbara 2011).

38 Montecito Water District uses groundwater from the Montecito Groundwater  
39 Basin. Carpinteria Valley Water District uses groundwater from the Carpinteria  
40 Groundwater Basin (Carpinteria Valley WD 2011). Total groundwater pumping  
41 averages approximately 3,700 acre-feet per year.

1 **7.3.6 Southern California Region**

2 The Southern California Region includes portions of Ventura, Los Angeles,  
 3 Orange, San Diego, Riverside, and San Bernardino counties served by the SWP.  
 4 The Southern California Region groundwater basins are as varied as the geology  
 5 that occurs in different geographic portions of the region. Therefore, the  
 6 following discussions are organized in the following subregions.

- 7 • Ventura County and northwestern Los Angeles County
- 8 • Central and southern Los Angeles County and Orange County
- 9 • Western San Diego County
- 10 • Western and central Riverside County and southern San Bernardino County
- 11 • Antelope Valley and Mojave Valley

12 **7.3.6.1 Western Ventura County and Northwestern Los Angeles County**

13 The areas within the SWP service area in Ventura County and northwestern  
 14 Los Angeles County in the Southern California Region include the Acton Valley  
 15 Groundwater Basin in Los Angeles County; Santa Clara River Valley, Thousand  
 16 Oaks Area, and Russell Valley groundwater basins in Ventura and Los Angeles  
 17 counties; and Simi Valley, Las Posas Valley, Pleasant Valley, Arroyo Santa Rosa  
 18 Valley, Tierra Rejada, and Conejo Valley groundwater basins in Ventura County,  
 19 as shown in Figure 7.10.

20 **7.3.6.1.1 Hydrogeology and Groundwater Conditions**

21 *Acton Valley Groundwater Basin*

22 The Acton Valley Groundwater Basin is located upgradient of the Santa Clara  
 23 River Valley Groundwater Basin and drains towards the Santa Clara River.  
 24 Water bearing formations include unconsolidated alluvium of sand, gravel, silt,  
 25 and clay with cobbles and boulders; and poorly consolidated terraced deposits  
 26 (DWR 2004as; 2013f). Recharge occurs along the streambed, water applied to  
 27 the soils, and subsurface inflow. Groundwater is characterized by calcium,  
 28 magnesium, and sulfate bicarbonate with localized areas of high concentrations of  
 29 TDS, sulfate, nitrate, and chlorides.

30 Acton Valley Groundwater Basin was designated by the CASGEM program as  
 31 very low priority.

32 *Santa Clara River Valley Groundwater Basin*

33 The Santa Clara River Valley Groundwater Basin is the source of local  
 34 groundwater along the Santa Clara River watershed from the Santa Clarita Valley  
 35 in northwestern Los Angeles County to the Pacific Ocean near the City of Oxnard  
 36 in Ventura County. The Santa Clara River Valley Groundwater Basin includes  
 37 the Piru, Fillmore, Santa Paula, Mound, and Oxnard subbasins in Ventura county;  
 38 and Santa Clara River Valley East Subbasin in Los Angeles County.

39 Groundwater movement is effected by the occurrence of several fault zones  
 40 (DWR 2004at, 2004au, 2006s, 2006t, 2006u, 2013f). Groundwater recharge

1 occurs along the Santa Clara River and its tributaries, and by percolation of  
2 precipitation and applied irrigation water.

3 The Santa Clara River Valley East Subbasin is characterized by unconsolidated  
4 alluvium of sand, gravel, silt, and clay; poorly consolidated terrace deposits of  
5 gravel, sand, and silt; and the Saugus Formation of poorly consolidated sandstone,  
6 siltstone, and conglomerate (DWR 2006s, 2013f).

7 The Piru, Fillmore, Santa Paula, Mound, and Oxnard subbasins are characterized  
8 by alluvium of silts and clays interbedded with sand and gravel lenses; and the  
9 San Pedro Formation of fine sands and gravels over the alluvium (DWR 2004at,  
10 2004au, 2006t, 2006u, 2006v, 2013f).

11 Groundwater quality in the Santa Clara River Valley Groundwater Basin is  
12 suitable for a variety of beneficial uses. However, some areas have been impaired  
13 by elevated TDS, nitrate, and boron concentrations (DWR 2004at, 2004au, 2006t,  
14 2006u, 2006v, 2013f; CLWA et al. 2012). Groundwater quality is characterized  
15 by fluctuating salinity that increases during dry periods. Localized areas of high  
16 nitrates and organic compounds occur due to historic agricultural activities and  
17 wastewater disposal.

18 The Piru, Oxnard, and Santa Clara River Valley East subbasins were designated  
19 by the CASGEM program as high priority. The Fillmore, Santa Paula, and  
20 Mound subbasins were designated as medium priority.

21 *Simi Valley Groundwater Basin*

22 The Simi Valley Groundwater Basin is located in Ventura County (DWR 2004av,  
23 2013f). Water bearing formations in this basin are characterized by generally  
24 unconfined alluvium of gravel, clays, and sands; with local clay lenses that  
25 provide confined aquifers. The Simi Fault confines the basin on the northern  
26 boundary. Groundwater recharge occurs along stream beds. Groundwater quality  
27 is characterized as calcium sulfate with localized areas of high TDS and organic  
28 contaminants.

29 Simi Valley Groundwater Basin was designated by the CASGEM program as low  
30 priority.

31 *Las Posas Valley and Pleasant Valley Groundwater Basins*

32 The Las Posas Valley and Pleasant Valley groundwater basins are located in  
33 western Ventura County. Groundwater is found within these basins in thick  
34 alluvium that is dominated by sand and gravel in the eastern part of the Las Posas  
35 Valley Groundwater Basin; and by silts and clays with lenses of sands and gravels  
36 in the western part of the Las Posas Valley Groundwater Basin and the Pleasant  
37 Valley Groundwater Basin (DWR 2006w, 2006x, 2013f). Underlying the  
38 alluvium are the San Pedro and Santa Barbara formations of gravels, sands, silts  
39 and clays with a discontinuous aquitard located within the Santa Barbara  
40 Formation. The movement of groundwater is locally influenced by features such  
41 as faults, structural depressions and constrictions and operating production wells;  
42 however, groundwater generally flows west-southwest toward the Oxnard  
43 Subbasin. Hydrographs from the Las Posas Valley and Pleasant Valley

1 Groundwater Basins have exhibited a variety of groundwater-level histories over  
2 the past couple decades. Most hydrographs in the eastern part of the Las Posas  
3 Valley Groundwater Basin indicate relatively unchanged groundwater levels or a  
4 slight rise since 1994. Most hydrographs in the western Las Posas Valley and  
5 Pleasant Valley groundwater basins indicate that groundwater levels have risen to  
6 and been maintained at moderate levels since 1992.

7 Groundwater quality in the Las Posas Valley and Pleasant Valley groundwater  
8 basins is suitable for a variety of beneficial uses. Moderate to high TDS  
9 concentrations occur in the Las Posas Valley Groundwater Basin and the Pleasant  
10 Valley Groundwater Basin (DWR 2006w, 2006x, 2013f).

11 The Las Posas Valley and Pleasant Valley groundwater basins were designated by  
12 the CASGEM program as high priority.

13 *Arroyo Santa Rosa Valley Groundwater Basin*

14 The Arroyo Santa Rosa Valley Groundwater Basin is located within Ventura  
15 County. The water bearing formations include alluvium of gravel, sand, and clay;  
16 and the alluvial San Pedro Formation of sand and gravel (DWR 2006y, 2013f).  
17 Groundwater recharge occurs along the Santa Clara River and the tributaries, and  
18 by percolation of precipitation and applied irrigation water. Fault zones affect  
19 groundwater movement within the basin. Groundwater quality is adequate for  
20 community and agricultural water uses. Localized areas of high sulfate and  
21 nitrate concentrations occur within the basin.

22 Arroyo Santa Rosa Valley Groundwater Basin was designated by the CASGEM  
23 program as medium priority.

24 *Tierra Rejada Valley, Conejo Valley, and Thousand Oaks Area Groundwater*  
25 *Basins*

26 The Tierra Rejada Valley, Conejo Valley, and Thousand Oaks groundwater basins  
27 in southern Ventura County are characterized by shallow alluvium that overlays  
28 marine sandstone and shale of the Modelo and Topanga formations (DWR  
29 2004aw, 2004ax, 2004ay, 2013f). In some portions of the basin, the Topanga  
30 Formation of volcanic tuff, debris flow, and basaltic flow occurs. Groundwater  
31 recharge occurs along the streambeds and by percolation of precipitation and  
32 applied irrigation water. Fault zones affect groundwater movement within the  
33 basins. Groundwater quality is adequate for community and agricultural water  
34 uses. Localized areas of high alkalinity and nitrate concentrations occur within  
35 the basins. High iron and TDS occur in the Thousand Oaks Area Groundwater  
36 Basin (Thousand Oaks 2011).

37 Conejo Valley Groundwater Basin was designated by the CASGEM program as  
38 low priority. The Tierra Rejada Valley and Thousand Oaks Area groundwater  
39 basin were designated as very low priority.

40 *Russell Valley Groundwater Basin*

41 The Russell Valley Groundwater Basin is located along the boundaries of Ventura  
42 and Los Angeles counties (DWR 2004az, 2013f). This small groundwater basin  
43 is characterized by unconsolidated, poorly bedded, sand, gravel, silt, and clay with



1 cobbles and boulders. The groundwater is recharged by precipitation within the  
2 basin. Groundwater quality is characterized by sodium bicarbonate and calcium  
3 bicarbonate with high sulfates and TDS in some localized areas.  
4 Russell Valley Groundwater Basin was designated by the CASGEM program as  
5 very low priority.

#### 6 **7.3.6.1.2 Groundwater Use and Management**

7 Groundwater is an important water supply throughout the Southern California  
8 Region. Many of the basins have been adjudicated and groundwater management  
9 agencies have been established to manage, preserve, and regulate groundwater  
10 withdrawals and recharge actions. In Ventura County, the Fox Canyon  
11 Groundwater Management Agency was established in 1982 to implement a  
12 groundwater plan that identifies withdrawal allocations and groundwater elevation  
13 and quality criteria (MWDSC 2007).

#### 14 *Acton Valley Groundwater Basin*

15 As described in Chapter 5, Surface Water Resources and Water Supplies, the  
16 Acton community primarily uses groundwater supplemented by SWP water  
17 treated at the Antelope Valley East Kern Acton Water Treatment Plant (Los  
18 Angeles County 2014b).

#### 19 *Santa Clara River Valley Groundwater Basin*

20 Communities and agricultural water users in the Santa Clara River Valley  
21 Groundwater Basin use a combination of surface water and groundwater to meet  
22 water demands. Agricultural use of groundwater is greater than community use  
23 of groundwater in this basin (UCWD 2012).

24 Four retail water purveyors provide water service to most residents of the Santa  
25 Clara River Valley East Subbasin. These water purveyors include the Castaic  
26 Lake Water Agency; Santa Clarita Water Division, Los Angeles County  
27 Waterworks District Number 36; Newhall County Water District; and Valencia  
28 Water Company. Groundwater is used by the communities of Santa Clarita,  
29 Saugus, Canyon Country, Newhall, Val Verde, Hasley Canyon, Valencia, Castaic,  
30 Stevenson Ranch (CLWA et al. 2012).

31 Water purveyors in the Piru, Fillmore, Santa Paula, Mound, and Oxnard subbasins  
32 include United Water Conservation District and Ventura County. United Water  
33 Conservation District operates surface water facilities to encourage groundwater  
34 protection through conjunctive use (UWCD 2012). Groundwater issues within  
35 the United Water Conservation District service area (which includes all of the  
36 basin) include overdraft conditions, sea water intrusion, and high nitrate  
37 concentrations.

#### 38 *Simi Valley Groundwater Basin*

39 The Simi Valley area primarily relies upon surface water supplies, including SWP  
40 water supplies. Groundwater is used to supplement these supplies and by users  
41 that cannot be easily served with surface water. Groundwater is provided by  
42 Golden State Water Company service area and Ventura County Waterworks

1 District No. 8. The Golden State Water Company provides less 10 percent of the  
2 total water supply to the area (Golden State Water Company 2011b). Ventura  
3 County Waterworks District No. 8 provides groundwater to a golf course, nursery,  
4 and industrial user in the Simi Valley area (VCWD8 2011).

5 *Las Posas Valley and Pleasant Valley Groundwater Basins*

6 Communities and agricultural water users in the Las Posas Valley and Pleasant  
7 Valley groundwater basins use a combination of surface water and groundwater to  
8 meet water demands. Agricultural use of groundwater is greater than community  
9 use of groundwater in this basin (UCWD 2012). United Water Conservation  
10 District and Ventura County manage water service to many residents of the Las  
11 Posas Valley and Pleasant Valley groundwater basins.

12 As described above, United Water Conservation District operates surface water  
13 facilities to encourage groundwater protection through conjunctive use  
14 (UWCD 2012). Groundwater is used within the United Water Conservation  
15 District service area, which includes western Las Posas Valley and Pleasant  
16 Valley groundwater basins. The Oxnard Subbasin of the Santa Clara River  
17 Valley Groundwater Basin and Las Posas Valley and Pleasant Valley  
18 groundwater basins are within the groundwater management plan established by  
19 the Fox Canyon Groundwater Management Agency (Fox Canyon GMA 2013).  
20 The groundwater management agency manages and monitors groundwater in  
21 areas with groundwater overdraft and seawater intrusion which includes the  
22 communities of Port Hueneme, Oxnard, Camarillo, and Moorpark. The long-term  
23 average groundwater use within Fox Canyon Groundwater Management Agency  
24 includes a portion of the withdrawals reported by United Water Conservation  
25 District.

26 The Calleguas Municipal Water District, in partnership with Metropolitan Water  
27 District of Southern California (Metropolitan), operates the Las Posas Basin  
28 Aquifer Recharge and Recovery project. Calleguas Municipal Water District  
29 stores SWP surplus water in the Las Posas Valley Groundwater Basin, near the  
30 City of Moorpark. The current Aquifer Recharge and Recovery system includes  
31 18 wells (Calleguas MWD 2011).

32 *Arroyo Santa Rosa Valley Groundwater Basin*

33 Communities and agricultural water users in the Arroyo Santa Rosa Valley  
34 Groundwater Basin use a combination of surface water and groundwater to meet  
35 water demands. Camarosa Water District and Fox Canyon Groundwater  
36 Management Agency manage groundwater supplies within the basin (Camarosa  
37 WD 2013).

38 *Tierra Rejada Valley, Conejo Valley, and Thousand Oaks Area Groundwater*  
39 *Basins*

40 Groundwater in the Tierra Rejada Valley, Conejo Valley, and Thousand Oaks  
41 Area groundwater basins is primarily used by agricultural and individual  
42 residential water users. Portions of the Tierra Rejada Valley Groundwater Basin  
43 is within the Camarosa Water District; however, this area is primarily open space  
44 and agricultural land uses with individual wells (Camarosa WD 2013). The City

1 of Thousand Oaks does operate two wells; however, the city primarily relies upon  
2 SWP water supplies because of the high iron concentrations and salinity in the  
3 groundwater (Thousand Oaks 2011).

#### 4 *Russell Valley Groundwater Basin*

5 Most groundwater users in the Russell Valley Groundwater Basin are agricultural  
6 and individual residential water users. Portions of the basin are located within the  
7 Calleguas Municipal Water District. However, the district does not use water  
8 from this basin (Calleguas MWD 2011). The Las Virgenes Municipal Water  
9 District withdraws groundwater from the Russell Basin to augment recycled water  
10 supplies (GLCIRWMR 2014).

### 11 **7.3.6.2 Western Los Angeles County and Orange County**

12 The areas within the SWP service area in Central and Southern Los Angeles  
13 County and Orange County in the Southern California Region include the San  
14 Fernando Valley, Raymond, San Gabriel Valley, Coastal Plain of Los Angeles,  
15 and Malibu Valley groundwater basins in Los Angeles County; Coastal Plain of  
16 Orange County and San Juan Valley groundwater basins in Orange County, as  
17 shown in Figure 7.10.

#### 18 **7.3.6.2.1 Hydrogeology and Groundwater Conditions**

##### 19 *San Fernando Valley Groundwater Basin*

20 The San Fernando Valley Groundwater Basin extends under the Los Angeles  
21 River watershed. Groundwater flows toward the middle of the basin, beneath the  
22 Los Angeles River Narrows, to the Central Subbasin of the Coastal Plain of  
23 Los Angeles Basin. The water bearing formation is mainly unconfined gravel and  
24 sand with clay lenses that provide some confinement in the western part of the  
25 basin (DWR 2004ba).

26 Groundwater movement is affected by the occurrence of several fault zones  
27 (DWR 2004ba). Groundwater is recharged naturally from precipitation and  
28 stream flow and from imported water and reclaimed wastewater that percolates  
29 into the groundwater from stormwater spreading grounds.

30 In the San Fernando Valley Groundwater Basin, the groundwater is characterized  
31 by calcium, magnesium, radioactive material, and sulfate bicarbonate with  
32 localized areas of high TDS, volatile organic compounds, petroleum compounds,  
33 chloroform, pesticides, nitrate, and sulfate (DWR 2004ba, ULARAW 2013).

34 There are several ongoing groundwater remediation programs within the  
35 groundwater basin to reduce volatile organic compounds and one program to  
36 reduce hexavalent chromium.

37 San Fernando Valley Groundwater Basin was designated by the CASGEM  
38 program as medium priority.

##### 39 *Raymond Groundwater Basin*

40 The Raymond Groundwater Basin is located to the north of the San Gabriel  
41 Valley Groundwater Basin. Groundwater flow is affected by the occurrence of  
42 several fault zones; and causes the groundwater to flow into the San Gabriel

1 Valley Groundwater Basin. The water bearing formations are mainly  
2 unconsolidated gravel, sand, and silt with local areas of confinement  
3 (DWR 2004bb). Groundwater is recharged naturally from precipitation and  
4 stream flow and from water that percolates into the groundwater from spreading  
5 grounds and local dams.

6 In the Raymond Groundwater Basin, the groundwater is characterized by calcium,  
7 magnesium, and sulfate bicarbonate with localized areas of high volatile organic  
8 compounds, nitrate, radioactive material, and perchlorate (DWR 2004bb). There  
9 is an ongoing groundwater remediation program within the groundwater basin to  
10 reduce volatile organic compounds and perchlorate.

11 Raymond Groundwater Basin was designated by the CASGEM program as  
12 medium priority.

13 *San Gabriel Valley Groundwater Basin*

14 Groundwater in the San Gabriel Valley Groundwater Basin flows from the  
15 San Gabriel Mountains towards the west under the San Gabriel Valley to the  
16 Whittier Narrows where it discharges into the Coastal Plain of the Los Angeles  
17 Groundwater Basin (DWR 2004bc). Groundwater in the San Gabriel Valley  
18 Groundwater Basin also is interconnected to groundwater in the Chino subbasin  
19 of the Upper Santa Ana Valley Groundwater Basin in Riverside County. The  
20 northeastern portion of the San Gabriel Valley Groundwater Basin adjacent to the  
21 Chino subbasin includes six subbasins and is known as “Six Basins.” The water-  
22 bearing formations include unconsolidated to semi-consolidated alluvium deposits  
23 of gravel, sands, and silts.

24 Groundwater recharge occurs from direct percolation of precipitation and stream  
25 flow, including treated wastewater effluent conveyed in the San Gabriel River  
26 (DWR 2004bc). In the San Gabriel Valley Groundwater Basin, the groundwater  
27 is characterized by calcium bicarbonate with localized areas of high TDS, carbon  
28 tetrachloride nitrate, and volatile organic compounds (DWR 2004bc).

29 San Gabriel Valley Groundwater Basin was designated by the CASGEM program  
30 as high priority.

31 *Coastal Plain of Los Angeles Groundwater Basin*

32 The Coastal Plain of Los Angeles Groundwater Basin includes the Hollywood,  
33 Santa Monica, Central, and West Coast subbasins.

34 *Hollywood Subbasin*

35 The Hollywood subbasin is located to the north of the Central subbasin and  
36 upgradient of the Santa Monica subbasin. Groundwater flows towards the Pacific  
37 Ocean (DWR 2004bd). The water bearing formations are mainly alluvial gravel.  
38 Groundwater is recharged naturally from precipitation and stream flow.

39 The Hollywood subbasin was designated by the CASGEM program as very low  
40 priority.

1           *Santa Monica Subbasin*

2   The Santa Monica subbasin is located to the north of the West Coast subbasin and  
3   to the west of the Hollywood subbasin. Groundwater flows towards the west and  
4   the Hollywood subbasin (DWR 2004be). The water bearing formations are  
5   mainly alluvial gravel and sand with semi-perched areas over silt and clay  
6   deposits. Unconfined shallow aquifers occur in the northern and eastern portions  
7   of the subbasin. Confined deeper aquifers occur in the remaining portion of the  
8   subbasin. Groundwater is recharged naturally from precipitation and stream flow.  
9   The Santa Monica subbasin was designated by the CASGEM program as high  
10  priority.

11           *Central Subbasin*

12   The Central subbasin is located to the east of the West Coast subbasin. The  
13   Central subbasin is characterized by shallow sediments and extends from the Los  
14   Angeles River Narrows with groundwater flows from the San Gabriel Valley  
15   (DWR 2004bf).

16   The non-pressurized, or forebay, portions of the subbasin are located in the  
17   northern portion of the subbasin in unconfined aquifers underlying the Los  
18   Angeles and San Gabriel rivers (DWR 2004bf). These areas provide the major  
19   recharge areas for the subbasin. The “pressure” areas are confined aquifers  
20   composed of permeable sands and gravel separated by less permeable sandy clay  
21   and clay, and constitute the main water-bearing formations. Several faults and  
22   uplifts create some restrictions to groundwater flow in the subbasin while others  
23   run parallel to the groundwater flow and do not restrict flow.

24   In the Central subbasin, the groundwater is characterized by localized areas of  
25   high inorganics and volatile organic compounds (DWR 2004bf).

26   The Central subbasin was designated by the CASGEM program as high priority.

27           *West Coast Subbasin*

28   The West Coast subbasin is located on the southern coast of Los Angeles County  
29   to the west of the Central subbasin. The water bearing formations are composed  
30   of unconfined and semi-confined aquifers composed of sands, silts, clays, and  
31   gravels (DWR 2004bg). Several fault zones paralleling the coast act as partial  
32   barriers to groundwater flow in certain areas. The general regional groundwater  
33   flow pattern is southward and westward toward the Pacific Ocean. Recharge  
34   occurs through groundwater flow from the Central subbasin, and from infiltration  
35   along the Los Angeles and San Gabriel rivers. Seawater intrusion occurs along  
36   the Pacific Ocean coast.

37   In the West Coast subbasin, the most critical issue is high TDS along the Pacific  
38   Ocean coast due to seawater intrusion. As described below, several agencies have  
39   implemented sea water barrier projects to protect the groundwater quality.

40   The West Coast subbasin was designated by the CASGEM program as high  
41   priority.

1 *Malibu Valley Groundwater Basin*

2 The Malibu Valley Groundwater Basin is an isolated alluvial basin in northern  
3 Los Angeles County along the Pacific Ocean Coast under the Malibu Creek  
4 watershed (DWR 2004bh). Groundwater flows towards the Pacific Ocean. The  
5 water bearing formations are mainly gravel, sand, clays, and silt (DWR 2004bb).  
6 Groundwater is recharged naturally from precipitation and stream flow.

7 In the Malibu Valley Groundwater Basin, the groundwater is characterized by  
8 localized areas of high TDS due to sea water intrusion along the Pacific Ocean  
9 coast (DWR 2004bh).

10 The Malibu Valley Groundwater Basin was designated by the CASGEM program  
11 as very low priority.

12 *Coastal Plain of Orange County Groundwater Basin*

13 The Coastal Plain of Orange County Groundwater Basin is located under a coastal  
14 alluvial plain in northern Orange County (DWR 2004 bi). Groundwater is  
15 recharged naturally from precipitation and injection wells to reduce seawater  
16 intrusion. The water bearing formations are mainly interbedded marine and  
17 continental sand, silt, and clay deposits (DWR 2004bi). The Newport-Inglewood  
18 fault zone parallels the coast and generally forms a barrier to groundwater flow.  
19 Groundwater recharge occurs along the Santa Ana River. Water levels are  
20 characterized by seasonal fluctuations (DWR 2013f; Orange County 2009).  
21 Groundwater flowed towards the Pacific Ocean prior to recent development.  
22 However, due to extensive groundwater withdrawals, there are groundwater  
23 depressions that result in potential sea water intrusion. Groundwater levels have  
24 increased since the 1990s following implementation of several recharge programs.

25 In the Coastal Plain of Orange County Groundwater Basin, the groundwater is  
26 characterized as sodium-calcium bicarbonate with localized areas of high TDS  
27 due to sea water intrusion along the Pacific Ocean coast, as well as nitrate, and  
28 volatile organic compounds (DWR 2004bi).

29 The Coastal Plain of Orange County Groundwater Basin was designated by the  
30 CASGEM program as medium priority.

31 *San Juan Valley Groundwater Basin*

32 The San Juan Valley Groundwater Basin is located in southern Orange County  
33 (DWR 2004bj). Groundwater flows towards the Pacific Ocean. The water  
34 bearing formations are mainly sand, clays, and silt. Groundwater is recharged  
35 naturally from precipitation and stream flows from San Juan and Oso creeks and  
36 Arroyo Trabuca.

37 In the San Juan Valley Groundwater Basin, the groundwater is characterized as  
38 calcium bicarbonate, bicarbonate-sulfate, calcium-sodium sulfate, and sulfate-  
39 chloride with localized areas of high TDS due to sea water intrusion along the  
40 Pacific Ocean coast and high fluoride near hot springs near Thermal Canyon  
41 (DWR 2004bj).

1 The San Juan Valley Groundwater Basin was designated by the CASGEM  
2 program as low priority.

### 3 **7.3.6.2.2 Groundwater Use and Management**

4 Groundwater is an important water supply throughout the Southern California  
5 Region. Many of the groundwater basins in Los Angeles and Orange counties  
6 have been adjudicated, as summarized in Table 7.1, and groundwater  
7 management agencies have been established to manage, preserve, and regulate  
8 groundwater withdrawals and recharge actions.

#### 9 *San Fernando Valley Groundwater Basin*

10 The communities and agricultural users in the San Fernando Valley Groundwater  
11 Basin use a combination of surface water and groundwater to meet water demands  
12 (GLCIRWMR 2014; ULARAW 2013). The Metropolitan Water District of  
13 Southern California provides wholesale surface water supplies to several  
14 communities. The cities of Los Angeles, Glendale, Burbank, San Fernando,  
15 Crescenta Valley, Bell Canyon, and Hidden Hills provide retail water supplies,  
16 including groundwater, to the communities. The groundwater basin has been  
17 adjudicated and is managed by the Upper Los Angeles River Area Watermaster.

18 Groundwater is recharged in the San Fernando Valley Groundwater Basin through  
19 seepage of precipitation within the groundwater basin, including the recharge of  
20 stormwater at spreading grounds between 1968 and 2012; and storage of imported  
21 water (ULARAW 2013). The spreading basins for stormwater flows are operated  
22 by Los Angeles County and the cities of Los Angeles and Burbank. A portion of  
23 the extracted groundwater is exported to areas that overly other groundwater  
24 basins.

25 The operations of the San Fernando Valley Groundwater Basin are defined by the  
26 Upper Los Angeles River Area January 26, 1979 Final Judgment; the Sylmar  
27 Basin Stipulations of August 26, 1983; and subsequent agreements. These  
28 agreements, as managed by the Upper Los Angeles River Area Watermaster,  
29 provide for the right to extract a percent of surface water, including applied  
30 recycled water, that enters within specified subbasins of the San Fernando Valley  
31 Groundwater Basin with specific calculations to identify maximum withdrawals  
32 for the cities of Burbank, Glendale, Los Angeles, and San Fernando and  
33 Crescenta Valley Water District; the right to store and withdraw water within  
34 specified subbasins by the cities of Burbank, Glendale, Los Angeles, and San  
35 Fernando; and the acknowledgment that the City of Los Angeles has an exclusive  
36 Pueblo Water Right for the native safe yield of the San Fernando subbasin within  
37 the larger San Fernando Valley Groundwater Basin.

#### 38 *Raymond Groundwater Basin*

39 The communities in the Raymond Groundwater Basin use a combination of  
40 surface water and groundwater to meet water demands (GLCIRWMR 2014). The  
41 Metropolitan Water District of Southern California and Foothills Municipal Water  
42 District provide wholesale surface water supplies to several communities. The  
43 cities of Alhambra, Arcadia, Pasadena, San Marino, and Sierra Madre; Upper San

1 Gabriel Municipal Water District; and Valley Water Company and several other  
 2 private water companies, provide retail water supplies, including groundwater, to  
 3 the communities to Altadena, Las Crescenta-Montrose, La Cañada Flintridge,  
 4 Rubio Canyon, and South Pasadena. The City of Alhambra and San Gabriel  
 5 Valley Municipal Water District; can withdraw groundwater from the Raymond  
 6 Basin, but currently are not operating wells within this groundwater basin (City of  
 7 Alhambra 2011).

8 The groundwater basin was the first adjudicated groundwater basin in California  
 9 and is managed by the Raymond Basin Management Board as the Watermaster  
 10 (RBMB 2014). The Raymond Basin Management Board limits the amount of  
 11 groundwater withdrawals in different areas of the basin, and allows for short-term  
 12 and long-term storage of water in the groundwater basin.

13 Groundwater is recharged in the Raymond Groundwater Basin through seepage of  
 14 precipitation within the groundwater basin, injection wells, and spreading basins  
 15 operated by Los Angeles County and the cities of Pasadena and Sierra Madre  
 16 (MWDC 2007). Water from Metropolitan Water District of Southern California,  
 17 which is generally a combination of SWP water and Colorado River water, cannot  
 18 be used for direct recharge if the TDS is greater than 450 milligrams/liter  
 19 (RBMB 2014). A portion of the extracted groundwater is exported to areas that  
 20 overly other groundwater basins.

21 *San Gabriel Valley Groundwater Basin*

22 The communities in the San Gabriel Valley Groundwater Basin use a combination  
 23 of surface water and groundwater to meet water demands (GLCIRWMR 2014;  
 24 MWDC 2007). The Metropolitan Water District of Southern California, San  
 25 Gabriel Valley Municipal Water District, Upper San Gabriel Municipal Water  
 26 District; Three Valleys Municipal Water District, and Covina Irrigating Company  
 27 provide wholesale surface water and/or groundwater supplies to several  
 28 communities. The cities of Alhambra, Arcadia, Azusa, Covina, El Monte,  
 29 Glendora, La Verne, Monrovia, Pomona, San Marino, and Upland; San Gabriel  
 30 County Water District and Valley County Water District; Golden State Water  
 31 Company, San Antonio Water Company, San Gabriel Valley Water Company,  
 32 Suburban Water Systems, Valencia Heights Water Company, and several other  
 33 private water companies, provide retail water supplies, including groundwater, to  
 34 users within their communities and to the communities of Baldwin Park,  
 35 Bradbury, Claremont, Duarte, Hacienda Heights, Irwindale, La Puente,  
 36 Montebello, Monterey Park, Pico Rivera, Rosemead, San Dimas, San Gabriel,  
 37 Santa Fe Springs, Sierra Madre, South El Monte, South San Gabriel, Temple City,  
 38 Valinda, and Whittier (City of Alhambra 2011; City of Arcadia 2011; City of La  
 39 Verne 2011; City of Pomona 2011; City of Upland 2011; Golden State Water  
 40 Company 2011c; SGCWD 2011; SGVWC 2011; Suburban Water Systems 2011;  
 41 SAWCO 2011; TVMWD 2011; USGVMWD 2011).

42 The San Gabriel Valley Groundwater Basin includes several adjudicated basins.  
 43 A portion of the groundwater basin is managed by the San Gabriel River  
 44 Watermaster and the Main San Gabriel Basin Watermaster (MWDC 2007;  
 45 SGVWC 2011). The Watermasters coordinate groundwater elevation and water



1 quality monitoring, coordinate imported water supplies, coordinate recharge  
2 operations with imported water and recycled water, manage the amount of  
3 groundwater withdrawals in different areas of the basin by balancing the amount  
4 of groundwater recharge, and allow for short-term and long-term storage of water  
5 in the groundwater basin. Groundwater is recharged through seepage of  
6 precipitation within the groundwater basin, injection wells, and spreading basins  
7 operated by Los Angeles County and a private water company (MWDSC 2007).  
8 Water recharged into the spreading basins from Metropolitan Water District of  
9 Southern California and San Gabriel Valley Municipal Water District.

10 The Six Basins portion of the groundwater basin also is adjudicated and managed  
11 by the Six Basins Watermaster Board (MWDSC 2007). The Watermaster  
12 manages withdrawals and requires replenishment obligation of equal amounts for  
13 withdrawals over the operating safe yield of the basin. The Pomona Valley  
14 Protective Agency conveys flows from San Antonio Creek and SWP water to the  
15 San Antonio Spreading Grounds; and from local waters to the Thompson Creek  
16 Spreading Grounds. The City of Pomona conveys flows from local surface  
17 waters to the Pomona Spreading Grounds. Los Angeles County Department of  
18 Public Works conveys flows from local surface water and SWP water to the Live  
19 Oak Spreading Grounds.

20 The cities of Alhambra, Arcadia, La Verne, Monterey Park, San Gabriel Valley  
21 Water Company, and other water entities operate groundwater treatment facilities  
22 to remove dichloroethane, chloroform, other volatile organic compounds, and/or  
23 nitrates (City of Alhambra 2011; City of Arcadia 2011; City of Monterey  
24 Park 2012; MWDSC 2007; SGVWC 2011).

25 *Coastal Plain of Los Angeles Groundwater Basin*

26 The Coastal Plain of Los Angeles Groundwater Basin includes four subbasins:  
27 Hollywood, Santa Monica, Central and West Coast.

28 *Hollywood Subbasin*

29 The primary user of groundwater in the Hollywood subbasin is the City of  
30 Beverly Hills (MWDSC 2007). The basin is not adjudicated. The city manages  
31 the groundwater subbasin through limits on withdrawals and discharges to the  
32 groundwater. Groundwater is recharged through seepage of precipitation within  
33 the groundwater subbasin (City of Beverly Hills 2011). All groundwater  
34 withdrawn by the city is treated to reduce salinity.

35 *Santa Monica Subbasin*

36 The primary user of groundwater in the Santa Monica subbasin is the City of  
37 Santa Monica (MWDSC 2007). The basin is not adjudicated. Groundwater is  
38 recharged through seepage of precipitation within the groundwater subbasin  
39 (City of Santa Monica 2011; MWDSC 2007). Groundwater treatment is provided  
40 to a portion of the subbasin withdrawals to reduce volatile organic compounds,  
41 and methyl tertiary butyl ether.

1            *Central Subbasin*

2    The communities in the Central subbasin use a combination of surface water and  
 3    groundwater to meet water demands (GLCIRWMR 2014; MWDSC 2007). The  
 4    Metropolitan Water District of Southern California and Central Basin Municipal  
 5    Water District provide wholesale surface water supplies to several communities.  
 6    The cities of Bell, Bell Gardens, Cerritos, Compton, Cudahy, Downey,  
 7    Huntington Park, Lakewood, Long Beach, Los Angeles, Lynwood, Monterey  
 8    Park, Norwalk, Paramount, Pico Rivera, Santa Fe Springs, Signal Hill, South  
 9    Gate, Vernon, and Whittier; Los Angeles County Water District, La Habra  
 10   Heights County Water District, Orchard Dale Water District, and Paramount  
 11   Water District; Golden State Water Company, Suburban Water Systems,  
 12   Bellflower-Somerset Mutual Water Company, Montebello Land & Water  
 13   Company; Park Water Company, Dominguez Water Corp, California Water  
 14   Service Company, San Gabriel Valley Water Company, Walnut Park Mutual  
 15   Water Company, and several other private water companies, provide retail water  
 16   supplies, including groundwater, to users within their communities and to the  
 17   communities of Artesia, Commerce, Dominguez, East La Mirada, East Los  
 18   Angeles, East Rancho, Florence-Graham, Hawaiian Gardens, La Mirada, Los  
 19   Nieto, Maywood, Montebello, South Whittier, Walnut Park, Westmount, West  
 20   Whittier, and Willow Brook (CBMWD 2011; BSMWC 2011; City of Compton  
 21   2011; City of Downey 2012; City of Huntington Park 2011; City of Lakewood  
 22   2011; City of Long Beach 2011; City of Los Angeles 2011; City of Monterey  
 23   Park 2012; City of Norwalk 2011; City of Paramount 2011; City of Pico Rivera  
 24   2011; City of Santa Fe Springs 2011; City of South Gate; City of Vernon 2011;  
 25   City of Whittier 2011; LHHWCWD 2012; Golden State Water Company 2011d,  
 26   2011e, 2011f, 2011g; Suburban Water Systems 2011).

27   The Central subbasin was adjudicated, and is managed by DWR. The  
 28   adjudication specifies a total amount of allowed annual withdrawals (or  
 29   Allowable Pumping Allocation) in the Central subbasin (MWDSC 2007; WRD  
 30   2013a). Approximately 25 percent of the water users of groundwater from the  
 31   Central subbasin are not located on the land that overlies the subbasin (CBMWD  
 32   2011). Groundwater from the San Gabriel Valley Groundwater Basin also is used  
 33   by water users that overlie the Central subbasin.

34   The Water Replenishment District of Southern California has the statutory  
 35   authority to replenish the groundwater in the Central and West Coast subbasins of  
 36   the Coastal Plain of Los Angeles Groundwater Basin. The Water Replenishment  
 37   District of Southern California purchases water for water replenishment facilities  
 38   operated by Los Angeles County Department of Public Works at the Montebello  
 39   Forebay near the Rio Hondo and San Gabriel Rivers near the boundaries of the  
 40   Central and West Coast subbasins (CBMWD 2011; Los Angeles County 2015;  
 41   WRD 2013a). The Montebello Forebay includes the Rio Hondo Coastal Basin  
 42   Spreading Grounds along the Rio Hondo Channel; the San Gabriel River Coastal  
 43   Basin Spreading Grounds; and the unlined reach of the lower San Gabriel River  
 44   from Whittier Narrows Dam to Florence Avenue (LACDPW 2014, WRD 2013a).

1 The replenishment water is purchased water from two different sources: recycled  
2 water from various regional treatment facilities, and imported water (WRD  
3 2013a). The recycled water is used for groundwater recharge at the spreading  
4 grounds and at the seawater barrier wells. Water Replenishment District of  
5 Southern California must blend recycled water with other water sources to meet  
6 the groundwater recharge water quality and volumetric requirements established  
7 by the State Water Resources Control Board. This blended water is either  
8 imported water from the SWP and/or the Colorado River, or untreated surface  
9 water flows from the San Gabriel River, Rio Hondo River, and waterways in the  
10 San Gabriel Valley (CBMWD 2011). Up to 35 percent of the replenishment  
11 water can be provided from recycled water supplies. Several recent projects have  
12 been implemented to store stormwater flows for increased replenishment water  
13 volumes.

14 In the Central subbasin, the Water Replenishment District of Southern California  
15 also purchases imported and recycled water for injection by the Los Angeles  
16 County Department of Public Works into the portion of the Alamitos Barrier  
17 Project located in Los Angeles County to reduce seawater intrusion  
18 (MWDC 2007; WRD 2007). Initially, imported SWP water was used to prevent  
19 seawater intrusion. However, over the past 20 years, recycled water has been  
20 used for a substantial amount of the groundwater injection program. The Water  
21 Replenishment District of Southern California is planning to fully use recycled  
22 water at the Alamitos Gap Barrier Project by 2014 (WRD 2013b).

23 The cities of Long Beach, Monterey Park, South Gate, and Whittier operate  
24 groundwater treatment facilities in the Central subbasin (City of Long Beach  
25 2012; City of Monterey Park 2012; City of South Gate; City of Whittier 2011).

26 *West Coast Subbasin*

27 The communities in the Central subbasin use a combination of surface water and  
28 groundwater to meet water demands (GLCIRWMR 2014; MWDC 2007). The  
29 Metropolitan Water District of Southern California and West Basin Municipal  
30 Water District provide wholesale surface water supplies to several communities.  
31 The cities of Inglewood, Lomita, Manhattan Beach, and Torrance; Golden State  
32 Water Company, California Water Service Company, and several other private  
33 water companies, provide retail water supplies, including groundwater, to users  
34 within their communities and to the communities of Athens, Carson, Compton,  
35 Del Aire, Gardena, Hawthorne, Hermosa Beach, Inglewood, Lawndale, Lennox,  
36 Redondo Beach, Torrance (WBMWD 2011a; City of Inglewood 2011; City of  
37 Lomita 2011; City of Manhattan Beach 2011; City of Torrance 2011; Golden  
38 State Water 2011h; California Water Service Company 2011b, 2011c, 2011d,  
39 2011e). The communities of El Segundo, Long Beach, and Los Angeles overlie  
40 the West Coast subbasin; however, no groundwater from this subbasin is used in  
41 these communities due to water quality issues and facilities locations.  
42 Groundwater use is primarily for emergency uses, including firefighting, in the  
43 communities of Hawthorne, Lomita, and Torrance due to high concentrations of  
44 minerals (e.g., iron and manganese), sulfides, and/or volatile organic compounds.

1 The West Coast subbasin was adjudicated, and is managed by DWR. The  
 2 adjudication specifies a total amount of allowed annual withdrawals (or  
 3 Allowable Pumping Allocation) in the West Coast subbasin (MWDC 2007;  
 4 WBMWD 2011a; WRD 2013a). Groundwater from the Central subbasin is used  
 5 by some water users that overlie the West Coast subbasin.

6 The Water Replenishment District of Southern California has the statutory  
 7 authority to replenish the groundwater in the Central and West Coast subbasins of  
 8 the Coastal Plain of Los Angeles Groundwater Basin. In the West Coast  
 9 subbasin, the Water Replenishment District of Southern California purchases  
 10 imported and recycled water for injection by the Los Angeles County Department  
 11 of Public Works into the West Coast Barrier Project and the Dominguez Barrier  
 12 Project (MWDC 2007; WRD 2007; WRD 2013). Water is purchased by the  
 13 Water Replenishment District of Southern California for injection at the barrier  
 14 projects (WRD 2013). Initially, imported SWP water was used to prevent  
 15 seawater intrusion. However, over the past 20 years, recycled water has been  
 16 used for a substantial amount of the groundwater injection program. The Water  
 17 Replenishment District of Southern California is planning to fully use recycled  
 18 water at the West Coast Barrier Project and the Dominguez Barrier Project by  
 19 2014 and 2017, respectively (WRD 2013b).

20 California Water Service Company operates groundwater treatment facilities  
 21 within the community of Hawthorne (California Water Service Company 2011b).  
 22 The Water Replenishment District of Southern California operates the Robert W.  
 23 Goldsworthy Desalter near Torrance to reduce salinity for up to 18,000 acre-  
 24 feet/year of groundwater that is located inland of the West Coast Basin Barrier  
 25 (WRD 2013a).

26 The West Basin Municipal Water District treats brackish groundwater at the  
 27 C. Marvin Brewer Desalter Facility for two wells near Torrance that are affected  
 28 by a saltwater plume in the West Coast subbasin (WBMWD 2011a).

29 *Malibu Valley Groundwater Basin*

30 No groundwater is used by the communities in this groundwater basin, including  
 31 the Malibu area (Los Angeles County 2011; MWDC 2007).

32 *Coastal Plain of Orange County Groundwater Basin*

33 The communities in the Coastal Plain of Orange County Groundwater Basin use a  
 34 combination of surface water and groundwater to meet water demands  
 35 (MWDC 2007). The Municipal Water District of Orange County, Orange  
 36 County Water District, and East Orange County Water District provide wholesale  
 37 surface water supplies to several communities. The cities of Anaheim, Buena  
 38 Park, Fountain Valley, Fullerton, Garden Grove, Huntington Beach, La Habra,  
 39 La Palma, Newport Beach, Orange, Santa Ana, Seal Beach, Tustin, and  
 40 Westminster; East Orange County Water District, Irvine Ranch Water District,  
 41 Mesa Consolidated Water District, Rowland Water District, Serrano Water  
 42 District, Walnut Valley Water District, and Yorba Linda Water District; Golden  
 43 State Water Company, California Water Service Company, California Domestic  
 44 Water Company, and several other private water companies, provide retail water

1 supplies, including groundwater, to users within their communities and to the  
2 communities of Brea, Costa Mesa, Cypress, Diamond Bar, Garden Grove,  
3 Hacienda Heights, Industry, Irvine, La Palma, La Puente, Los Alamitos, Midway  
4 City, Newport Beach, Orange, Panorama Heights, Placentia, Pomona, Rowland  
5 Heights, Rossmoor, Seal Beach, Stanton, Villa Park, Walnut, West Covina, West  
6 Orange, and Yorba Linda (City of Anaheim 2011; City of Brea 2011; City of  
7 Buena Park 2011; City of Fountain Valley 2011; City of Fullerton 2011; City of  
8 Garden Grove 2011; City of Huntington Beach 2011; City of La Habra 2011; City  
9 of La Palma 2011; City of Newport Beach 2011; City of Orange 2011; City of  
10 Santa Ana 2011; City of Seal Beach 2011; City of Tustin 2011; City of  
11 Westminster 2011; IRWD 2011; MCWD 2011; RWD 2011; SWD 2011; WVWD  
12 2011; YLWD 2011; Golden State Water Company 2011i, 2011j). Groundwater  
13 use is primarily for non-potable water uses in West Covina and for supplemental  
14 supplies for users of recycled water in Rowland Heights.

15 The Coastal Plain of Orange County Groundwater Basin is managed by Orange  
16 County Water District in accordance with special State legislation to increase  
17 supply and provide uniform costs for groundwater (MWDSC 2007). The basin is  
18 managed to maintain a water balance over several years using two step pricing  
19 levels to incentivize users to obtain alternative water supplies after withdrawing a  
20 basin production target. The groundwater basin is managed to provide  
21 approximately a three-year drought supply.

22 Orange County Water District manages an extensive groundwater recharge  
23 program in the Coastal Plain of Orange County Basin (Orange County Water  
24 District 2014). The Orange County Water District manages spreading basins  
25 along the Santa Ana River and Santiago Creek for groundwater recharge  
26 (MWDSC 2007). Water is supplied to these basins with flows diverted from the  
27 Santa Ana River into the recharge basins at inflatable rubber dams, SWP water,  
28 and recycled water from the Orange County Water District/Orange County  
29 Sanitation District Groundwater Replenishment System Advanced Water  
30 Purification Facility (OCWD n.d.).

31 The Orange County Water District also injects water into the Talbert Barrier and  
32 the portion of the Alamitos Barrier Project within Orange County. Water supplies  
33 for the seawater barriers include water from the Groundwater Replenishment  
34 System and SWP water (GWRS n.d.; MWDSC 2007).

35 The Irvine Desalter Project was initiated in 2007 by Orange County Water  
36 District, Irvine Ranch Water District, Metropolitan Water District of Orange  
37 County, Metropolitan Water District of Southern California, and the U.S. Navy to  
38 reduce TDS and salts (IRWD 2011; MWDSC 2007). Several other treatment  
39 facilities remove volatile organic compounds. The city of Tustin operates the  
40 Tustin Seventeenth Street Desalter to reduce TDS within the Tustin community  
41 (MWDSC 2007). The City of Garden Grove and Mesa County Water District  
42 operate treatment facilities to reduce nitrates and compounds that change the color  
43 of the water, respectively (City of Garden Grove 2011; MCWD 2011).

1 *San Juan Valley Groundwater Basin*

2 The communities in the San Juan Groundwater Basin use a combination of  
3 surface water and groundwater to meet water demands (MWDSC 2007). The  
4 Municipal Water District of Orange County provides wholesale surface water  
5 supplies to several communities. The City of San Juan Capistrano; Moulton  
6 Niguel Water District, Santa Margarita Water District, and South Coast Water  
7 District provide retail water supplies to users within their communities and to the  
8 communities of Coto de Caza, Dana Point, Laguna Forest, Laguna Woods, Las  
9 Flores, Ladera Ranch, Mission Viejo, Rancho Santa Margarita, South Laguna,  
10 Talega, (City of San Juan Capistrano 2011; MNWD 2011; SCWD 2011;  
11 SMWD 2011). Most of the groundwater use occurs within or near the City of San  
12 Juan Capistrano. Groundwater use is small or does not occur within the Santa  
13 Margarita Water District, South Coast Water District, and Moulton Niguel Water  
14 District service areas.

15 The San Juan Basin Authority manages water resources development in the  
16 San Juan Valley Groundwater Basin and in the surrounding San Juan watershed to  
17 protect water quality and water resources (MWDSC 2007; SJBA 2013). In  
18 addition to community uses, groundwater also is used for agricultural and  
19 industrial purposes and golf course irrigation. Overall, groundwater provides less  
20 than 10 percent of the total water supply within the groundwater basin.

21 The City of San Juan Capistrano Groundwater Recovery Plant reduces iron,  
22 manganese, and TDS concentrations. This city is modifying the treatment plant to  
23 reduce recently observed high concentrations of methyl tertiary butyl ether  
24 (MTBE) (City of San Juan Capistrano 2011; MWDSC 2007). The South Coast  
25 Water District operates the Capistrano Beach Groundwater Recovery Facility in  
26 Dana Point to reduce iron and manganese concentrations (SCWD 2011;  
27 MWDSC 2007).

28 **7.3.6.3 Western San Diego County**

29 The areas within the SWP service area in western San Diego County in the  
30 Southern California Region include the San Mateo Valley Groundwater Basin in  
31 Orange and San Diego counties; and the San Onofre Valley, Santa Margarita  
32 Valley, San Luis Rey Valley, Escondido Valley, San Marcos Area, Batiquitos  
33 Lagoon Valley, San Elijo Valley, San Dieguito Creek, Poway Valley, San Diego  
34 River Valley, El Cajon Valley, Mission Valley, Sweetwater Valley, Otay Valley,  
35 Tijuana Basin groundwater basins in San Diego County, as shown in Figure 7.11.

36 **7.3.6.3.1 Hydrogeology and Groundwater Conditions**

37 In San Diego County, several smaller groundwater basins exist, in the western  
38 portion of the county. The most productive groundwater basins are characterized  
39 by narrow river valleys filled with shallow sand and gravel deposits.  
40 Groundwater occurs farther inland in fractured bedrock and semi consolidated  
41 sedimentary deposits with limited yield and storage (SDCWA et al. 2013).

1 *San Mateo Valley, San Onofre Valley, and Santa Margarita Valley*  
2 *Groundwater Basins*

3 The San Mateo Valley Groundwater Basin is located in southern Orange County  
4 and northern San Diego County (DWR 2004bk). The San Onofre Valley and  
5 Santa Margarita Valley groundwater basins are located in northwestern San Diego  
6 County (DWR 2004bl, 2004bm). Groundwater flows towards the Pacific Ocean.  
7 The water bearing formations are mainly gravel, sand, clays, and silt.  
8 Groundwater is recharged naturally from precipitation and stream flows. In the  
9 San Mateo Valley and San Onofre Valley groundwater basins, treated wastewater  
10 effluent discharged from the Marine Corps Base Camp Pendleton wastewater  
11 treatment plants into local streams also recharges the groundwater. In the San  
12 Mateo Valley and Santa Margarita Valley groundwater basins, the groundwater is  
13 characterized as calcium-sulfate-chloride. In the San Onofre Valley Groundwater  
14 Basin, the groundwater is characterized as calcium-sodium bicarbonate-sulfate.  
15 Localized areas with high boron, chloride, magnesium, nitrate, sulfate, and TDS  
16 occur in the Santa Margarita Valley Groundwater Basin.

17 Santa Margarita Valley Groundwater Basin was designated by the CASGEM  
18 program as medium priority. San Mateo Valley and San Onofre Valley  
19 groundwater basins were designated as very low priority.

20 *San Luis Rey Valley Groundwater Basin*

21 The San Luis Rey Valley Groundwater Basin is located in northwestern  
22 San Diego County (DWR 2004bn). Groundwater flows towards the Pacific  
23 Ocean. The water bearing formations are mainly gravel and sand. Under some  
24 portions of the alluvial aquifer, partially consolidated marine terrace deposits of  
25 partly consolidated sandstone, mudstone, siltstone, and shale occur. Groundwater  
26 is recharged naturally from precipitation and stream flows, and from runoff that  
27 flows into the streams from lands irrigated with SWP water. The groundwater is  
28 characterized as calcium-sodium bicarbonate-sulfate with localized areas of high  
29 magnesium, nitrate, and TDS (MWDC 2007).

30 San Luis Rey Valley Groundwater Basin was designated by the CASGEM  
31 program as medium priority.

32 *San Marcos Valley, Escondido Valley, San Pasqual Valley, Pamo Valley, Santa*  
33 *Maria Valley, and Poway Valley Groundwater Basins*

34 The San Marcos Valley, Escondido Valley, San Pasqual Valley, Pamo Valley,  
35 Santa Maria Valley, and Poway Valley groundwater basins are located in the  
36 foothills within central, western San Diego County. The water bearing formations  
37 are mainly alluvium of sand, gravel, clay, and silt; consolidated sandstone; or  
38 weathered crystalline basement rock (DWR 2004bo, 2004bp, 2004bq, 2004br,  
39 2004bs, 2004bt). The basins area bounded by semi-permeable marine and non-  
40 marine deposits and impermeable granitic and metamorphic rocks. Groundwater  
41 is recharged naturally from precipitation and stream flows, and from runoff that  
42 flows into the streams from irrigated lands. The groundwater is characterized  
43 with moderate to high concentrations of salinity. There are localized areas with

1 high sulfate and nitrate concentrations in the Santa Maria Valley Groundwater  
2 Basin.

3 San Pasqual Valley Groundwater Basin was designated by the CASGEM program  
4 as medium priority. San Marcos Valley, Escondido Valley, Pamo Valley, Santa  
5 Maria, and Poway Valley groundwater basins were designated as very low  
6 priority.

7 *Batiquitos Lagoon Valley, San Elijo Valley, and San Dieguito Valley*  
8 *Groundwater Basins*

9 The Batiquitos Lagoon Valley, San Elijo Valley, and San Dieguito Valley  
10 groundwater basins are located along the central San Diego County coast of the  
11 Pacific Ocean. The water bearing formations are mainly alluvium of sand, gravel,  
12 clay, and silt with areas of consolidated sandstone (DWR 2004bu, 2004bv,  
13 2004bw). Some areas of the Batiquitos Lagoon Valley Groundwater Basin are  
14 bounded by impermeable crystalline rock. Groundwater is recharged naturally  
15 from precipitation and stream flows, and from runoff that flows into the streams  
16 from irrigated lands. The groundwater is characterized with moderate to high  
17 concentrations of salinity.

18 Batiquitos Valley, San Elijo Valley, and San Dieguito Valley groundwater basins  
19 were designated by the CASGEM program as very low priority.

20 *San Diego River Valley, El Cajon, Mission Valley, Sweetwater Valley, Otay*  
21 *Valley, and Tijuana Groundwater Basins*

22 The San Diego River Valley, El Cajon, Mission Valley, Sweetwater Valley, Otay  
23 Valley, and Tijuana groundwater basins are located in the southwestern portion of  
24 San Diego County. The water bearing formations are mainly alluvium of sand,  
25 gravel, cobble, clay, and silt; or siltstone and sandstone (DWR 2004bx, 2004by,  
26 2004bz, 2004ca, 2004cb, 2004cc). Groundwater is recharged naturally from  
27 precipitation and stream flows, and from runoff that flows into the streams from  
28 irrigated lands. The groundwater is characterized with moderate to high levels of  
29 salinity. A recent study by USGS evaluated the sources and movement of saline  
30 groundwater in these groundwater basins (USGS 2013b). The chloride  
31 concentrations ranged from 57 to 39,400 mg/L. The sources of salinity were  
32 natural geologic sources and sea water intrusion. There are localized areas with  
33 high sulfate and magnesium concentrations.

34 San Diego River Valley Groundwater Basin was designated by the CASGEM  
35 program as medium priority. El Cajon, Mission Valley, Sweetwater Valley, Otay  
36 Valley, and Tijuana groundwater basins were designated as very low priority.

37 **7.3.6.3.2 Groundwater Use and Management**

38 Groundwater production and use in the San Diego region is currently limited due  
39 to a lack of aquifer storage capacity, available recharge, and degraded water  
40 quality due to high salinity. Groundwater currently represents about 3 percent of  
41 the water supply portfolio within the areas of San Diego County that could be  
42 served by SWP water (SDCWA et al. 2013).



1 *San Mateo Valley, San Onofre Valley, and Santa Margarita Valley Groundwater*  
2 *Basins*

3 The primary user of groundwater in the San Mateo Valley, San Onofre Valley,  
4 and Santa Margarita Valley groundwater basins is the Marine Corps Base Camp  
5 Pendleton (FPUD 2011; MWDSC 2007; SCWD 2011; SDCWA et al. 2013). The  
6 Marine Corps Base Camp Pendleton withdraws approximately 8,500 acre-  
7 feet/year from the three groundwater basins and operates spreading basins to  
8 recharge the groundwater in the Santa Margarita Valley Groundwater Basin.  
9 Portions of the South Coast Water District overlie the northern portions of the San  
10 Mateo Valley Groundwater Basin; however, the district does not withdraw water  
11 from that basin. Fallbrook Public Utility District overlies northern portions of the  
12 Santa Margarita Valley Groundwater Basin; however, the district currently uses a  
13 small amount of groundwater to meet their water demand (FPUD 2011).

14 The Santa Margarita Valley Groundwater Basin is within an adjudicated  
15 watershed (SMRW 2011). The Santa Margarita River Watermaster manages both  
16 surface water and groundwater that contributes direct or indirect flows into the  
17 Santa Margarita River in accordance with the Modified Final Judgment and  
18 Decrees of 1966 by the U.S. District Court in the *United States v. Fallbrook*  
19 *Public Utility et al.* The watershed includes the Santa Margarita Valley  
20 Groundwater Basin near the Pacific Ocean and the Temecula Valley groundwater  
21 basins in the upper Santa Margarita River Watershed within Riverside County, as  
22 discussed in the following subsection. Within San Diego County, the only  
23 groundwater user in the Santa Margarita Valley Groundwater Basin is the Marine  
24 Corps Base Camp Pendleton.

25 *San Luis Rey Valley Groundwater Basin*

26 The communities in the San Luis Rey Valley Groundwater Basin use a  
27 combination of surface water and groundwater to meet water demands (City of  
28 Oceanside 2011; MWDSC 2007; RMWD 2011; VCMWD 2011; YMWD 2014a,  
29 2014b). The San Diego County Water Authority provides wholesale surface  
30 water supplies to several communities. The City of Oceanside; Rainbow  
31 Municipal Water District, Valley Center Municipal Water District, and Yuima  
32 Municipal Water District; and Rancho Pauma Mutual Water Company and  
33 several other private water companies provide retail water supplies to users within  
34 their communities. Groundwater use is small or does not occur within the  
35 Rainbow Municipal Water District or Valley Center Municipal Water District.  
36 Groundwater also is used on agricultural lands, especially for orchards in the  
37 Pauma area (San Diego County 2010). The Tribal lands also depend upon  
38 groundwater including lands within the La Jolla Reservation, Los Coyotes  
39 Reservation, Pala Reservation, Pauma & Yuima Reservation, Rincon Reservation,  
40 and Santa Ysabel Reservation (SDCWA et al. 2013).

41 There are three municipal water districts that overlie the San Luis Rey Valley  
42 Groundwater Basin that manage water rights protection efforts. Groundwater is  
43 the only water supply within the Pauma Municipal Water District and the primary  
44 water supplies within the Mootamai Municipal Water District and the San Luis  
45 Rey Municipal Water District (SDLAFCO 2011; SDCWA et al. 2013). The

1 districts protect groundwater, surface water rights, and water storage; and to  
2 coordinate planning studies and legal activities within the San Luis Rey River  
3 watershed. Vista Irrigation District withdraws and stores groundwater in Lake  
4 Henshaw and withdraws groundwater in a subbasin located upgradient the  
5 San Luis Rey Valley Groundwater Basin.

6 *San Marcos, Escondido Valley, San Pasqual Valley, Pamo Valley, Santa Maria*  
7 *Valley, and Poway Valley Groundwater Basins*

8 The communities in the San Marcos, Escondido Valley, San Pasqual Valley,  
9 Pamo Valley, Santa Maria Valley, and Poway Valley groundwater basins use a  
10 combination of surface water and groundwater to meet water demands (City of  
11 Escondido 2011; City of Poway 2011; Ramona MWD 2011; RDDMWD 2011;  
12 VWD 2011). The San Diego County Water Authority provides wholesale surface  
13 water supplies to several communities. The cities of Escondido and Poway;  
14 Ramona Municipal Water District, Rincon del Diablo Municipal Water District,  
15 Vallecitos Water District, and Vista Irrigation District; and private water  
16 companies provide retail water supplies to users within their communities.  
17 Groundwater use is small or does not occur within the cities of Escondido and  
18 Poway, Ramona Municipal Water District, Rincon del Diablo Municipal Water  
19 District, and Vallecitos Water District. Ramona Municipal Water District used to  
20 use groundwater until high nitrate concentrations required the district to abandon  
21 the wells.

22 *Batiquitos Lagoon Valley, San Elijo Valley, and San Dieguito Valley*  
23 *Groundwater Basins*

24 The communities in the Batiquitos Lagoon Valley, San Elijo Valley, and San  
25 Dieguito Valley groundwater basins primarily use surface water to meet water  
26 demands (CMWD 2011; OMWD 2011; SDLAFCO 2011; SDWD 2011; SFID  
27 2011). The San Diego County Water Authority provides wholesale surface water  
28 supplies to several communities. Groundwater use is limited to private wells  
29 within the Carlsbad Municipal Water District, including the City of Carlsbad;  
30 Olivenhain Municipal Water District, including the cities of Encinitas, Carlsbad,  
31 San Diego, Solano Beach, and San Marcos, and the communities of Olivenhain,  
32 Leucadia, Elfin Forest, Rancho Santa Fe, Fairbanks Ranch, Santa Fe Valley, and  
33 4S Ranch; San Dieguito Water District, including the communities of Encinitas,  
34 Cardiff-by-the-Sea, New Encinitas, and Old Encinitas; and Santa Fe Irrigation  
35 District, including the City of Solana Beach and the communities of Rancho Santa  
36 Fe and Fairbanks Ranch. Groundwater was used within the Carlsbad Municipal  
37 Water District area until high salinity caused the area to abandon the wells.  
38 Questhaven Municipal Water District manages groundwater for a recreation  
39 community located to the west of Escondido.

40 *San Diego River Valley, El Cajon, Mission Valley, Sweetwater Valley, Otay*  
41 *Valley, and Tijuana Groundwater Basins*

42 The communities in the San Diego River Valley, El Cajon, Mission Valley,  
43 Sweetwater Valley, Otay Valley, and Tijuana groundwater basins use a  
44 combination of surface water and groundwater to meet water demands (California  
45 American Water Company 2012; City of San Diego 2011; HWD 2011; OWD

1 2011; PDMWD 2011; SDCWA et al. 2013; Sweetwater Authority 2011). The  
2 San Diego County Water Authority provides wholesale surface water supplies to  
3 several communities. The City of San Diego, Helix Water District, and  
4 Sweetwater Authority provide retail surface water and/or groundwater supplies to  
5 users within cities of La Mesa, Lemon Grove, National City, and San Diego;  
6 portions of Chula Vista and El Cajon; and all or portions of the communities of  
7 Bonita, Lakeside, and Spring Valley. The County of San Diego–Campo Water  
8 and Sewer Maintenance District, Cuyamaca Water District, Decanso Community  
9 Services District, Julian Community Services District, Majestic Pines Community  
10 Services District, Wynola Water District, Lake Morena Oak Shores Mutual  
11 Water Company, Pine Hills Mutual Water Company, and Pine Valley Mutual  
12 Water Company rely upon groundwater to meet their water demands.  
13 Groundwater is not used for water supplies within Padre Dam Municipal Water  
14 District which serves the City of Santee and portions of the City of El Cajon; Otay  
15 Water District which serves portions of the cities of Chula Vista, El Cajon, and La  
16 Mesa, and several unincorporated communities; and California American Water  
17 which serves the City of Imperial Beach and portions of the cities of Chula Vista,  
18 Coronado, and San Diego. Sweetwater Authority operates the Desalination  
19 Facility to treat brackish groundwater (San Diego County LAFCO 2011).

20 **7.3.6.4 Western Riverside County and Southwestern San Bernardino**  
21 **County**

22 The areas within the SWP service area in western and central Riverside County  
23 and southern San Bernardino County in the Southern California Region include  
24 the Upper Santa Ana Valley Groundwater Basin in Riverside and San Bernardino  
25 counties; the Elsinore, San Jacinto Groundwater Basin in Riverside County; and  
26 the Temecula Valley Groundwater Basin in Riverside and San Diego counties, as  
27 shown in Figure 7.12.

28 **7.3.6.4.1 Hydrogeology and Groundwater Conditions**

29 *Upper Santa Ana Valley Groundwater Basin*

30 The Upper Santa Ana Valley Groundwater Basin consists of the Cucamonga,  
31 Chino, Riverside-Arlington, Temescal, Rialto-Colton, Cajon, Bunker Hill,  
32 Yucaipa, and San Timoteo groundwater subbasins.

33 *Cucamonga Subbasin*

34 The Cucamonga subbasin is located within San Bernardino County in the upper  
35 Santa Ana River watershed (DWR 2004 cd; MWDSC 2007). Groundwater is  
36 contained within the basin by the Red Hill fault. The water bearing formations  
37 are mainly alluvium of gravel, sand, and silt with beds of compacted clay.  
38 Groundwater is recharged naturally from precipitation and stream flows, water  
39 discharged to spreading basins, and runoff that flows into the streams from  
40 irrigated lands, including lands irrigated with SWP water. The groundwater is  
41 characterized as calcium-sodium bicarbonate with moderate to high TDS and  
42 nitrates, and localized areas with high volatile organic compounds, perchlorate,  
43 and dibromochloropropane (DBCP) (MWDSC 2007).

1 The Cucamonga subbasin was designated by the CASGEM program as medium  
2 priority.

3 *Chino Subbasin*

4 The Chino subbasin is located in San Bernardino County. The Chino subbasin is  
5 composed of alluvial material. The Rialto-Colton, San Jose, and the Cucamonga  
6 faults act as groundwater flow barriers (DWR 2006z). Along the southern  
7 boundary of the subbasin, groundwater can rise to the elevation of the Santa Ana  
8 River and be discharged into the stream. Groundwater is recharged naturally  
9 from precipitation and stream flows along the Santa Ana River and its tributaries,  
10 water discharged to spreading basins, and runoff that flows into the streams from  
11 irrigated lands, including lands irrigated with SWP water.

12 The Chino subbasin is characterized with high TDS and nitrate concentrations and  
13 localized areas of high volatile organic compounds, and perchlorate  
14 (MWDC 2007).

15 The Chino subbasin was designated by the CASGEM program as high priority.

16 *Riverside-Arlington Subbasin*

17 The Riverside-Arlington subbasin is located within the Santa Ana River Valley in  
18 southwestern San Bernardino County and northwestern Riverside County  
19 (DWR 2004ce). Water bearing formations include alluvial deposits of sand,  
20 gravel, silt, and clay. The Rialto-Colton Fault separates this subbasin from the  
21 Rialto-Colton subbasin. The Riverside and Arlington portions of the subbasin are  
22 also separated. Groundwater flows to the northwest and to the Arlington Gap in  
23 the southwest area of the subbasin; and continues into the Temescal subbasin.  
24 Groundwater is recharged naturally from precipitation and stream flows in the  
25 Santa Ana River, and flow from adjacent subbasins. The groundwater is  
26 characterized as calcium-sodium bicarbonate with moderate to high TDS and  
27 nitrates, and localized areas with high volatile organic compounds, perchlorate,  
28 and DBCP (MWDC 2007).

29 The Riverside-Arlington subbasin was designated by the CASGEM program as  
30 high priority.

31 *Temescal Subbasin*

32 The Temescal subbasin is located within the Santa Ana River Valley in Riverside  
33 County. Water bearing formations consist of alluvium bounded by the Elsinore  
34 fault zone on the west and the Chino fault zone on the northwest (DWR 2006aa).  
35 Groundwater is recharged naturally from precipitation and stream flows in the  
36 tributaries of the Santa Ana River. The groundwater is characterized as calcium-  
37 sodium bicarbonate with moderate to high TDS and nitrates, and localized areas  
38 with high volatile organic compounds, perchlorate, iron, and manganese  
39 (MWDC 2007).

40 The Temescal subbasin was designated by the CASGEM program as medium  
41 priority.

1           *Cajon Subbasin*

2   The Cajon subbasin is located within the upper Santa Ana River Valley in San  
3   Bernardino County. Water bearing formations consist of alluvium bounded by  
4   the San Andreas Fault zone on the south and impermeable rock formations on the  
5   east and west (DWR 2004cf). Groundwater is recharged naturally from  
6   precipitation, stream flows in the tributaries of the Santa Ana River, and runoff  
7   that flows into the streams from irrigated lands, including lands irrigated with  
8   SWP water. The groundwater quality is good for the beneficial uses.

9   The Cajon subbasin was designated by the CASGEM program as very low  
10   priority.

11           *Rialto-Colton Subbasin*

12   The Rialto-Colton subbasin is located within the upper Santa Ana River Valley in  
13   southwestern San Bernardino County and northwestern Riverside County. Water  
14   bearing formations consist of alluvium bounded by the Rialto-Colton and San  
15   Jacinto fault zones (DWR 2004cg). Groundwater is recharged naturally from  
16   precipitation and stream flows. The groundwater quality is good for the  
17   beneficial uses with localized areas of high volatile organic compounds.

18   The Rialto-Colton subbasin was designated by the CASGEM program as medium  
19   priority.

20           *Bunker Hill Subbasin*

21   The Bunker Hill subbasin is located in San Bernardino County. The water  
22   bearing formations include alluvium of sand, gravel, and boulders with deposits  
23   of silt and clay bounded by the Rialto-Colton and San Jacinto fault zones  
24   (DWR 2004ch). Groundwater is recharged naturally from precipitation, stream  
25   flows in the Santa Ana River and its tributaries, water discharged to spreading  
26   basins, and runoff that flows into the streams from irrigated lands, including lands  
27   irrigated with SWP water. The groundwater quality is good for the beneficial  
28   uses. The groundwater is characterized as calcium- bicarbonate with localized  
29   areas of high volatile organic compounds and perchlorate within several  
30   contamination plumes (*Lockheed Martin Corporation v. United States, Civil*  
31   *Action No. 2008-1160*).

32   The Bunker Hill subbasin was designated by the CASGEM program as high  
33   priority.

34           *Yucaipa Subbasin*

35   The Yucaipa subbasin is located within the upper Santa Ana River Valley in San  
36   Bernardino County. Water bearing formations include alluvial deposits of sand,  
37   gravel, boulders, silt, and clay (DWR 2004ci). Several fault zones restrict  
38   groundwater movement. The San Timoteo formation along the western boundary  
39   of the basin causes the water to rise to the elevation of the San Timoteo Wash, a  
40   tributary of the Santa Ana River. Groundwater is recharged naturally from  
41   precipitation and stream flows, and water discharged to recharge basins. The  
42   groundwater is characterized as calcium-sodium bicarbonate with moderate TDS

1 and high nitrate concentrations, and localized areas with high volatile organic  
2 compounds.

3 The Yucaipa subbasin was designated by the CASGEM program as medium  
4 priority.

5 *San Timoteo Subbasin*

6 The San Timoteo subbasin is located within the upper Santa Ana River Valley in  
7 Riverside County. Water bearing formations include alluvial deposits of gravel,  
8 silt, and clay (DWR 2004cj). Several fault zones restrict groundwater movement.  
9 Groundwater is recharged naturally from precipitation and stream flows, and  
10 water discharged to recharge basins. The groundwater is characterized as  
11 calcium-sodium bicarbonate and good quality for the beneficial uses.

12 The San Timoteo subbasin was designated by the CASGEM program as medium  
13 priority.

14 *San Jacinto Groundwater Basin*

15 The San Jacinto Groundwater Basin is located in upper Santa Ana River Valley in  
16 Riverside County, and underlies the San Jacinto, Perris, Moreno and Menifee  
17 valleys and Lake Perris. The water bearing formations are alluvium over  
18 crystalline basement rock (DWR 2006ab). Several fault zones restrict  
19 groundwater movement. Groundwater is recharged naturally from precipitation  
20 and stream flows along the San Jacinto River and its tributaries, percolation from  
21 Lake Perris, and water discharged to recharge basins. The groundwater is  
22 characterized as calcium-sodium bicarbonate with high TDS and nitrate  
23 concentrations and localized areas with high iron, manganese, sulfides, volatile  
24 organic compounds, and perchlorate (DWR 2006ac; MWDSC 2007).

25 The San Jacinto Groundwater Basin was designated by the CASGEM program as  
26 high priority.

27 *Elsinore Groundwater Basin*

28 The Elsinore Groundwater Basin is located in upper Santa Ana River Valley in  
29 Riverside County. The water bearing formations are alluvial fan, floodplain, and  
30 lacustrine deposits underlain by alluvium of gravel, sand, silt, and clay  
31 (DWR 2006ac). Several fault zones restrict groundwater movement.  
32 Groundwater is recharged naturally from precipitation and stream flows along the  
33 San Jacinto River, and water discharged to recharge basins. The groundwater is  
34 characterized as calcium-sodium bicarbonate with moderate salinity and localized  
35 areas with high fluoride, arsenic, nitrate, iron, manganese, volatile organic  
36 compounds, and perchlorate (DWR 2006ac; MWDSC 2007).

37 The Elsinore Groundwater Basin was designated by the CASGEM program as  
38 high priority.

39 *Temecula Valley Groundwater Basin*

40 The Temecula Valley Groundwater Basin is located in the upper Santa Margarita  
41 River watershed within Riverside and San Diego counties. The water bearing  
42 formations are alluvium of sand, tuff, and silt underlain by fractured bedrock

1 (DWR 2004ck). Several fault zones restrict groundwater movement.  
2 Groundwater is recharged naturally from precipitation and stream flows. The  
3 groundwater is characterized as calcium-sodium bicarbonate with high TDS,  
4 fluoride, nitrate, volatile organic compounds, and perchlorate (DWR 2006ac;  
5 MWDC 2007).

6 The Temecula Valley Groundwater Basin was designated by the CASGEM  
7 program as high priority.

#### 8 **7.3.6.4.2 Groundwater Use and Management**

##### 9 *Upper Santa Ana Valley Groundwater Basin*

10 The Upper Santa Ana Valley Groundwater Basin consists of the Cucamonga,  
11 Chino, Riverside-Arlington, Temescal, Rialto-Colton, Cajon, Bunker Hill,  
12 Yucaipa, and San Timoteo groundwater subbasins.

##### 13 *Cucamonga and Chino Subbasins*

14 The communities in the Cucamonga and Chino subbasins use a combination of  
15 surface water and groundwater to meet water demands (City of Chino 2011; City  
16 of Ontario 2011; City of Pomona 2011; City of Upland 2011; Cucamonga Valley  
17 WD 2011; FWC 2011; JCSD 2011; MWDC 2007; MVWD 2011; SAWC 2011;  
18 WMWD 2011). The cities of Chino, Ontario, Pomona, and Upland; Cucamonga  
19 Valley Water District, Jurupa Community Services District, Monte Vista Water  
20 District, and Western Municipal Water District; San Antonio Water Company,  
21 Fontana Water Company, Santa Ana River Water Company, and Marygold  
22 Mutual Water Company, and Golden State Water Company provide wholesale  
23 and/or retail water supplies, including groundwater, to users within their  
24 communities and to portions of the City of Rialto, Montclair, Rancho Cucamonga,  
25 and San Antonio Heights.

26 The Cucamonga subbasin was adjudicated in 1958 to allocate groundwater rights  
27 in the basin and surface water rights to Cucamonga Creek (City of Chino 2011;  
28 Cucamonga Valley WD 2011; MWDC 2007). The water supplies are allocated  
29 to the Cucamonga Valley Water District, San Antonio Water Company, and the  
30 West End Consolidated Water Company. The City of Upland has agreements  
31 with San Antonio Water Company and the West End Consolidated Water  
32 Company to divert from the subbasin.

33 The Chino subbasin was adjudicated in 1978 through the Chino Basin Judgment  
34 which established the Chino Basin Watermaster to manage the subbasin and  
35 enforce the provisions of the judgment (City of Chino 2011; Cucamonga Valley  
36 WD 2011; MWDC 2007). The judgment and subsequent agreements allocated  
37 the available safe yield to three categories, or pools: Overlying Agricultural Pool,  
38 including dairies, farms, and the State of California; Overlying Non-Agricultural  
39 Pool for industrial users; and the Appropriative Pool Committee, including local  
40 cities, public water agencies, and private water companies. The judgment and  
41 subsequent agreements included provisions for reallocation of water rights,  
42 groundwater replenishment if the subbasin is operated in a controlled overdraft  
43 condition, and development of a groundwater management plan. Through “Peace

1 Agreements” adopted in 2000 and amended in 2004, included provisions to allow:  
 2 members of the Overlying Non-Agricultural Pool to transfer their water within  
 3 their pool or to the Watermaster, appropriators to provide water service to  
 4 overlying lands, and the Watermaster to allocate unallocated safe yield. The  
 5 Peace Agreement also addressed use of local storage facilities, management of the  
 6 subbasin under the Dry Year Yield program when imported water, including SWP  
 7 water, is not fully available. Groundwater replenishment is allowed through  
 8 spreading basins, percolation, groundwater injection, and in-lieu use of other  
 9 water supplies, including SWP water. The Chino Basin Watermaster also was  
 10 required to develop an Optimum Basin Management Plan, adopted in 1998, to  
 11 address approaches that would enhance basin water supplies, protect and enhance  
 12 water quality, enhance management of the basin, and equitably finance  
 13 implementation of programs identified in the plan. The Peace II Agreement was  
 14 adopted in 2007 addressed procedures related to basin reoperation under  
 15 controlled overdraft conditions using the Chino Desalters to meet the  
 16 replenishment obligation and to maintain hydraulic control in the subbasin, and  
 17 transfers. The Groundwater Recharge Master Plan update was prepared by the  
 18 Watermaster in 2010.

19 The Santa Ana Regional Water Quality Control Board adopted a Water Quality  
 20 Control Plan in 2004 for the entire Santa Ana River Basin which included a  
 21 Maximum Benefit Basin Plan, recommended by the Chino Basin Watermaster  
 22 and the Inland Empire Utilities Agency. The plan established water quality  
 23 objectives in groundwater quality objectives for TDS and Total Inorganic  
 24 Nitrogen and wasteload allocations to allow use of recycled water for  
 25 groundwater recharge. The Maximum Benefit Basin Plan includes commitments  
 26 for surface water and groundwater monitoring programs; implementation of up to  
 27 40 million gallons/day of treated groundwater at desalters; implementation of  
 28 recharge facilities, conjunctive use programs, and recycled water quality  
 29 management programs; and groundwater management to provide hydraulic  
 30 controls to protect the Santa Ana River water quality.

31 Operations of the Chino Basin portion of the upper Santa Ana River are also  
 32 affected by surface water right judgments administered by the Santa Ana River  
 33 Watermaster.

34 A large portion of the natural runoff in the upper Santa Ana River watershed is  
 35 captured and used to recharge the groundwater aquifers. Flood control channels  
 36 and percolation basins are operated by San Bernardino County Flood Control  
 37 District to allow for flood control and groundwater recharge (MWDSC 2007).  
 38 Groundwater recharge also occurs in spreading basins operated by the City of  
 39 Upland, San Antonio Water Company, and San Antonio Water Company. The  
 40 Chino Basin Water Conservation District operates percolation ponds and  
 41 spreading basins to facilitate groundwater recharge (IEUA 2011).

42 The Inland Empire Utilities Agency manages production and treatment of  
 43 recycled water supplies that are used in groundwater recharge operations and as  
 44 part of conjunctive use programs in the cities of Chino, Chino Hills, Ontario, and  
 45 Upland; and in the service areas of the Cucamonga Valley Water District, Monte



1 Vista Water District, Fontana Water Company, and San Antonio Water Company  
2 (IEUA 2011). The district is a member of the Chino Basin Watermaster Board of  
3 Directors. The Inland Empire Utilities Agency operates several recharge facilities  
4 in the Chino subbasin. Recharge water comes from three sources: recycled water,  
5 stormwater, and imported SWP water. The Inland Empire Utilities Agency  
6 operates the Chino Desalter Authority's Chino I and Chino II Desalters that treat  
7 water from 22 wells. The Chino Desalter Authority is a joint powers authority  
8 that includes the cities of Chino, Chino Hills, Norco, and Ontario; and the Jurupa  
9 Community Services District, Santa Ana River Water Company, Western  
10 Municipal Water District, and Inland Empire Utilities Agency. The treated water  
11 from the desalters is used for potable water supplies, groundwater recharge with  
12 water with reduced salts and nitrates, and improved water quality of the Santa  
13 Ana River.

14 *Riverside-Arlington and Temescal Subbasins*

15 The communities in the Riverside-Arlington and Temescal subbasins use a  
16 combination of surface water and groundwater to meet water demands (City of  
17 Corona 2011; City of Norco 2014; City of Rialto 2011; City of Riverside 2011;  
18 JCSD 2011; MWDSC 2007; RCWD 2011; SBVMWD 2011; WMWD 2011).  
19 The San Bernardino Valley Municipal Water District and Western Municipal  
20 Water District provide wholesale and retail water supplies, including  
21 groundwater, in the areas that overlay the Riverside-Arlington and Temescal  
22 subbasins. The cities of Colton, Corona, Norco, Rialto, and Riverside; Elsinore  
23 Valley Municipal Water District; Jurupa Community Services District, Lee Lake  
24 Water District; Rubidoux Community Services District, San Bernardino Valley  
25 Municipal Water District, Western Municipal Water District, and West Valley  
26 Water District; and Box Springs Mutual Water Company, Riverside Highland  
27 Mutual Water Company, and Terrace Water Company provide retail water  
28 supplies, including groundwater, to users within their communities. The Jurupa  
29 Community Services District uses wells within the Riverside-Arlington subbasin  
30 for non-potable uses (JCSD 2011).

31 The Riverside portion of the Riverside-Arlington subbasin was adjudicated in  
32 1969 through the stipulated judgment for the *Western Municipal Water District of*  
33 *Riverside County et al. versus East San Bernardino County Water District, et al.*  
34 The judgment provided average annual extraction volumes and replenishment  
35 schedules for the separate sections of the subbasin as defined by the San  
36 Bernardino County and Riverside County boundary (Riverside North and  
37 Riverside South portions of the subbasin) (City of Riverside 2011; MWDSC  
38 2007). Within the Riverside North portion, the judgment affects only withdrawals  
39 that are to be used in Riverside County because withdrawals for use of water in  
40 San Bernardino County are not limited. The Western-San Bernardino  
41 Watermaster manages the monitoring and reporting of groundwater conditions of  
42 the Riverside portion of the subbasin.

43 The northern portion of the Riverside portion of the subbasin also was part of the  
44 1969 judgment in the *Orange County Water District v. City of Chino et al.* This  
45 judgment primarily includes the Bunker Hill subbasin and small portions of the

1 northern Riverside, Rialto-Colton, and Yucaipa subbasins; and requires minimum  
 2 downstream flows into the lower Santa Ana River (SBVMWD 2011). To meet  
 3 the flow obligations, the San Bernardino Valley Municipal Water District is  
 4 responsible to manage groundwater and surface waters within the San Bernardino  
 5 Basin Area, as defined in the judgment. The district manages the groundwater by  
 6 allocation of groundwater withdrawal amounts and requiring replenishment when  
 7 additional groundwater is withdrawn.

8 The Arlington portion of the Riverside-Arlington subbasin and the Temescal  
 9 subbasins are not adjudicated (City of Corona 2011; MWDCS 2007). In 2008, an  
 10 agreement was adopted between Elsinore Valley Municipal Water District and the  
 11 City of Corona for use of water from the southern portion of the Temescal  
 12 subbasin.

13 The City of Riverside operates two water treatment plants as part of the North  
 14 Riverside Water Project to remove volatile organic compounds. The City of  
 15 Corona operates the Temescal Basin Desalter Treatment Plant/Facility and the  
 16 Western Municipal Water District operates the Arlington Desalter (City of Corona  
 17 2011; WMWD 2011) to reduce TDS. The City of Norco operates a groundwater  
 18 treatment plant to reduce iron, manganese, and hydrogen sulfide (City of  
 19 Norco 2014).

20 *Cajon, Rialto-Colton, Bunker Hill, Yucaipa, and San Timoteo Subbasins*

21 The communities in the Cajon, Rialto-Colton, Bunker Hill, Yucaipa, and San  
 22 Timoteo subbasins use a combination of surface water and groundwater to meet  
 23 water demands (City of Rialto 2011; City of Riverside 2011; MWDCS 2007;  
 24 SBVMWD 2011; YVWD 2011; WMWD 2011; West Valley WD 2014a). The  
 25 San Bernardino Valley Municipal Water District and Western Municipal Water  
 26 District provide wholesale and retail water supplies, including groundwater, in the  
 27 areas that overlay the Cajon, Rialto-Colton, Bunker Hill, Yucaipa, and San  
 28 Timoteo subbasins. The cities of Colton, Loma Linda, Redlands, Rialto,  
 29 Riverside, and San Bernardino; Beaumont-Cherry Valley Water District, East  
 30 Valley Water District, South Mesa Water District, West Valley Water District,  
 31 Western Municipal Water District, West Valley Water District, and Yucaipa  
 32 Valley Water District; and several private water companies provide retail water  
 33 supplies, including groundwater, to users within their communities and to portions  
 34 of the cities of Beaumont, Calimesa, and Yucaipa; the communities of Cherry  
 35 Valley, Mission Grove, Orange Crest, and Woodcrest; and numerous private  
 36 water companies.

37 Groundwater adjudication in these subbasins have occurred over the past 90  
 38 years. A portion of the Bunker Hill subbasin underlays the Lytle Creek watershed  
 39 (City of Rialto 2011). The remaining portion of the Lytle Creek watershed  
 40 overlays the Lytle Creek groundwater basin that is not included in the DWR  
 41 Bulletin 118. The entire Lytle Creek groundwater basin, including the portion in  
 42 the Bunker Hill subbasin, is a major groundwater recharge source to the Bunker  
 43 Hill and Rialto-Colton subbasins; and was adjudicated in 1924. The stipulation of  
 44 the judgment allocated groundwater withdrawal right to the City of Rialto,

1 Citizens Land and Water Company, Lytle Creek Water and Improvement  
2 Company, Rancheria Water Company, and Mutual Water Company.

3 The Rialto-Colton subbasin was adjudicated in 1961 under the *Lytle Creek Water*  
4 *& Improvement Company vs. Fontana Ranchos Water Company et al* (City of  
5 Rialto 2011). The adjudication allocated groundwater withdrawals between the  
6 cities of Rialto and Colton, West Valley Water District, and Fontana Union Water  
7 Company based upon spring groundwater levels at three index wells between  
8 March and May of each water year. The groundwater subbasin is managed by the  
9 Rialto Basin Management Association. The stipulation of the judgment allocated  
10 groundwater withdrawal right to the City of Rialto, Citizens Land and Water  
11 Company, Lytle Creek Water and Improvement Company, and private well users.  
12 Use of this aquifer has been limited due to contamination with volatile organic  
13 compounds which are currently being treated. The City of Rialto also has  
14 agreements with San Bernardino Municipal Water District to store SWP water in  
15 the Rialto subbasin. The city can withdraw the stored water without affecting the  
16 water allowed to be withdrawn under the 1961 decree.

17 As described above under the Riverside-Arlington and Temescal Subbasins  
18 section, in 1969 the stipulated judgment for the *Western Municipal Water District*  
19 *of Riverside County et al. versus East San Bernardino County Water District,*  
20 *et al.* to preserve the safe yield of the San Bernardino Basin Area through  
21 entitlements to groundwater withdrawals to protect the safe yield and  
22 establishment of replenishment schedules when the safe yield is exceeded (City of  
23 Rialto 2011; SBVMWD 2011). The San Bernardino Basin Area includes the  
24 Bunker Hill subbasin and portions of the Rialto-Colton and Yucaipa subbasins;  
25 and portions of the Mill Creek, Lytle Creek, and upper Santa Ana River  
26 watersheds. The Western-San Bernardino Watermaster, which includes Western  
27 Municipal Water District and San Bernardino Municipal Water District, manages  
28 the monitoring and reporting of groundwater conditions. The primary users of the  
29 groundwater under this decree include the cities of Colton, Loma Linda,  
30 Redlands, and Rialto; East Valley Water District, San Bernardino Municipal  
31 Water District, West Valley Water District, and Yucaipa Valley Water District;  
32 Riverside-Highland Water Company and 13 private water companies.

33 In 2002, the City of Beaumont, Beaumont-Cherry Valley Water District, South  
34 Mesa Water Company, and Yucaipa Valley Water District formed the San  
35 Timoteo Watershed Management Authority to enhance water supplies and water  
36 quality, manage groundwater in the Beaumont Basin (part of the San Timoteo  
37 subbasin), protect riparian habitat in San Timoteo Creek, and allocate benefits and  
38 costs of these programs (Beaumont Basin Watermaster 2013; SBVMWD 2011).  
39 One of the issues that the authority initiated was negotiations related to  
40 groundwater withdrawals by the City of Banning. A Stipulated Agreement was  
41 adopted in 2004 in accordance with the judgment for the *San Timoteo Watershed*  
42 *Management Authority, vs. City of Banning et al.* The judgment established a  
43 Watermaster committee of the cities of Banning and Beaumont, Beaumont-Cherry  
44 Valley Water District, South Mesa Water Company, and Yucaipa Valley Water

1 District. The judgment allocated groundwater supplies in a manner that allows  
2 for storage of groundwater recharge from spreading basins or in-lieu programs.

3 The Seven Oaks Accord, a settlement agreement, was signed by the City of  
4 Redlands; East Valley Water District, San Bernardino Valley Municipal Water  
5 District, and Western Municipal Water District; and Bear Valley Mutual Water  
6 Company, Lugonia Water Company, North Fork Water Company, and Redlands  
7 Water Company to recognize prior rights of water users of a portion of the natural  
8 flow of the Santa Ana River (SBVMWD 2011). The Seven Oaks Accord requires  
9 that San Bernardino Valley Municipal Water District, and Western Municipal  
10 Water District develop a groundwater spreading program to recharge the  
11 groundwater in cooperation with other parties to the accord to maintain relatively  
12 constant groundwater levels.

13 In 2005, the San Bernardino Valley Municipal Water District entered into an  
14 agreement with the San Bernardino Valley Water Conservation District to work  
15 cooperatively to develop and implement a groundwater management plan which  
16 includes groundwater banking programs (SBVMWD 2011).

17 The City of Rialto, San Bernardino Valley Municipal Water District, West Valley  
18 Water District, and Riverside Highland Water District have jointly constructed the  
19 Baseline Feeder to convey groundwater from the Bunker Hill subbasin to the  
20 Rialto area and West Valley Water District to be used in an in-lieu program that  
21 would reduce reliance on SWP water supplies (City of Rialto 2011; West Valley  
22 WD 2014c, 2014d).

23 West Valley Water District implemented a bioremediation wellhead treatment  
24 system (West Valley Water District 2014b).

25 *San Jacinto Groundwater Basin*

26 The communities in the San Jacinto Groundwater Basin use a combination of  
27 surface water and groundwater to meet water demands (City of Hemet 2011; City  
28 of San Jacinto 2011; EMWD 2011; LHMWD 2011; MWDSC 2007; RCWD  
29 2011). The Eastern Municipal Water District provides wholesale and retail water  
30 supplies, including groundwater, in the areas that overlay the San Jacinto  
31 Groundwater Basin. The cities of Hemet and San Jacinto; and Eastern Municipal  
32 Water District and Rancho California provide retail water supplies, including  
33 groundwater, to users within their communities and to portions of the cities of  
34 Menifee, Moreno Valley, Murrieta, and Temecula; Lake Hemet Municipal Water  
35 District; Nuevo Water Company and numerous private water companies; and the  
36 communities of Edgemont, Homeland, Juniper Flats, Lakeview, Mead Valley,  
37 North Perris Water System, Romoland, Sunnymead, Valle Vista, and Winchester.  
38 The City of Perris overlays a portion of the San Jacinto Groundwater Basin;  
39 however, the city does not use groundwater. A substantial portion of the  
40 groundwater supplies within the San Jacinto Groundwater Basin are used by  
41 agricultural water users.

42 The 1954 Fruitvale Judgment allows for Eastern Municipal Water District to  
43 withdraw water from the San Jacinto Groundwater Basin if the groundwater  
44 elevation is greater than a specified elevation (EMWD 2009, 2011, 2014). The

1 judgment includes a maximum withdrawal volume for use outside of the  
2 groundwater basin. There are further restrictions within the Canyon Basin  
3 subbasin of the San Jacinto Groundwater Basin. DWR worked with the cities of  
4 Hemet and San Jacinto, Lake Hemet Municipal Water District, Eastern Municipal  
5 Water District, and private groundwater companies to file a stipulated judgment in  
6 2007 to form a Watermaster to develop and implement the Hemet/San Jacinto  
7 Water Management Plan, including the Hemet/San Jacinto Integrated Recharge  
8 and Recovery Program, Recycled Water In-Lieu Project, and Hemet Filtration  
9 Plant. The stipulated judgment also limited groundwater withdrawals to protect  
10 the groundwater basin, provide for recharge programs, expand water production,  
11 and protect water quality. The program uses SWP water and San Jacinto River  
12 runoff to recharge the San Jacinto-Upper Pressure Groundwater Management  
13 Zone. In 2013, the judgment was filed with the court to adopt the Hemet/San  
14 Jacinto Water Management Plan and create the Watermaster Board.

15 The stipulated judgment also addressed methods to fulfil the Soboba Band of  
16 Luiseño Indians water rights in accordance with the findings of the Court for the  
17 *Soboba Band of Luiseño Indians Water Settlement Agreement* in 2006. In 2008,  
18 the Soboba Settlement Act was signed by the President of the United States to  
19 provide an annual water supply and provide funds for economic development.  
20 The legislation also provides funds to construct recharge facilities and provisions  
21 for the Soboba Tribe to participate in restoration efforts.

22 The Eastern Municipal Water District adopted the West San Jacinto Groundwater  
23 Basin Management Plan in 1995. The management plan includes the Nuevo  
24 Water Company, City of Moreno Valley, City of Perris, and McCanna Ranch  
25 Water Company (MWDSC 2007).

26 Eastern Municipal Water District operates two desalination plants to treat  
27 brackish water within the San Jacinto Groundwater Basin as part of the  
28 Groundwater Salinity Management Program (EMWD 2011). Other wells within  
29 the Eastern Municipal Water District also include treatment facilities to reduce  
30 hydrogen sulfide, iron, and/or manganese.

### 31 *Elsinore Groundwater Basin*

32 The communities in the Elsinore Groundwater Basin use a combination of surface  
33 water and groundwater to meet water demands (EVMWD 2011; MWDSC 2007).  
34 The Elsinore Valley Municipal Water District provides wholesale and retail water  
35 supplies, including groundwater, in the areas that overlay the Elsinore  
36 Groundwater Basin. The cities of Lake Elsinore, Canyon Lake, and Wildomar;  
37 Elsinore Valley Municipal Water District and Elsinore Water District; and Farm  
38 Mutual Water Company provide retail water supplies, including groundwater, to  
39 users within their communities and to portions of Cleveland Ranch, Farm,  
40 Horsethief Canyon, Lakeland Village, Meadowbrook, Rancho Capistrano –  
41 El Cariso Village, and Temescal Canyon.

42 The Elsinore Groundwater Basin is not adjudicated. The Elsinore Valley  
43 Municipal Water District was responsible for over 90 percent of the groundwater  
44 withdrawals in mid-2000s (EVMWD 2011). The Elsinore Basin Groundwater

1 Management Plan, adopted by Elsinore Valley Municipal Water District in 2005,  
2 identifies conjunctive use projects, including direct recharge projects. The direct  
3 recharge projects use imported water, including SWP water.

4 *Temecula Valley Groundwater Basin*

5 The communities in the Temecula Valley Groundwater Basin use a combination  
6 of surface water and groundwater to meet water demands (MWDSC 2007;  
7 RCSD 2011; WMWD 2011). The Rancho California Water District and Western  
8 Municipal Water District (including Murrieta County Water District) provide  
9 wholesale and retail water supplies, including groundwater, in the areas that  
10 overlay the Temecula Valley Groundwater Basin, including the cities of Murrieta  
11 and Temecula. The Pechanga Indian Reservation operates groundwater wells  
12 within the Temecula Valley Groundwater Basin (MWDSC 2007).

13 The Temecula Valley Groundwater Basin is located within the Santa Margarita  
14 River watershed. As described above for the San Mateo Valley, San Onofre  
15 Valley, and Santa Margarita Valley Groundwater Basins, the groundwater basins  
16 that contribute direct or indirect flows into the Santa Margarita River have been  
17 adjudicated and are managed by the Santa Margarita River Watermaster in  
18 accordance with the 1940 Stipulated Judgment, the 1966 Modified Final  
19 Judgment and Decree, and subsequent court orders (MWDSC 2007;  
20 RCWD 2011; SMRW 2011; WMWD 2011). The court-appointed steering  
21 committee for the Watermaster includes Eastern Municipal Water District,  
22 Fallbrook Public Utility District, Metropolitan Water District of Southern  
23 California, Pechanga Band of Luiseno Mission Indians of the Pechanga  
24 Reservation, Rancho California Water District, Western Municipal Water District,  
25 and Marine Corps Base Camp Pendleton. In accordance with the judgment, the  
26 Rancho California Water District prepares the annual Groundwater Audit and  
27 Recommended Groundwater Production Report that allocates groundwater  
28 withdrawals based upon rainfall, recharge area, and pumping capacity. The  
29 subsequent orders adopted following 1966 included the Cooperative Water  
30 Resource Management Agreement between Rancho California Water District and  
31 the Marine Corps Base Camp Pendleton to manage groundwater levels and  
32 surface water flows; water rights to Vail Lake on Temecula Creek; and an  
33 agreement between the Rancho California Water District and the Pechanga Band  
34 of Luiseno Mission Indians of the Pechanga Reservation.

35 Rancho California Water District provides imported water, including SWP water,  
36 and natural runoff released from Vail Lake to the Valle de Los Caballos Recharge  
37 Basins (RCWD 2011). The district also has implemented the Vail Lake  
38 Stabilization and Conjunctive Use Project to store imported water in Vail Lake for  
39 subsequent groundwater recharge (RCWD et al. 2014).

40 **7.3.6.5 Central Riverside County**

41 The areas within the SWP service area which receive Colorado River water in-  
42 lieu of SWP water deliveries are located within the Coachella Valley  
43 Groundwater Basin. The Coachella Valley Groundwater Basin includes the

1 Desert Hot Springs, Indio, Mission Creek, and San Gorgonio Pass subbasins, as  
2 shown in Figure 7.12.

### 3 **7.3.6.5.1 Hydrogeology and Groundwater Conditions**

4 The Coachella Valley Groundwater Basin underlies the entire floor of the  
5 Coachella Valley. Primary water-bearing materials in the Coachella Valley  
6 Groundwater Basin are unconsolidated alluvial deposits along the valley floor  
7 which consist of older alluvium and a thick sequence of poorly bedded coarse  
8 sand and gravel; terrace deposits under the surrounding foothills in the Mission  
9 Creek subbasin; and partly consolidated fine to coarse sandstone in the  
10 surrounding mountains in the San Gorgonio Pass subbasin (DWR 2004cm,  
11 2004cn, 2004co, 2004cp). The movement of groundwater is locally influenced by  
12 features such as faults, structural depressions, and constrictions; however,  
13 groundwater generally flows to the southeast towards the Salton Sea.  
14 Groundwater recharge occurs along stream beds and from groundwater inflows  
15 from adjacent subbasins. Within the Indio subbasin, groundwater also is  
16 recharged from spreading basins and injection wells.

17 The groundwater quality is characterized as calcium-sodium bicarbonate.  
18 Groundwater quality is adequate for community and agricultural water uses  
19 within the San Gorgonio Pass, Mission Creek, and Indio subbasins. There are  
20 localized areas with high fluoride near the Banning and San Andreas fault zones.  
21 Groundwater quality in the Desert Hot Springs subbasin is poor due to the  
22 geothermal activity which results in high sodium sulfate, TDS, and chlorides.  
23 The hot springs water is only used by a resort for bathing.

24 Desert Hot Springs Groundwater Basin was designated by the CASGEM program  
25 as low priority. Indio, Mission Creek, and San Gorgonio Pass groundwater basins  
26 were designated as medium priority.

### 27 **7.3.6.5.2 Groundwater Use and Management**

#### 28 *Coachella Valley Groundwater Basin*

29 The Coachella Valley Groundwater Basin includes the San Gorgonio Pass,  
30 Mission Creek, Desert Hot Springs, and Indio subbasins.

#### 31 *San Gorgonio Pass Subbasin*

32 The communities in the San Gorgonio Pass subbasin use a combination of surface  
33 water and groundwater to meet water demands (BCVWD 2013; City of Banning  
34 2011; SGPWA 2010). The City of Banning, Beaumont-Cherry Valley Water  
35 District, Cabazon Water District, and High Valley Water District provide retail  
36 water supplies, including groundwater, in the areas that overlay the San Gorgonio  
37 Pass subbasin, including the City of Banning and the eastern portion of the City of  
38 Beaumont; Banning Heights Mutual Water Company; and the community of  
39 Cabazon. The Morongo Band of Mission Indians operates groundwater wells  
40 within the San Gorgonio Pass subbasin.

41 The western portion of the San Gorgonio Pass subbasin is located within the  
42 Beaumont Basin (USGS 1974). As described above, the City of Beaumont,

1 Beaumont-Cherry Valley Water District, South Mesa Water Company, and  
 2 Yucaipa Valley Water District formed the San Timoteo Watershed Management  
 3 Authority to enhance water supplies and water quality, manage groundwater,  
 4 protect riparian habitat in San Timoteo Creek, and allocate benefits and costs of  
 5 these programs (Beaumont Basin Watermaster 2013). One of the issues that the  
 6 authority initiated was negotiations related to groundwater withdrawals by the  
 7 City of Banning. A Stipulated Agreement was adopted in 2004 in accordance  
 8 with the judgment for the *San Timoteo Watershed Management Authority, vs. City*  
 9 *of Banning et al.* The judgment established a Watermaster committee of the cities  
 10 of Banning and Beaumont, Beaumont-Cherry Valley Water District, South Mesa  
 11 Water Company, and Yucaipa Valley Water District. The judgment allocated  
 12 groundwater supplies in a manner that allows for storage of groundwater recharge  
 13 from spreading basins or in-lieu programs.

14 *Mission Creek, Desert Hot Springs, and Indio Subbasins*

15 The communities in the Mission Creek, Desert Hot Springs, and Indio subbasins  
 16 use a combination of surface water and groundwater to meet water demands (City  
 17 of Coachella 2011; CVWD 2011, 2012; DWA 2011; IWA 2010; MSWD 2011).  
 18 The City of Coachella, Coachella Valley Water District, Desert Water Agency,  
 19 Indio Water Authority, and Mission Springs Water District provide retail water  
 20 supplies, including groundwater, in the areas that overlay the Mission Creek,  
 21 Desert Hot Springs, and Indio subbasins, including the cities of Cathedral City,  
 22 Coachella, Desert Hot Springs, Indian Wells, Indio, La Quinta, Palm Desert, Palm  
 23 Springs, and Rancho Mirage; and the communities of Barton Canyon, Bermuda  
 24 Dunes, Bombay Beach, Desert Crest, Desert Edge, Indio Hills, Mecca, Mecca  
 25 Hills, Palm Springs Crest, Salton City, Thermal, and West Palm Springs Village.  
 26 The Cabazon Band of Mission Indians and the Torres-Martinez Desert Cahuilla  
 27 Indians operate groundwater wells within the subbasins.

28 The Coachella Valley Water District, Desert Water Agency, and Mission Springs  
 29 Water District all participate in groundwater management programs within the  
 30 subbasins (CVWD 2011, 2012; DWA 2011; MSWD 2011). These programs  
 31 include purchasing imported Colorado River water for groundwater recharge and  
 32 in-lieu programs, conjunctive use programs, and conservation programs.  
 33 Coachella Valley Water District and Desert Water Agency are SWP water  
 34 contractors. However, because no conveyance facilities exist to deliver the SWP  
 35 water, these districts have agreements with the Metropolitan Water District of  
 36 Southern California to exchange SWP water for Colorado River water  
 37 (CVWD 2012). Since 1973, these agencies have recharged more than 2.6 million  
 38 acre-feet of water in the groundwater basin with delivery of Colorado River water  
 39 to the Whitewater River Recharge Facility. The Metropolitan Water District of  
 40 Southern California also has an agreement with Coachella Valley Water District  
 41 and Desert Water Agency to store water in the Coachella Valley Groundwater  
 42 Basin. The Coachella Valley Water District also operates the Thomas E. Levy  
 43 Groundwater Replenishment Facility and the Martinez Canyon Pilot Recharge  
 44 Facility. Coachella Valley Water District and Desert Water Agency also provide  
 45 recycled water for in-lieu programs. The Coachella Valley Water District has



1 agreed to operate groundwater recharge facilities to store Colorado River water  
2 for Imperial Irrigation District (CVWD 2011).

3 These groundwater recharge programs and broader groundwater management  
4 programs for the Indio subbasin have been developed in accordance with the  
5 Whitewater Basin Water Management Plan developed by Coachella Valley Water  
6 District and Desert Water Agency, and the Coachella Valley Water Management  
7 Plan developed by Coachella Valley Water District (CVWD 2011, 2012;  
8 DWA 2011).

9 The Coachella Valley Water District, Desert Water Agency, and Mission Springs  
10 Water District jointly manage the Mission Creek subbasin in accordance with the  
11 2004 Mission Creek Settlement Agreement (DWA 2011; MSWD 2011). The  
12 Coachella Valley Water District and Desert Water Agency also manage portions  
13 of the subbasin in accordance with the 2003 Mission Creek Groundwater  
14 Replenishment Agreement. These agreements provide for the allocation of  
15 available Colorado River water under the SWP water exchange agreement with  
16 the Metropolitan Water District of Southern California between the Mission  
17 Creek and Indio (also known as the Whitewater) subbasins.

#### 18 **7.3.6.6 Antelope Valley and Mojave Valley**

19 The areas within the SWP service area in the Antelope Valley and Mojave Valley  
20 include Salt Wells Valley, Cuddeback Valley, Pilot Knob Valley, Grass Valley,  
21 Superior Valley, El Mirage Valley, Upper Mojave River Valley, Middle Mojave  
22 River Valley, Lower Mojave River Valley, Caves Canyon Valley, Langford  
23 Valley, Cronise Valley, Coyote Lake Valley, Kane Wash Area, Iron Ridge Area,  
24 Bessemer Valley, Lucerne Valley, Johnson Valley, Means Valley, Deadman  
25 Valley, Twentynine Palms Valley, Joshua Tree, Ames Valley, Copper Mountain  
26 Valley, Warren Valley, and Morongo Valley groundwater basins in San  
27 Bernardino County; Harper Valley and Fremont Valley groundwater basins in  
28 San Bernardino Kern counties; Lost Horse Valley in Riverside and San  
29 Bernardino counties; Antelope Valley Groundwater Basin in San Bernardino,  
30 Kern, and Los Angeles counties; and Indian Wells and Searles Valley  
31 groundwater basin in San Bernardino, Inyo, and Kern counties, as shown in  
32 Figure 7.13.

#### 33 **7.3.6.6.1 Hydrogeology and Groundwater Conditions**

##### 34 *Indian Wells Valley Groundwater Basin*

35 Indian Wells Valley Groundwater Basin is located in Inyo, Kern, and San  
36 Bernardino Counties. Water bearing formations consist of unconsolidated  
37 lakebed, stream, and alluvial fan deposits with upper and lower aquifers  
38 (DWR 2004cn). The lower aquifer is more productive and has a saturated  
39 thickness of approximately 1000 feet. The upper aquifer provides low yield and  
40 has low quality. The lower aquifer is considered unconfined in most of the valley.  
41 There is indication that some faults within the valley could obstruct groundwater  
42 flow. Groundwater is recharged from runoff on the southwest to northeast sides  
43 of the valley. Groundwater levels have been declining since 1945. Groundwater

1 quality varies throughout the groundwater basin from appropriate for beneficial  
2 uses to areas with poor water quality due to wastewater disposal practices. Areas  
3 near geothermal activity are characterized by high chloride, boron, and arsenic  
4 concentrations.

5 Indian Wells Valley Groundwater Basin was designated by the CASGEM  
6 program as medium priority.

7 *Salt Wells Valley Groundwater Basin*

8 Salt Wells Valley Groundwater Basin is located in San Bernardino County.  
9 Water bearing formations consist of unconsolidated to poorly consolidated  
10 alluvium (DWR 2004co). Groundwater is recharged from the Indian Wells  
11 Groundwater Basin and percolation of rainfall on the valley floor. The regional  
12 groundwater flow direction is towards the east into the Searles Valley  
13 Groundwater Basin. The groundwater has extremely high salinity, TDS, and  
14 boron.

15 Salt Wells Valley Groundwater Basin was designated by the CASGEM program  
16 as very low priority.

17 *Searles Valley Groundwater Basin*

18 Searles Valley Groundwater Basin is located in San Bernardino, Inyo, and Kern  
19 Counties. Water bearing formations consist of alluvium with unconsolidated to  
20 semi-consolidated deposits (DWR 2004cp). The Garlock fault may be a barrier to  
21 groundwater flow in the southern part of the basin. Groundwater is recharged  
22 from percolation of mountain runoff through the alluvial fan deposits and  
23 subsurface inflow from Salt Wells Valley and Pilot Knob Valley groundwater  
24 basins. Groundwater flows towards Searles Lake except in the northern portion  
25 of the basin where pumping by industrial water users has altered the groundwater  
26 flow. Groundwater levels near Searles Lake are close to the lake bed elevations.  
27 Groundwater quality is generally appropriate for beneficial uses with localized  
28 areas with high levels of fluoride and nitrate. In the vicinity of Searles Lake, the  
29 groundwater quality is poor with high levels of fluoride, boron, sodium, chloride,  
30 sulfate, and TDS.

31 Searles Valley Groundwater Basin was designated by the CASGEM program as  
32 very low priority.

33 *Cuddeback Valley, Pilot Knob Valley, Grass Valley, and Superior Valley,*  
34 *Groundwater Basins*

35 Cuddeback Valley, Pilot Knob Valley, Grass Valley, and Superior Valley  
36 Groundwater basins are located in northern San Bernardino County. Water  
37 bearing formations consist of unconsolidated to poorly consolidated alluvium  
38 (DWR 2004cq, 2004cr, 2004cs, 2004ct). Several fault zones restrict groundwater  
39 movement. Groundwater is recharged in the Cuddeback Valley, Pilot Knob  
40 Valley, Grass Valley, and Superior Valley groundwater basins primarily through  
41 groundwater inflow into the basins and percolation of precipitation at the valley  
42 margins. Groundwater within Cuddeback Valley, Grass Valley, and Superior  
43 Valley groundwater basins flows towards the Harper Valley Groundwater Basin.

1 Groundwater in the Cuddeback Valley Groundwater Basin also flows towards  
2 Cuddeback Lake. Groundwater in Pilot Knob Valley Groundwater Basin flows  
3 towards the Searles Valley and Brown Mountain Valley groundwater basins.  
4 Groundwater quality is characterized as sodium chloride-bicarbonate with high  
5 salinity and TDS in the Cuddeback Valley Groundwater Basin and high  
6 concentrations of sodium and fluoride in the Superior Valley Groundwater Basin.  
7 Cuddeback Valley, Pilot Knob Valley, Grass Valley, and Superior Valley  
8 groundwater basins were designated by the CASGEM program as very low  
9 priority.

10 *Harper Valley Groundwater Basin*

11 Harper Valley Groundwater Basin is located in western San Bernardino County  
12 and eastern Kern County. Water bearing formations consist of lacustrine deposits  
13 and unconsolidated to semi-consolidated alluvial deposits (DWR 2004cu). The  
14 alluvial deposits at the center of the basin are generally more interbedded with  
15 lacustrine silty clay. Faults in the Harper Valley Groundwater Basin cause at least  
16 partial barriers to groundwater flow. Groundwater is recharged from percolation  
17 of rainfall and runoff through alluvial fan material at the valley edges and  
18 underflow from Cuddeback Valley, Grass Valley, Superior Valley, and Middle  
19 Mojave River Valley groundwater basins. Regional groundwater flows toward  
20 the south and Harper Lake. Groundwater quality is characterized as sodium  
21 chloride-bicarbonate with high concentrations of boron, fluoride, and sodium.

22 Harper Valley Groundwater Basin was designated by the CASGEM program as  
23 low priority.

24 *Fremont Valley Groundwater Basin*

25 The Fremont Valley Groundwater Basin is located in eastern Kern County and in  
26 northwestern San Bernardino County. Water bearing formations consist of  
27 alluvial and lacustrine deposits (DWR 2004cv). The alluvial deposits are  
28 generally unconfined and the lacustrine deposits may exhibit locally confined  
29 conditions. Fault zones, including the Garlock and El Paso fault zones, are  
30 barriers to groundwater flow. Groundwater is recharged along streambeds in the  
31 Sierra Nevada Mountains. Groundwater flow is generally toward the center of the  
32 valley and Koehn Lake. Groundwater is characterized as sodium bicarbonate  
33 with high concentrations of calcium, chloride, fluoride, and sodium.

34 Fremont Valley Groundwater Basin was designated by the CASGEM program as  
35 low priority.

36 *Antelope Valley Groundwater Basin*

37 The Antelope Valley Groundwater Basin is located in Kern, Los Angeles, and San  
38 Bernardino counties. Water bearing formations consist of unconsolidated alluvial  
39 and lacustrine deposits consisting of compact gravels, sand, silt, and clay (DWR  
40 2004cw). Several fault zones restrict groundwater movement. Groundwater is  
41 recharged along streams from the surrounding mountains, including Big Rock  
42 Creek and Little Rock Creek. The regional groundwater flow direction  
43 historically was towards the dry lakebeds of Rosamond, Rogers, and Buckhorn

1 Lakes. However, extensive groundwater pumping has caused subsidence and  
2 reduced the groundwater storage and flow direction. The groundwater is  
3 characterized as sodium bicarbonate with localized areas of high nitrate and  
4 boron.

5 Antelope Valley Groundwater Basin was designated by the CASGEM program as  
6 high priority.

7 *El Mirage Valley Groundwater Basin*

8 The El Mirage Valley Groundwater Basin is located in San Bernardino County.

9 Water bearing formations consist of unconsolidated to semi-consolidated

10 alluvium (DWR 2003c). Several fault zones restrict groundwater movement.

11 Groundwater is recharged in alluvial deposits at the mouth of Sheep Creek. The

12 regional groundwater flow direction is generally north toward El Mirage Lake.

13 The groundwater is characterized as sodium bicarbonate with localized areas of

14 high levels of fluoride, sulfate, sodium, and TDS.

15 El Mirage Valley Groundwater Basin was designated by the CASGEM program  
16 as medium priority.

17 *Upper Mojave River Valley, Middle Mojave River Valley, Lower Mojave River  
18 Valley, and Caves Canyon Valley Groundwater Basins*

19 The Upper Mojave River Valley, Middle Mojave River Valley, Lower Mojave

20 River Valley, and Caves Canyon Valley groundwater basins are located along the

21 Mojave River in southwestern and central San Bernardino County. The water

22 bearing formations consist of alluvial fan deposits overlain by river channel,

23 floodplain, or lake deposits (DWR 2004cx, 2004cy, 2003d, 2003e). The general

24 groundwater flow direction follows the Mojave River north through the Upper

25 Mojave River Valley Groundwater Basin, and east through the Middle Mojave

26 River Valley, Lower Mojave River Valley, and Caves Canyon Valley

27 groundwater basins. Several fault zones restrict groundwater movement.

28 Groundwater is recharged from precipitation on the valley floor, underflow from

29 the Mojave River, streamflow, and flow between the basins. Treated wastewater

30 and irrigation return flows also provide a source of groundwater recharge in these

31 basins. Groundwater quality in the Upper Mojave River Valley, Middle Mojave

32 River Valley, Lower Mojave River Valley, and Caves Canyon Valley

33 groundwater basins varies throughout the basins due to geological formations and

34 includes areas dominated by calcium bicarbonate, calcium-sodium bicarbonate,

35 calcium-sodium sulfate, sodium-calcium sulfate, and sodium sulfate-chloride.

36 There are localized areas of high nitrate, iron, and manganese in the Upper

37 Mojave River Valley Groundwater Basin; and areas with high nitrates, fluoride,

38 and boron in the Middle Mojave River Valley and Lower Mojave River Valley

39 groundwater basins. Localized areas with high volatile organic compounds occur

40 in the Upper Mojave River Valley and Lower Mojave River Valley groundwater

41 basins.

42 Upper Mojave River Valley Groundwater Basin was designated by the CASGEM

43 program as high priority. Lower Mojave River Valley Groundwater Basin was

44 designated as medium priority. Middle Mojave River Valley Groundwater Basin

1 was designated as low priority. Caves Canyon Valley Groundwater Basin was  
2 designated as very low priority.

3 *Langford Valley Groundwater–Langford Well Lake Subbasin, and Cronise Valley*  
4 *and Coyote Lake Valley Groundwater Basins*

5 The Langford Well Lake subbasin and the Cronise Valley and Coyote Lake  
6 Valley groundwater basins are located in central San Bernardino County. Water  
7 bearing formations consist of unconsolidated to semi-consolidated alluvium  
8 (DWR 2004cz, 2004da, 2004db). Groundwater is recharged from precipitation,  
9 stream flows into alluvial deposits along the mountains at the basin boundaries,  
10 and subsurface inflow from other groundwater basins including the Superior  
11 Valley Groundwater Basin. Groundwater quality is poor due to high  
12 concentrations of fluoride, boron, and TDS, and localized areas with high iron in  
13 the Langford Well Lake subbasin.

14 Langford Well Lake subbasin and the Cronise Valley and Coyote Lake Valley  
15 groundwater basins were designated by the CASGEM program as very low  
16 priority.

17 *Kane Wash Area Groundwater Basin*

18 The Kane Wash Area Groundwater Basin is located in San Bernardino County.  
19 Water bearing formations consist of unconsolidated to semi-consolidated  
20 alluvium with undissected coarse gravel to sand in the younger deposits and  
21 dissected gravel sand and silt in the older deposits (DWR 2004dc). Groundwater  
22 is recharged from precipitation and stream flows. The groundwater is  
23 characterized as sodium sulfate-bicarbonate with moderate TDS concentrations.

24 Kane Wash Area Groundwater Basin was designated by the CASGEM program  
25 as very low priority.

26 *Iron Ridge Area Groundwater Basin*

27 The Iron Ridge Area Groundwater Basin is located in southern San Bernardino  
28 County. Water bearing formations consist of unconsolidated to semi-consolidated  
29 alluvium (DWR 2004dd). Several fault zones restrict groundwater movement.  
30 Groundwater is recharged from precipitation and stream flows from the nearby  
31 mountains.

32 Iron Ridge Area Groundwater Basin was designated by the CASGEM program as  
33 very low priority.

34 *Bessemer Valley Groundwater Basin*

35 The Bessemer Valley Groundwater Basin is located in eastern San Bernardino  
36 County. Water bearing formations consist of unconsolidated to semi-consolidated  
37 alluvial deposits, fanglomerate, and playa lake deposits (DWR 2004de). More  
38 recent deposits consist of unconsolidated, undissected coarse gravel to sand.  
39 Older deposits consist of gravel, sand, and silt from dissected alluvial fans.  
40 Several fault zones restrict groundwater movement. Groundwater is recharged  
41 from precipitation and stream flows at the valley margins.

1 Bessemer Valley Groundwater Basin was designated by the CASGEM program  
2 as very low priority.

3 *Lucerne Valley Groundwater Basin*

4 The Lucerne Valley Groundwater basin is located in San Bernardino County.  
5 Water bearing formations consist of unconsolidated or semi-consolidated alluvial  
6 deposits and dune sand deposits composed of gravel, sand, silt, clay, and  
7 occasional boulders (DWR 2004df). Several fault zones restrict groundwater  
8 movement. Groundwater is recharged from precipitation and stream flows.  
9 Groundwater levels have declined throughout the basin and caused subsidence.  
10 The groundwater is characterized as calcium-magnesium bicarbonate or  
11 magnesium-sodium sulfate with TDS and nitrates.

12 Lucerne Valley Groundwater Basin was designated by the CASGEM program  
13 low priority.

14 *Johnson Valley Groundwater Basin*

15 The Johnson Valley Groundwater Basin is located in San Bernardino County and  
16 includes the Soggy Lake and Upper Johnson Valley subbasins. Water bearing  
17 formations in both subbasins consist of alluvial deposits with mainly sand and  
18 gravel in the Soggy Lake subbasin and silt, clay, sand, and gravel in the Upper  
19 Johnson Valley subbasin (DWR 2004dg, 2004dh). Springs occur throughout the  
20 Soggy Lake subbasin. Groundwater flows from Soggy Lake subbasin into the  
21 Upper Johnson Valley subbasin. Several fault zones restrict groundwater  
22 movement. The groundwater is characterized with moderate to high TDS and  
23 localized areas with high fluoride.

24 Johnson Valley Groundwater Basin was designated by the CASGEM program as  
25 very low priority.

26 *Means Valley Groundwater Basin*

27 The Means Valley Groundwater Basin is located in south central part of San  
28 Bernardino County. Water bearing formations consist of alluvial and lacustrine  
29 deposits with unconsolidated fine to coarse grained sand, pebbles, and boulders;  
30 and varying silt and clay deposits throughout the basin (DWR 2004di). Several  
31 fault zones restrict groundwater movement. Groundwater is recharged from  
32 precipitation and subsurface inflow from the Johnson Valley Groundwater Basin.  
33 The groundwater is characterized as sodium-chloride bicarbonate with high TDS,  
34 fluoride, and nitrates.

35 Means Valley Groundwater Basin was designated by the CASGEM program as  
36 very low priority.

37 *Deadman Valley Groundwater Basin*

38 The Deadman Valley Groundwater Basin is located in San Bernardino County.  
39 The Deadman Valley Groundwater Basin includes the Deadman Lake and  
40 Surprise Spring subbasins. Water bearing formations consist of unconsolidated to  
41 partly consolidated continental deposits including interbedded gravels,  
42 conglomerates, clays, and silts in alluvial fan units (DWR 2004dj, 2004dk).  
43 Several fault zones restrict groundwater movement. Groundwater is recharged

1 from precipitation and stream flows. Groundwater flows from the Surprise Spring  
2 subbasin into the Deadman Lake subbasin, and from Deadman Lake subbasin to  
3 the dry Mesquite Lake. Groundwater also flows from the Ames Valley  
4 Groundwater Basin into the Surprise Spring subbasin. The groundwater is  
5 characterized as sodium bicarbonate with moderate to high TDS and localized  
6 areas of high fluoride.

7 Deadman Valley Groundwater Basin was designated by the CASGEM program as  
8 very low priority.

9 *Twentynine Palms Valley, Joshua Tree, Ames Valley, Copper Mountain Valley,*  
10 *and Warren Valley Groundwater Basins*

11 The Twentynine Palms Valley, Ames Valley, and Copper Mountain Valley  
12 groundwater basins are located in southern San Bernardino County. The Joshua  
13 Tree and Warren Valley groundwater basins are located in southern San  
14 Bernardino County and northern Riverside County. Water bearing formations  
15 consist of unconfined, unconsolidated to partly consolidated continental deposits  
16 with interbedded gravels, conglomerates, lake playa, silts, clays, and sandy-clay  
17 deposits (DWR 2004di, 2004dj, 2004dk, 2004dl, 2004dm). Several fault zones  
18 restrict groundwater movement. Groundwater is recharged from precipitation,  
19 stream flows, and wastewater effluent disposal. Groundwater flows from the  
20 Joshua Tree Groundwater Basin into the Copper Mountain Valley Groundwater  
21 Basin. Groundwater recharge in the Warren Valley Groundwater Basin also  
22 occurs at spreading grounds. The groundwater is characterized as calcium-  
23 sodium bicarbonate or sodium sulfate with moderate to high TDS in all of the  
24 basins except the Copper Mountain Valley Groundwater Basin; and localized  
25 areas with high fluoride, nitrate, sulfate, and chloride.

26 Warren Valley Groundwater Basin was designated by the CASGEM program as  
27 medium priority. Twentynine Palms Valley was designated as low priority.  
28 Joshua Tree, Ames, and Copper Mountain Valley groundwater basins were  
29 designated as very low priority.

30 *Morongo Valley Groundwater Basin*

31 The Morongo Valley Groundwater basin is located in southern San Bernardino  
32 County. Water bearing formations consist of alluvial deposits composed of sand,  
33 gravel, silt, and clay (DWR 2003f). Several fault zones restrict groundwater  
34 movement. Groundwater is recharged from precipitation and stream flows in the  
35 Big Morongo and Little Morongo creeks. The groundwater is characterized as  
36 calcium-sodium bicarbonate with moderate TDS.

37 Morongo Valley Groundwater Basin was designated by the CASGEM program as  
38 very low priority.

39 *Lost Horse Valley Groundwater Basin*

40 The Lost Horse Valley Groundwater Basin is located on the border between  
41 southeastern San Bernardino County and northeastern Riverside County. Water  
42 bearing formations consist of unconsolidated to semi-consolidated alluvial

1 deposits (DWR 2004dn). Groundwater is recharged from precipitation and  
 2 stream flows.  
 3 Lost Horse Valley Groundwater Basin was designated by the CASGEM program  
 4 as very low priority.

5 **7.3.6.6.2 Groundwater Use and Management**

6 Within the Antelope Valley and Mojave Valley, groundwater management is  
 7 facilitated by the Antelope Valley-East Kern Water Agency and Mojave Water  
 8 Agency. These agencies purchase SWP water and other water supplies to be used  
 9 for groundwater recharge or in-lieu uses to protect groundwater within the  
 10 Antelope and Mojave valleys.

11 *Antelope Valley*

12 The Antelope Valley-East Kern Water Agency (AVEK) provides SWP water to  
 13 areas that overlay portions of the Antelope Valley, Fremont Valley, and Indian  
 14 Wells Valley groundwater basins. To maintain groundwater aquifers in the area,  
 15 the AVEK provides treated SWP water to users through the Domestic-  
 16 Agricultural Water Network and untreated SWP water to some agricultural users  
 17 (AVEK 2011a). The AVEK participates in groundwater banking programs.  
 18 Communities within the AVEK service area also use groundwater, including the  
 19 cities of California City, Lancaster, and Palmdale; Edwards Air Force Base;  
 20 County of Los Angeles Waterworks District No. 40; Boron Community Services  
 21 District, Desert Lake Community Services District, Indian Wells Water District  
 22 (including the City of Ridgecrest), Mojave Public Utilities District, Palmdale  
 23 Water District, Palm Ranch Irrigation District, Quartz Hill Water District, and  
 24 Rosamond Community Services District; and California Water Service Company  
 25 (Antelope Valley, Lake Hughes, areas outside of the City of Lancaster, and Leona  
 26 Valley), Edgemont Crest Municipal Water Company, El Dorado Mutual Water  
 27 Company, Lake Elizabeth Mutual Water Company, Shadow Acres Mutual Water  
 28 Company, Sunnyside Farm Mutual Water Company, Westside Park Mutual Water  
 29 Company, and White Fence Farms Mutual Water Company provide retail  
 30 groundwater supplies (AVEK 2011a; AVRWC 2011; California Water Service  
 31 Company 2011f; City of California City 2013; IWVWD 2011; Los Angeles  
 32 County et al. 2011; PWD 2011; Rosamond CSD 2011).

33 In 2004, the County of Los Angeles Waterworks District No. 40 and Palmdale  
 34 Water District filed for the adjudication of the Antelope Valley Groundwater  
 35 Basin (DWR 2014a; Los Angeles County et al. 2011; PWD 2011). The request of  
 36 the filing is to allocate groundwater rights within the basin to these districts, other  
 37 municipal and industrial water users, and Overlying Landowners and provide for  
 38 a program to replace groundwater withdrawals in excess of a specified yield in  
 39 order to stabilize or reverse groundwater declines.

40 *Mojave Valley*

41 Within the Mojave Water Agency service area, most of the water supply is from  
 42 groundwater (AVRWC 2011; City of Adelanto 2011; Golden State Water  
 43 Company 2011k; HDWD 2011; Hesperia Water District 2011; JBWD 2011;



1 MWA 2011; PPHCSD 2011; San Bernardino County 2012; TPWD 2014;  
2 Victorville Water District 2011). The Mojave Water Agency uses natural surface  
3 water flows, recycled water imported from outside of the agency's service area,  
4 SWP water, and return flows from water users of groundwater within the service  
5 area to recharge groundwater. These water supplies are provided as wholesale  
6 water supplies to retail groundwater users to maintain groundwater levels in the  
7 area. The Mojave Water Agency overlays all or portions of all of the  
8 groundwater basins described in this subsection. The City of Adelanto; Hesperia  
9 Water District, Hi-Desert Water District, Joshua Water District, Twentynine  
10 Palms Water District, Victorville Water District, Apple Foothill County Water  
11 District, Apple Heights County Water District, Juniper Riviera County Water  
12 District, Thunderbird County Water District, Daggett Community Services  
13 District, Helendale Community Services District, Phelan Piñon Hills Community  
14 Services District, Yermo Community Services District, Bighorn-Desert View  
15 Water Agency, and San Bernardino County Service Areas numbers 64 and 70;  
16 and Golden State Water Company, Apple Valley Ranchos Water Company,  
17 Jubilee Water Company, and Rancharitos Mutual Water Company provide retail  
18 groundwater supplies. These entities provide water to the cities of Adelanto,  
19 Barstow, Hesperia, Twentynine Palms, Victorville; towns of Apple Valley and  
20 Yucca; Joshua Tree National Park; Twentynine Palms Marine Corps Base; and  
21 the communities of Apple Heights, Apple Valley, Daggett, Flamingo Heights,  
22 Helendale, Johnson Valley, Landers, Lucerne Valley, Newberry Springs, Oak  
23 Hills, Spring Valley Lake, Yermo, and users between these communities. The  
24 Morongo Band of Mission Indians also rely upon groundwater from this area.

25 The Mojave Water Agency has implemented 13 groundwater recharge facilities  
26 (MWA 2011). The SWP water is delivered to the recharge facilities throughout  
27 the Mojave Water Agency service area.

28 The area known as the Mojave Basin Area has been adjudicated. This area  
29 includes all or portions of Cuddeback Valley, Superior Valley, Harper Valley,  
30 Antelope Valley, El Mirage Valley, Upper Mojave River Valley, Middle Mojave  
31 River Valley, Lower Mojave River Valley, Caves Canyon Valley, Langford  
32 Valley, Cronise Valley, Coyote Lake Valley, Kane Wash Area, Iron Ridge Area,  
33 Lucerne Valley, and Johnson Valley groundwater basins (Golden State Water  
34 Company 2011k; MWA 2011). The Mojave Basin Judgment allocated  
35 groundwater withdrawals in the area and required groundwater users that  
36 withdraw more than the allocated amount to purchase replenishment SWP water  
37 from the Watermaster or from another entity within the judgment. The judgment  
38 considers local surface water sources, including groundwater recharge near  
39 Hesperia with treated wastewater effluent from Lake Arrowhead Community  
40 Services District (LACSD 2011). The judgment also provides for carry over  
41 storage between water years. The Mojave Water Agency has been appointed as  
42 the Watermaster.

43 The Warren Valley Groundwater Basin was adjudicated in 1977 (MWA 2011).  
44 The Hi-Desert Water District was appointed as the Watermaster to manage

1 groundwater withdrawals and groundwater quality; to provide SWP water,  
2 captured stormwater, and recycled water; and to encourage conservation.  
3 In 1991, the Bighorn-Desert Water Agency and the Hi-Desert Water District  
4 agreed to the court approved Ames Valley Basin Water Management Agreement.  
5 In accordance with this agreement, the Hi-Desert Water District implemented the  
6 Mainstream Wells and expansion to conveyance and monitoring approaches.

## 7 **7.4 Impact Analysis**

8 This section describes the potential mechanisms and analytical methods for  
9 change in groundwater resources, results of the impact analysis, potential  
10 mitigation measures, and cumulative effects.

### 11 **7.4.1 Potential Mechanisms for Change and Analytical Methods**

12 As described in Chapter 4, Approach to Environmental Analysis, the impact  
13 analysis considers changes in groundwater conditions related to changes in CVP  
14 and SWP operations under the alternatives as compared to the No Action  
15 Alternative and Second Basis of Comparison.

#### 16 **7.4.1.1 Changes in Groundwater Use and Groundwater Levels**

17 Changes in availability of CVP and SWP water supplies could result in changes in  
18 groundwater use. For example, if CVP and SWP water supplies are decreased,  
19 water users may increase the amount of groundwater withdrawals in response.

20 Historically, groundwater resources were the only source of water supply in the  
21 Central Valley. The heavy use of groundwater has caused groundwater quality  
22 issues, drainage issues, groundwater overdraft, and land subsidence (as discussed  
23 in Section 7.3). Throughout many areas of the San Joaquin Valley, shallow  
24 groundwater is characterized by high salinity. Use of this groundwater for  
25 irrigation deposited salts along with agricultural chemicals (nutrients and  
26 fertilizers) in the upper soil layer. These constituents leached into the underlying  
27 shallow groundwater aquifers and caused them to be unsuitable for irrigation.  
28 Surface water was provided through the CVP and SWP to provide irrigation water  
29 of higher quality than was available in local groundwater. The expanded use of  
30 surface water for irrigation has resulted in a reduction in the degree of  
31 groundwater overdraft of local groundwater basins.

32 Generally, when available, agricultural water users in the San Joaquin Valley  
33 prefer to use surface water for irrigation because the water quality is better than  
34 for groundwater. When adequate surface water is not available, they will use  
35 groundwater (USGS 2009).

36 As previously described in Section 7.2.3, Sustainable Groundwater Management  
37 Act, most groundwater users in California must develop Groundwater  
38 Sustainability Plans (GSPs) by 2020 or 2022, and meet the sustainable goal within  
39 20 years after adoption of the plan. The timeframe of this EIS analysis is 2030.  
40 Therefore, the EIS analysis assumes that groundwater users have developed the

1 GSPs before that timeframe (by 2020 or 2022), and have begun to plan, design,  
2 and possibly construct alternative water supply facilities or implement water  
3 conservation measures to achieve full compliance by 2040 or 2042. However,  
4 this EIS analysis assumes that the new facilities or conservation measures are not  
5 fully implemented by 2030. Therefore, reductions in groundwater use in  
6 accordance with the SGMA are not anticipated until after 2030 and are discussed  
7 under Section 7.4.39, Cumulative Effects Analysis.

8 Changes in groundwater use by users of or providers to CVP and SWP water  
9 supplies could result in changes in groundwater storage and groundwater levels.  
10 For example, if CVP and SWP water supplies are decreased and water users  
11 increase the amount of groundwater withdrawals, groundwater levels could  
12 decline. Changes in groundwater levels resulting in levels declining could result  
13 in a decrease in well yields. Changes in groundwater levels also could result in  
14 different groundwater pumping costs, as analyzed in Chapter 12, Agricultural  
15 Resources, and Chapter 14, Socioeconomics, for agricultural and municipal water  
16 users of CVP and SWP water supplies, respectively.

#### 17 **7.4.1.1.1 Use of Central Valley Hydrologic Model**

18 There are many groundwater models that have been developed for portions of the  
19 Central Valley. However, most of these models were not developed in a manner  
20 that would allow for analysis of groundwater changes throughout the Central  
21 Valley which includes the majority of CVP and SWP agricultural water users. As  
22 described in Appendix 7A, Groundwater Model Documentation, changes in  
23 groundwater use, and levels in the Central Valley have been evaluated using the  
24 Central Valley Hydrologic Model (CVHM) because this model is readily  
25 available and covers the entire Central Valley. CVHM is a regional-scale  
26 calibrated historical finite-difference, block-centered saturated groundwater flow  
27 model application developed by the USGS and uses the MODFLOW-2000  
28 computer code (USGS 2000b). The CVHM model spans a 42-year simulation  
29 period between water years 1962 and 2003.

30 CVHM is used to estimate the changes in groundwater levels and groundwater  
31 withdrawals under the alternatives as compared to the No Action Alternative and  
32 Second Basis of Comparison. CVHM model output is also used as input files of  
33 the State Wide Agricultural Production (SWAP) model to simulate agricultural  
34 production changes based on groundwater pumping costs, as described in  
35 Chapter 12, Agricultural Resources.

36 The CVHM domain is subdivided into 21 WBSs, as summarized in Figure 7.14  
37 (USGS 2009). Applied water requirements for each WBS are computed based on  
38 crop type and available water from precipitation, shallow groundwater uptake,  
39 and surface water, as limited by surface water rights and CVP and SWP water  
40 supply deliveries.

41 CVHM simulates primarily subsurface and limited surface hydrologic processes  
42 over the entire Central Valley at a uniform grid-cell spacing of 1 mile. Boundary  
43 conditions were modified to reflect anticipated changes in surface water  
44 availability, including the effects of climate change.

1 Surface water inflows from the CalSim II model were used to define boundary  
2 conditions for CVHM for each alternative and the Second Basis of Comparison.  
3 The CalSim II model simulates the operation of the major SWP and CVP  
4 facilities in the Central Valley by calculating river flows; and CVP and SWP  
5 reservoir storage, exports, and deliveries (see Appendix 5A for more details on  
6 CalSim II). The CalSim II outputs are included in the CVHM input files.

7 The CVHM uses the FMP process (described in Appendix 7A) to estimate  
8 agricultural water supply needs and assumes that when surface water deliveries  
9 are available, they are used first, before groundwater is pumped for additional  
10 water supplies.

11 Changes in agricultural groundwater pumping under the alternatives are compared  
12 to groundwater pumping under the No Action Alternative and Second Basis of  
13 Comparison. The data for these results were processed from the FMP output  
14 files, which include the amount of water used from each available source by the  
15 farm, based on the computed crop water demand for each WBS.

16 For the analyses presented in this chapter, changes in groundwater use, elevation,  
17 and pumping volumes between the alternatives, No Action Alternative, and  
18 Second Basis of Comparison are described for agricultural water users only in the  
19 Central Valley Region.

#### 20 **7.4.1.1.2 Analysis of Changes in Municipal and Industrial** 21 **Groundwater Use**

22 Due to the regional scale of the CVHM model, municipal and industrial  
23 groundwater use is a very small portion of total groundwater use due to the  
24 predominance of agricultural groundwater use. Therefore, in the CVHM model,  
25 municipal and industrial groundwater use in the Central Valley was assumed to  
26 continue at the 2003 calibrated volume throughout the predictive simulations.

27 For municipal and industrial groundwater use in the Central Valley, the CWEST  
28 model is a more appropriate model than CVHM. The CWEST model evaluates  
29 total water use by municipal and industrial water users in the Central Valley, San  
30 Francisco Bay Area, Central Coast, and Southern California regions based upon  
31 economic decisions.

32 It is recognized that municipal and industrial pumping in urban areas in the  
33 Central Valley could cause localized impacts to groundwater levels from  
34 increased drawdown. The increased withdrawals could also impact groundwater  
35 quality due to the migration of existing plumes, as described in the Affected  
36 Environment section.

#### 37 **7.4.1.1.3 Analysis of Changes in Agricultural Groundwater Use Outside of** 38 **the Central Valley Region**

39 Agricultural groundwater use by CVP and SWP water users located outside of the  
40 Central Valley primarily occurs in Santa Clara and San Benito counties in the San  
41 Francisco Bay Area Region; San Luis Obispo and Santa Barbara counties in the  
42 Central Coast Region; and Ventura, Orange, San Bernardino, and Riverside

1 counties in the Southern California Region. Basin adjudication programs in many  
2 portions of these counties will minimize changes in groundwater use and levels as  
3 a result of changes in CVP and SWP water supplies. There are no regional  
4 groundwater flow models available that uniformly help analyze groundwater use  
5 and elevation in these areas linked to CVP and SWP water supply deliveries, in a  
6 similar manner as CVHM simulates in the Central Valley, however in some areas  
7 local models have been developed to support groundwater management activities.  
8 Therefore, changes in groundwater use and related changes in groundwater levels  
9 are assumed to be correlated to availability of CVP and SWP water supplies. It is  
10 generally assumed that an increase in CVP and SWP water supplies would result  
11 in a decrease in groundwater use in these areas. Similarly, a decrease in CVP and  
12 SWP water supplies could result in a short-term increase in groundwater use and  
13 associated groundwater level decrease. In adjudicated basins, groundwater use  
14 restrictions limit the amount of groundwater that can be pumped, even when  
15 surface water availability is reduced. In those basins, long-term groundwater use  
16 is assumed to not increase, and agricultural production could decrease if CVP and  
17 SWP water supplies decrease.

#### 18 **7.4.1.2 Changes in Land Subsidence**

19 Extensive groundwater withdrawals from confined and unconfined aquifers  
20 increases the potential for land subsidence. In aquifers with clay and silt lenses,  
21 decreased groundwater levels can result in compaction of fine-grained deposits  
22 which could lead to irreversible land subsidence. Subsidence could result in  
23 structural damage to roads, railroad tracks, pipelines and associated structures,  
24 drainage, buildings, and wells. Subsidence can also result in the permanent loss  
25 of groundwater storage potential within an aquifer system.

26 Subsidence is related to changes in groundwater levels; and a review of simulated  
27 changes in groundwater elevation output from the CVHM model as compared  
28 between alternatives is used to provide an indication of the potential occurrence of  
29 subsidence.

30 CVHM includes a module known as the SUB package that computes the  
31 cumulative compaction of each model layer during the model simulation. The  
32 cumulative layer compactions at the end of the simulation are summed into a total  
33 subsidence. However, this version of the SUB package does not consider the  
34 potential reduction in the rate of subsidence that would occur as the magnitude of  
35 compaction approaches the physical thickness of the affected fine-grained  
36 interbeds. Thus, subsidence forecasts from the predictive versions of CVHM  
37 were not used as they may not accurately depict long-term changes in subsidence  
38 using the current version of the SUB package. Therefore, a qualitative approach  
39 was used for the estimation of the potential for increased land subsidence in areas  
40 of the Central Valley that have historically experienced inelastic subsidence due  
41 to the compaction of fine-grained interbeds.

42 Potential changes in subsidence due to changes in municipal and industrial  
43 groundwater use were qualitatively analyzed for regions with historic or existing

1 subsidence issues, such as in Santa Clara County in the San Francisco Bay Area  
2 Region.

3 **7.4.1.3 Changes in Groundwater Quality**

4 Changes in groundwater quality could occur in several ways under  
5 implementation of the alternatives as compared to the No Action Alternative and  
6 Second Basis of Comparison. Reductions in groundwater levels could change  
7 groundwater flow directions, potentially causing poorer quality groundwater to  
8 migrate into areas with higher quality groundwater, or cause intrusion of poor  
9 water quality (e.g. from aquitards) as water levels decline.

10 Groundwater quality also could change due to changes in availability of CVP  
11 and/or SWP water supplies used by agricultural water users. For example, if  
12 reductions in CVP and/or SWP water supplies result in increased use of  
13 groundwater with higher salinity than CVP and/or SWP supplies, shallow  
14 groundwater could become more saline and soil salinity could increase, as  
15 described in Chapter 11, Geology and Soils. In addition, the reduced availability  
16 of higher quality surface water for use in recharge facilities may decrease the  
17 overall groundwater quality in those localized areas.

18 Changes in groundwater quality due to changes in CVP and SWP water supply  
19 availability could occur under the following mechanisms:

- 20 • Migration of reduced quality groundwater towards areas of groundwater  
21 withdrawals, including seawater intrusion and migration of contaminant  
22 plumes
- 23 • Depletion of the freshwater aquifer that overlays poorer quality groundwater,  
24 and the upwelling of the poorer quality groundwater into the upper aquifers
- 25 • Percolation of applied water with poorer water quality than underlying  
26 groundwater

27 Within the Central Valley, changes in groundwater use and groundwater flow  
28 direction are analyzed using the CVHM. The model does not directly simulate  
29 changes in groundwater quality. However, in regions with existing poorer quality  
30 groundwater, changes in groundwater levels or flow directions can be used to  
31 evaluate potential impacts to groundwater quality. For example, declines in  
32 groundwater levels that result in seawater intrusion, or the migration of good  
33 quality groundwater into areas with poor quality can result in groundwater quality  
34 degradation. Further, reduction in groundwater quality could also occur due to  
35 migration or upwelling of poorer quality groundwater into areas with good quality  
36 groundwater.

37 Long-term use of poorer quality groundwater due to changes in CVP and SWP  
38 water supplies could also result in a reduction in shallow aquifer groundwater  
39 quality. Application of poorer quality groundwater also could increase soil  
40 salinity, as described in Chapter 11, Geology and Soils Resources.

41 **7.4.1.4 Effects Related to Water Transfers**

42 Historically water transfer programs have been developed on an annual basis.

1 The demand for water transfers is dependent upon the availability of water  
2 supplies to meet water demands. Water transfer transactions have increased over  
3 time as CVP and SWP water supply availability has decreased, especially during  
4 drier water years.

5 Parties seeking water transfers generally acquire water from sellers who have  
6 available surface water who can make the water available through releasing  
7 previously stored water, pump groundwater instead of using surface water  
8 (groundwater substitution); idle crops; or substitute crops that uses less water in  
9 order to reduce normal consumptive use of surface water.

10 Water transfers using CVP and SWP Delta pumping plants and south of Delta  
11 canals generally occur when there is unused capacity in these facilities. These  
12 conditions generally occur during drier water year types when the flows from  
13 upstream reservoirs plus unregulated flows are adequate to meet the Sacramento  
14 Valley water demands and the CVP and SWP export allocations. In non-wet  
15 years, the CVP and SWP water allocations would be less than full contract  
16 amounts; therefore, capacity may be available in the CVP and SWP conveyance  
17 facilities to move water from other sources.

18 Projecting future groundwater conditions related to water transfer activities is  
19 difficult because specific water transfer actions required to make the water  
20 available, convey the water, and/or use the water would change each year due to  
21 changing hydrological conditions, CVP and SWP water availability, specific local  
22 agency operations, and local cropping patterns. Reclamation recently prepared a  
23 long-term regional water transfer environmental document which evaluated  
24 potential changes in groundwater conditions related to water transfer actions  
25 (Reclamation 2014c). Results from this analysis were used to inform the impact  
26 assessment of potential effects of water transfers under the alternatives as  
27 compared to the No Action Alternative and the Second Basis of Comparison.

#### 28 **7.4.2 Conditions in Year 2030 without implementation of** 29 **Alternatives 1 through 5**

30 The impact analysis in this EIS is based upon the comparison of the alternatives to  
31 the No Action Alternative and the Second Basis of Comparison in the Year 2030.  
32 Changes that would occur over the next 15 years without implementation of the  
33 alternatives are not analyzed in this EIS. However, the changes that are assumed  
34 to occur by 2030 under the No Action Alternative and the Second Basis of  
35 Comparison are summarized in this section. Many of the changed conditions  
36 would occur in the same manner under both the No Action Alternative and the  
37 Second Basis of Comparison.

38 This section of Chapter 7 provides qualitative projections of the No Action  
39 Alternative as compared to existing conditions described under the Affected  
40 Environment; and qualitative projections of the Second Basis of Comparison as  
41 compared to “recent historical conditions.” Recent historical conditions are not  
42 the same as existing conditions which include implementation of the  
43 2008 U.S. Fish and Wildlife Service (USFWS) biological opinion (BO) and 2009  
44 National Marine Fisheries Service (NMFS) BO; and consider changes that would

1 have occurred without implementation of the 2008 USFWS BO and the 2009  
2 NMFS BO.

3 **7.4.2.1 Common Changes in Conditions under the No Action**  
4 **Alternative and Second Basis of Comparison**

5 Conditions in 2030 would be different than existing conditions due to:

- 6 • Climate change and sea-level rise
- 7 • General plan development throughout California, including increased water  
8 demands in portions of Sacramento Valley
- 9 • Implementation of reasonable and foreseeable water resources management  
10 projects to provide water supplies

11 These changes would result in a decline of the long-term average CVP and SWP  
12 water supply deliveries by 2030 as compared to recent historical long-term  
13 average deliveries, as described in Chapter 5, Surface Water Resources and Water  
14 Supplies.

15 **7.4.2.1.1 Changes in Conditions due to Climate Change and Sea-Level Rise**

16 It is anticipated that climate change would result in more short-duration high-  
17 rainfall events and less snowpack in the winter and early spring months. The  
18 reservoirs would be full more frequently by the end of April or May by 2030 than  
19 in recent historical conditions. However, as the water is released in the spring,  
20 there would be less snowpack to refill the reservoirs. This condition would  
21 reduce reservoir storage and available water supplies to downstream uses in the  
22 summer. The reduced end of September storage also would reduce the ability to  
23 release stored water to downstream regional reservoirs. These conditions would  
24 occur for all reservoirs in the California foothills and mountains, including  
25 non-CVP and SWP reservoirs.

26 Climate change also would reduce groundwater supplies due to reduced  
27 groundwater recharge potential and increased groundwater overdraft potential as  
28 surface water supplies decline. However, in some locations, sustainable  
29 groundwater supplies could remain similar to recent historical conditions or rise  
30 due to implementation of groundwater management plans to reduce groundwater  
31 overdraft, including the completion of ongoing groundwater recharge and  
32 recovery programs.

33 **7.4.2.1.2 General Plan Development in California**

34 Counties and cities throughout California have adopted general plans which  
35 identify land use classifications including those for municipal and industrial uses  
36 and those for agricultural uses. Preparation of general plans includes an  
37 environmental evaluation under the California Environmental Quality Act to  
38 identify adverse impacts to the physical environment and to provide mitigation  
39 measures to reduce those impacts to a level of less than significance. Most of the  
40 counties where CVP and SWP water supplies are delivered have adopted general  
41 plans following the environmental review of the plans and appropriate



1 alternatives. Population projections from those general plan evaluations are  
2 provided to the State Department of Finance and are used to project future water  
3 needs and the potential for conversion of existing undeveloped lands and  
4 agricultural lands. Many of the existing general plans for counties with municipal  
5 areas recently have been modified to include land use and population projections  
6 through 2030. The No Action Alternative and the Second Basis of Comparison  
7 assume that land uses will develop through 2030 in accordance with existing  
8 general plans.

9 The assumptions related to 2030 municipal water demands are based upon a  
10 review of the 2010 Urban Water Management Plans (UWMPs) prepared by CVP  
11 and SWP water users. The No Action Alternative and the Second Basis of  
12 Comparison assumptions related to future water supplies presented in the  
13 UWMPs were evaluated to determine if the projects were reasonable and certain  
14 to occur by 2030. Projects that had undergone environmental review, were under  
15 design, or under construction were included in the future water supply  
16 assumptions for 2030 in the No Action Alternative and the Second Basis of  
17 Comparison. Projects described in the UWMPs that currently were under  
18 evaluation were included in the Cumulative Effects analysis for future water  
19 supplies.

20 Under the No Action Alternative and Second Basis of Comparison, it is assumed  
21 that water demands would be met on a long-term basis and in dry and critical dry  
22 years using a combination of conservation, CVP and SWP water supplies, other  
23 imported water supplies, groundwater, recycled water, infrastructure  
24 improvements, desalination water treatment, and water transfers and exchanges.  
25 It is anticipated that individual communities or users could be in a situation that  
26 would not allow for affordable water supply options, and that water demands  
27 could not be fully met. However, on a regional scale, it is anticipated that water  
28 demands would be met.

#### 29 **7.4.2.1.3 Reasonable and Foreseeable Water Resources Management** 30 **Projects**

31 The No Action Alternative and the Second Basis of Comparison assumes  
32 completion of water resources management and environmental restoration  
33 projects that would have occurred without implementation of the 2008 USFWS  
34 BO and 2009 NMFS BO by 2030, as described in Chapter 3, Description of  
35 Alternatives. Many of these future actions could affect groundwater conditions  
36 and use of groundwater.

37 The No Action Alternative and the Second Basis of Comparison assume that  
38 groundwater would continue to be used even if groundwater overdraft conditions  
39 continue or become worse. It is recognized that SGMA was enacted in September  
40 2014. The SGMA requires the formation of GSPs in groundwater basins or  
41 subbasins that DWR designates as medium or high priority based upon  
42 groundwater conditions identified using the CASGEM results by 2022.  
43 Sustainable groundwater operations must be achieved within 20 years following  
44 completion of the GSPs. In some areas with adjudicated groundwater basins,

1 sustainable groundwater management could be achieved and/or maintained by  
 2 2030. However, to achieve sustainable conditions in many areas, measures could  
 3 require several years to design and construct water supply facilities to replace  
 4 groundwater, such as seawater desalination. Therefore, it does not appear to be  
 5 reasonable and foreseeable that sustainable groundwater management would be  
 6 achieved by 2030; and it is assumed that groundwater pumping will continue to  
 7 be used to meet water demands not fulfilled with surface water supplies or other  
 8 alternative water supplies in 2030.

9 **7.4.2.1.4 Potential Future Groundwater Conditions in 2030 due to**  
 10 **Common Changes**

11 *Groundwater Conditions*

12 In the Central Valley Region, the combination of increased groundwater  
 13 withdrawals due to reductions in CVP and SWP water deliveries as compared to  
 14 recent historical long-term deliveries and reduced groundwater recharge due to  
 15 climate change could result in continued reductions in groundwater levels in the  
 16 same manner as recent declines of up to 10 feet in the Sacramento Valley and  
 17 more than 20 feet in the San Joaquin Valley, as described in Section 7.3.4, Central  
 18 Valley Region. It is also assumed that full implementation of SGMA GSPs would  
 19 not occur by 2030; and therefore, groundwater pumping will continue to be used  
 20 to meet water demands not fulfilled with surface water supplies or other  
 21 alternative water supplies in 2030, as described above.

22 Under the No Action Alternative and Second Basis of Comparison, groundwater  
 23 banks and other management programs would continue to be implemented, and  
 24 possibly expanded, including ongoing groundwater recharge efforts in the Eastern  
 25 San Joaquin, Kings, Kaweah, and Kern subbasins in the San Joaquin Valley  
 26 Groundwater Basin. These programs could result in groundwater levels that are  
 27 similar or higher as compared to recent groundwater conditions. If local agencies  
 28 fully implement GSPs in accordance with the state SGMA prior to the regulatory  
 29 deadline, groundwater levels could remain similar to recent conditions or rise.

30 Localized groundwater levels in portions of the Central Valley Region could  
 31 increase due to seepage in lands adjacent to the ecosystem restoration areas in the  
 32 Yolo Bypass, Cache Slough, and Suisun Marsh areas depending upon local  
 33 geological and soil conditions.

34 In the Southern California Region, several SWP water users have purchased  
 35 transferred water, expanded groundwater storage within their service areas,  
 36 implemented wastewater recycling and stormwater recycling programs to provide  
 37 water supplies for groundwater recharge, and participated in groundwater banks  
 38 outside of their service areas as part of ongoing sustainable groundwater  
 39 management programs. Under the No Action Alternative and the Second Basis of  
 40 Comparison, groundwater banks and other management programs would continue  
 41 to be implemented, and possibly expanded. Several of the programs include  
 42 expansion of groundwater storage by Kern County and Antelope Valley-East  
 43 Kern Water Agency; groundwater recharge programs using recycled stormwater  
 44 by the Los Angeles Department of Water and Power; groundwater recharge

1 programs using recycled wastewater by the Water Replenishment District; and  
2 groundwater treatment by City of Oxnard and Western Municipal Water District  
3 (AVEK 2011b; City of Los Angeles 2011; City of Oxnard 2013; Reclamation  
4 2010b; WMWD 2012; WRD 2015). Expansion of these programs could result in  
5 maintenance of groundwater levels in accordance with objectives in the current  
6 groundwater management plans even with reduced SWP water supplies under the  
7 No Action Alternative and Second Basis of Comparison.

#### 8 *Potential Land Subsidence*

9 Land subsidence due to groundwater withdrawals historically occurred in the  
10 Yolo subbasin of the Sacramento Valley Groundwater Basin and Delta-Mendota  
11 and Westside subbasins of the San Joaquin Valley Groundwater Basin in the  
12 Central Valley Region; Santa Clara Valley Groundwater Basin in the San  
13 Francisco Bay Area Region; and the Antelope Valley and Lucerne Valley  
14 groundwater basins in the Southern California Region. Under the No Action  
15 Alternative, it is anticipated that increased groundwater withdrawals due to  
16 reductions in CVP and SWP water supplies and reduced groundwater recharge  
17 due to climate change could result in increased irreversible land subsidence in  
18 these areas.

#### 19 *Groundwater Quality*

##### 20 *Central Valley Region*

21 As described in Section 7.3, Affected Environment, in the Central Valley, there  
22 are localized areas of high salinity related to natural geologic formations and/or  
23 historic land uses; high naturally occurring arsenic, calcium, iron, and/or  
24 manganese; and high levels of boron, and/or phosphates related to historic land  
25 use practices. High concentrations of nitrates due to current anthropogenic  
26 sources and legacy sources occur in many locations in the San Joaquin Valley  
27 Groundwater Basin, especially in the Eastern San Joaquin, Modesto, Merced,  
28 Kings, Kaweah, Tule, and Tulare Lake subbasins. Under the No Action  
29 Alternative, it is anticipated that these conditions would continue to occur; and  
30 that groundwater quality could be further degraded due to reduction of  
31 groundwater elevation that can cause adjacent poorer quality water to flow  
32 towards the groundwater withdrawals.

33 Groundwater quality in the Grasslands Drainage Area and near Mud Slough and  
34 the San Joaquin River is anticipated to improve as compared with historic  
35 conditions due to the implementation of the Grasslands Bypass project. This  
36 program would reduce seepage from unlined canals and capture, treat, and/or  
37 reuse drainage flows (Reclamation 2009).

38 In the Tulare Lake Area of the San Joaquin Valley Groundwater Basin (in the  
39 Westside, Tulare Lake, Kings, Kaweah, and Tule subbasins within Fresno, Kern,  
40 Kings, and Tulare counties) high salinity groundwater occurs in the shallow  
41 aquifers due to agricultural drainage issues and naturally occurring high saline  
42 soils. Salts are imported into the Tulare Lake Area through the use of CVP and  
43 SWP irrigation water supplies and introduced into groundwater from dissolution

1 of salts in the local soil from agricultural land use. Groundwater salinity increases  
 2 because the Tulare Lake Area is a closed basin.

3 The CV-SALTS program is preparing a Salinity and Nitrate Management Plan for  
 4 publication in 2016 (CVRWQCB 2015). The plan will include sustainable salt  
 5 management alternatives, including treatment and salt recovery technologies, such  
 6 as, reverse osmosis; and related brine disposal/storage options that could range  
 7 from deep well injection to dedicated disposal locations to conveyance of brine to  
 8 locations outside of the San Joaquin Valley. This plan also will address current  
 9 and legacy sources of nitrates; assimilative capacity of the groundwater subbasins  
 10 and aquifers; drinking water protection measures, including waste discharge  
 11 requirements from irrigated lands and dairies; and measurable and enforceable  
 12 milestones that do not disproportionately impact disadvantaged communities; and  
 13 measures that minimize costs and maximize benefits to the community and water  
 14 users. The 2015 CV-SALTS work plan projects completion of Central Valley  
 15 Basin Plan amendments and Water Quality Control Plans for the Sacramento  
 16 Valley and San Joaquin Valley updates to incorporate recommendations of  
 17 CV-SALTS by 2018, including source control strategies and real time  
 18 management strategies (CVRWQCB 2015; SWRCB 2015). The *2015 CV-SALTS*  
 19 *Annual Report* indicated that structural best management practices would not be  
 20 fully selected until 2018 and may not be implemented until after 2030  
 21 (SWRCB 2015). Under the No Action Alternative and Second Basis of  
 22 Comparison it is assumed that non-structural measures would be implemented by  
 23 2030 to reduce salinity and nitrate loadings; however, structural improvements  
 24 that would reduce total groundwater salinity and nitrate concentrations generally  
 25 would not be implemented. Therefore, water quality under the No Action  
 26 Alternative and the Second Basis of Comparison is anticipated to be poorer in  
 27 some portions of the Central Valley than under recent groundwater quality  
 28 conditions.

29 Poor groundwater quality occurs near urban areas in the Central Valley due to  
 30 contamination from municipal and industrial land use practices. In many of these  
 31 areas, groundwater quality improvement programs have been implemented, as  
 32 described above. However, in many areas, groundwater quality is managed by  
 33 reducing groundwater drawdown near contaminant plumes to avoid transporting  
 34 the contaminants into other portions of the aquifer. Under the No Action  
 35 Alternative and the Second Basis of Comparison, it is assumed that these  
 36 programs would continue. However, as CVP and SWP water supplies become  
 37 less available in 2030 as compared to recent conditions, increased reliance on  
 38 groundwater could cause groundwater contamination of portions of the aquifers  
 39 near existing wells.

40 *San Francisco Bay Area Region*

41 In the San Francisco Bay Area Region, there are localized areas of moderate to  
 42 high salinity due to natural geologic formations and/or seawater intrusion near  
 43 San Francisco Bay. High levels of boron due to natural geologic formations and  
 44 nitrates related to historic land use practices occur in the Livermore Valley and  
 45 the Gilroy-Hollister- Valley groundwater basins. Under the No Action

1 Alternative and the Second Basis of Comparison, it is anticipated that these  
2 conditions would continue to occur; and that groundwater quality could be further  
3 degraded due to reduction of groundwater elevation that can cause adjacent  
4 poorer quality water to flow towards the groundwater withdrawals, especially in  
5 locations with seawater intrusion near the coast.

6 *Central Coast Region*

7 In the Central Coast Region, there are localized areas of moderate to high salinity  
8 due to seawater intrusion near the coast. High levels of iron and manganese due  
9 to natural geologic formations and nitrates related to historic land use practices  
10 occur in local areas of the Central Coast Region. Under the No Action  
11 Alternative and Second Basis of Comparison, it is anticipated that these  
12 conditions would continue to occur. Seawater intrusion could increase and further  
13 degrade groundwater quality in groundwater adjacent to the coast if groundwater  
14 levels decline in the future.

15 *Southern California Region*

16 In the Southern California Region, there are localized areas of moderate to high  
17 salinity due to natural geologic formations, percolation of high salinity applied  
18 water supplies, and/or seawater intrusion near the coast. High levels of calcium,  
19 sulfate, magnesium, iron, manganese, and fluoride due to natural geologic  
20 formations, and nitrates and organic compounds related to historic land use  
21 practices. Under the No Action Alternative and the Second Basis of Comparison,  
22 it is anticipated that these conditions would continue to occur; and that  
23 groundwater quality could be further degraded due to reduction of groundwater  
24 elevation that can cause adjacent poorer quality water or seawater to flow towards  
25 the groundwater withdrawals.

26 **7.4.2.2 Changes in Conditions under the No Action Alternative**

27 Due to the climate change and sea-level rise and increased water demands in the  
28 Sacramento Valley, CVP and SWP water deliveries would be less in 2030 than  
29 under recent historical conditions. It is anticipated that these reductions in CVP  
30 and SWP water availability would result in a greater reliance on groundwater,  
31 especially during dry and critical dry year.

32 **7.4.2.3 Changes in Conditions under the Second Basis of Comparison**

33 Due to the climate change and sea-level rise and increased water demands in the  
34 Sacramento Valley, CVP and SWP water deliveries would be less in 2030 than  
35 under recent historical conditions. It is anticipated that these reductions in CVP  
36 and SWP water availability would result in a greater reliance on groundwater,  
37 especially during dry and critical dry year. However, as described in Chapter 5,  
38 Surface Water Resources and Water Supplies, the availability of CVP and SWP  
39 water supplies would be greater under the Second Basis of Comparison as  
40 compared to the No Action Alternative because CVP and SWP water operations  
41 would not include requirements of the 2008 USFWS BO and 2009 NMFS BO.  
42 However, reliance on groundwater in 2030 under the Second Basis of Comparison  
43 is anticipated to increase as compared to recent historical conditions due to the

1 climate change and sea-level rise and increased water demands in the  
2 Sacramento Valley.

3 **7.4.3 Evaluation of Alternatives**

4 As described in Chapter 4, Approach to Environmental Analysis, Alternatives 1  
5 through 5 have been compared to the No Action Alternative; and the No Action  
6 Alternative and Alternatives 1 through 5 have been compared to the Second Basis  
7 of Comparison.

8 During review of the numerical modeling analyses used in this EIS, an error was  
9 determined in the CalSim II model assumptions related to the Stanislaus River  
10 operations for the Second Basis of Comparison, Alternative 1, and Alternative 4  
11 model runs. Appendix 5C includes a comparison of the CalSim II model run  
12 results presented in this chapter and CalSim II model run results with the error  
13 corrected. Appendix 5C also includes a discussion of changes in the comparison  
14 of groundwater conditions for the following alternative analyses.

- 15 • No Action Alternative compared to the Second Basis of Comparison
- 16 • Alternative 1 compared to the No Action Alternative
- 17 • Alternative 3 compared to the Second Basis of Comparison
- 18 • Alternative 5 compared to the Second Basis of Comparison.

19 **7.4.3.1 No Action Alternative**

20 The No Action Alternative is compared to the Second Basis of Comparison.

21 **7.4.3.1.1 Trinity River Region**

22 Groundwater conditions in the Trinity River Region are not directly related to  
23 CVP and SWP water supplies or operations. Therefore, groundwater use, related  
24 groundwater levels, potential for land subsidence, and groundwater quality under  
25 the No Action Alternative would be the same as under the Second Basis of  
26 Comparison.

27 **7.4.3.1.2 Central Valley Region**

28 *Groundwater Use and Elevation*

29 In areas of the Central Valley Region that do not use CVP and SWP water  
30 supplies, areas that use CVP water under Sacramento River Exchange Settlement  
31 Contracts, and areas that use San Joaquin River Exchange Contracts water, under  
32 the No Action Alternative water supplies would be the same as under the Second  
33 Basis of Comparison. Therefore, in these areas of the Central Valley Region,  
34 groundwater use and groundwater levels under the No Action Alternative would  
35 be the same as under the Second Basis of Comparison.

36 In areas of the Central Valley Region that use CVP water service contract and  
37 SWP entitlement contract water supplies, the CVP and SWP water supplies would  
38 be less under the No Action Alternative as compared to the Second Basis of  
39 Comparison. The differences would result in increased groundwater use and

1 decreased groundwater levels in the San Joaquin Valley Groundwater Basin under  
2 the No Action Alternative as compared to the Second Basis of Comparison.  
3 Results of CVHM simulations indicate that groundwater levels would be similar  
4 in the Redding and Sacramento Valley Groundwater Basins and the northern  
5 portion of the San Joaquin Valley Groundwater Basin, as shown in Figures 7.15  
6 through 7.19. The CVHM simulation primarily focuses on changes in agricultural  
7 groundwater use in response to changes in the availability of CVP and SWP  
8 water. However, it is recognized that in the vicinity of some communities, such  
9 as in the area in the American River watershed served with CVP water supplies,  
10 groundwater use also would increase with the reduction in surface water  
11 availability. However, these changes are not considered to be substantial under  
12 the No Action Alternative as compared to the Second Basis of Comparison  
13 because the long-term reductions in CVP municipal water supplies are anticipated  
14 to be up to 7,000 acre-feet per year (or 6 percent) over the long-term condition, up  
15 to 8,000 acre-feet per year (or 8 percent) in dry years, and similar (or 5 percent or  
16 less) in critical dry years. The water demands are consistent between the No  
17 Action Alternative and Second Basis of Comparison; therefore, it is anticipated  
18 that reduced surface water supplies would result in increased groundwater use.

19 Groundwater levels decline under the No Action Alternative in the central and  
20 southern San Joaquin Valley Groundwater Basin as compared to the Second Basis  
21 of Comparison with greater reductions occurring in wet years than in critical dry  
22 years. Figures 7.20 and 7.21 present the simulated changes in groundwater levels  
23 over the 42-year CVHM study period. Simulated average July agricultural  
24 groundwater pumping under the No Action Alternative as compared to the  
25 Second Basis of Comparison is presented in Figures 7.22 and 7.23.

26 Overall, under the No Action Alternative as compared to the Second Basis of  
27 Comparison, July average groundwater levels decrease approximately 2 to 10 feet  
28 in most of the central and southern San Joaquin Valley Groundwater Basin in all  
29 water year types. July average groundwater levels decline 10 to 50 feet in the  
30 Delta-Mendota, Tulare Lake, and Kern County subbasins; and 50 to 200 feet in  
31 the Westside subbasin in all water year types. In critical dry years, groundwater  
32 levels decline by up to 100 feet on average in the Westside subbasin.  
33 Groundwater level changes in the Sacramento Valley are forecast to be less than  
34 2 feet. The groundwater level change hydrographs show that in the central and  
35 southern San Joaquin Valley, groundwater levels can fluctuate up to 200 feet in  
36 some areas due to climatic variations under the No Action Alternative compared  
37 to the Second Basis of Comparison.

38 The change in groundwater pumping in the Sacramento Valley would result in  
39 similar conditions (less than 5 percent change). Therefore, groundwater pumping  
40 in the Sacramento Valley is similar under the No Action Alternative compared to  
41 the Second Basis of Comparison.

42 Groundwater pumping in the San Joaquin and Tulare Basins would increase by  
43 approximately 8 percent under the No Action Alternative as compared to the  
44 Second Basis of Comparison. Figure 7.23 shows that the biggest change in  
45 groundwater pumping under the No Action Alternative as compared to the

1 Second Basis of Comparison occurs in the Westside subbasin, with an average  
2 July increase close to 40 thousand acre-feet (TAF).

3 *Land Subsidence*

4 Land subsidence due to groundwater withdrawals historically occurred in the  
5 Yolo subbasin of the Sacramento Valley Groundwater Basin. CVP and SWP  
6 water supplies are not used extensively in this area. The conditions under the No  
7 Action Alternative would be similar as conditions under the Second Basis of  
8 Comparison.

9 Under the No Action Alternative, potential for land subsidence due to  
10 groundwater withdrawals in the Delta-Mendota and Westside subbasins of the  
11 San Joaquin Valley Groundwater Basin would increase as compared to the  
12 Second Basis of Comparison due to the increased groundwater withdrawals.

13 Groundwater level-induced land subsidence has the highest potential to occur in  
14 the San Joaquin Groundwater Basin, based on historical data, if groundwater  
15 pumping substantially increases. Under the No Action Alternative, CVP and  
16 SWP water supplies are expected to decrease in the San Joaquin Valley as  
17 compared to the Second Basis of Comparison. Decreased surface water deliveries  
18 could result in an increase in groundwater pumping. The increased groundwater  
19 pumping would result in lower groundwater levels, and therefore, the potential for  
20 groundwater level-induced land subsidence is increased under the No Action  
21 Alternative as compared to the Second Basis of Comparison.

22 *Groundwater Quality*

23 Under the No Action Alternative, groundwater conditions, including groundwater  
24 quality, in areas that do not use CVP and SWP water supplies would be the same  
25 as under the Second Basis of Comparison.

26 In areas that use CVP and SWP water supplies, groundwater quality under the No  
27 Action Alternative could be reduced as compared to the Second Basis of  
28 Comparison in the central and southern San Joaquin Valley Groundwater Basin  
29 due to increased groundwater withdrawals and resulting potential changes in  
30 groundwater flow patterns. For example, potential impacts to groundwater  
31 quality may arise from deeper pumping close to the base of freshwater, where  
32 higher TDS water exists. Large areas in the San Joaquin Valley also experience  
33 impairments due to nitrate and other fertilizers used in agriculture, which could  
34 migrate to areas with better quality water due to increased pumping and potential  
35 changes in groundwater flow directions.

36 As described above, it is assumed that measures implemented in accordance with  
37 the CV-SALTS program or future sustainable groundwater management plans  
38 implemented in accordance with SGMA would not be fully implemented by 2030.  
39 Therefore, groundwater quality could decline under the No Action Alternative as  
40 compared to the Second Basis of Comparison.

41 *Effects Related to Cross Delta Water Transfers*

42 Potential effects to groundwater resources could be similar to those identified in a  
43 recent environmental analysis conducted by Reclamation for long-term water



1 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c).  
2 Potential effects to groundwater were identified as reduced groundwater levels  
3 and potentially subsidence in areas that sold water using groundwater substitution  
4 practices. Because all water transfers would be required to avoid adverse impacts  
5 to other water users and biological resources (see Section 3.A.6.3, Transfers),  
6 including impacts to other groundwater users, the analysis indicated that water  
7 transfers would not result in substantial changes in groundwater because  
8 mitigation and monitoring plans would be required. The mitigation measures  
9 would require reductions in providing water from groundwater substitutions if the  
10 monitoring results indicated substantial declines in groundwater levels. For the  
11 purposes of this EIS, it is anticipated that similar conditions would occur during  
12 implementation of cross Delta water transfers under the No Action  
13 Alternative and the Second Basis of Comparison.

14 Groundwater use in areas that purchase the transferred water could be reduced if  
15 additional surface water is provided. However, if the transferred water is used to  
16 meet water demands that would not have been met (e.g., crops that had been  
17 idled), groundwater conditions would be similar with or without water transfers.

18 Under the No Action Alternative, the timing of cross Delta water transfers would  
19 be limited to July through September and include annual volumetric limits, in  
20 accordance with the 2008 USFWS BO and 2009 NMFS BO. Under the Second  
21 Basis of Comparison, water could be transferred throughout the year without an  
22 annual volumetric limit. Overall, the potential for cross Delta water transfers  
23 would be less under the No Action Alternative than under the Second Basis of  
24 Comparison.

#### 25 **7.4.3.1.3 San Francisco Bay Area, Central Coast, and Southern** 26 **California Regions**

##### 27 *Groundwater Use and Elevation*

28 Under the No Action Alternative, it is anticipated that CVP and SWP water  
29 supplies in the San Francisco Bay Area, Central Coast, and Southern California  
30 regions would be reduced as compared to CVP and SWP water supplies under the  
31 Second Basis of Comparison, as discussed in Chapter 5, Surface Water Resources  
32 and Water Supplies. The reduction in surface water supplies could result in  
33 increased groundwater withdrawals, decreased groundwater recharge, and  
34 decreased groundwater levels in areas with CVP and SWP water users. It may be  
35 legally impossible to extract additional groundwater in adjudicated basins without  
36 gaining the permission of watermasters and accounting for groundwater pumping  
37 entitlements and various parties under their adjudicated rights.

##### 38 *Land Subsidence*

39 Increased use of groundwater and reductions in groundwater levels would result  
40 in an increased potential for additional land subsidence under the No Action  
41 Alternative as compared to the Second Basis of Comparison in the Santa Clara  
42 Valley Groundwater Basin in the San Francisco Bay Area Region, and the  
43 Antelope Valley and Lucerne Valley groundwater basins in the Southern  
44 California Region.

1 *Groundwater Quality*

2 As described in Section 7.3, Affected Environment, there are localized areas of  
3 moderate to high salinity due to natural geologic formations and/or seawater  
4 intrusion in the San Francisco Bay Area, Central Coast, and Southern California  
5 regions. Under the No Action Alternative as compared to the Second Basis of  
6 Comparison, it is anticipated that the increased groundwater withdrawals would  
7 cause poorer quality groundwater to flow towards the groundwater withdrawals,  
8 especially near the coast. This would result in poorer quality groundwater in  
9 some areas under the No Action Alternative as compared to the Second Basis of  
10 Comparison.

11 **7.4.3.2 Alternative 1**

12 Alternative 1 is identical to the Second Basis of Comparison. As described in  
13 Chapter 4, Approach to Environmental Analysis, Alternative 1 is compared to the  
14 No Action Alternative and the Second Basis of Comparison. However, because  
15 groundwater conditions under Alternative 1 are identical to groundwater  
16 conditions under the Second Basis of Comparison; Alternative 1 is only compared  
17 to the No Action Alternative.

18 **7.4.3.2.1 Alternative 1 Compared to the No Action Alternative**

19 *Trinity River Region*

20 Groundwater conditions in the Trinity River Region are not directly related to  
21 CVP and SWP water supplies or operations. Therefore, groundwater use, related  
22 groundwater levels, potential for land use subsidence, and groundwater quality  
23 degradation under Alternative 1 would be the same as under the No Action  
24 Alternative.

25 *Central Valley Region*

26 *Groundwater Use and Elevation*

27 In areas of the Central Valley Region that do not use CVP and SWP water  
28 supplies, areas that use CVP water under Sacramento River Exchange Settlement  
29 Contracts, and areas that use San Joaquin River Exchange Contracts under  
30 Alternative 1 water supplies would be the same as under the No Action  
31 Alternative. Therefore, in these areas of the Central Valley Region, groundwater  
32 use and groundwater levels under Alternative 1 would be the same as under the  
33 No Action Alternative.

34 In areas of the Central Valley Region that use CVP water service contract and  
35 SWP entitlement contract water supplies, the CVP and SWP water supplies would  
36 be greater under Alternative 1 as compared to the No Action Alternative. The  
37 differences would result in decreased groundwater use and increased groundwater  
38 levels in the San Joaquin Valley Groundwater Basin under Alternative 1 as  
39 compared to the No Action Alternative. Results of CVHM simulation indicate  
40 that groundwater levels would be similar in the Redding and Sacramento Valley  
41 groundwater basins and the northern portion of the San Joaquin Valley  
42 Groundwater Basin, as shown in Figures 7.24 through 7.28. The CVHM  
43 simulation primarily focuses on changes in agricultural groundwater use in

1 response to changes in the availability of CVP and SWP water. However, it is  
2 recognized that in the vicinity of some communities, such as in the area in the  
3 American River watershed served with CVP water supplies, groundwater use also  
4 would increase with the reduction in surface water availability. However, these  
5 changes are not considered to be substantial under Alternative 1 as compared to  
6 the No Action Alternative because the long-term increases in CVP municipal  
7 water supplies are anticipated to be up to 7,000 acre-feet per year (or up to 6  
8 percent) over the long-term condition, up to 8,000 acre-feet per year (or up to 8  
9 percent) in dry years, and up to 5,000 acre-feet per year (or up to 7 percent) in  
10 critical dry years. The water demands are consistent between Alternative 1 and  
11 the No Action Alternative; therefore, it is anticipated that increased surface water  
12 supplies would result in reduced groundwater use.

13 Groundwater levels increase under Alternative 1 in the central and southern San  
14 Joaquin Valley Groundwater Basin as compared to the No Action  
15 Alternative with greater increases occurring in wet years than in critical dry years  
16 (up to 100 feet). Figures 7.29 and 7.30 present the simulated changes in  
17 groundwater levels over the 42-year CVHM study period. Simulated average July  
18 agricultural groundwater pumping under Alternative 1 as compared to the No  
19 Action Alternative is presented in Figures 7.31 and 7.32.

20 Overall, under Alternative 1 as compared to the No Action Alternative, July  
21 average groundwater levels increase approximately 2 to 10 feet in most of the  
22 central and southern San Joaquin Valley Groundwater Basin in all water year  
23 types. July average groundwater levels rise 10 to 50 feet in the Delta-Mendota,  
24 Tulare Lake, and Kern County subbasins; and 50 to 200 feet in the Westside  
25 subbasin in most water year types. In critical dry years, groundwater levels  
26 increase by up to 100 feet on average in the Westside subbasin. The groundwater  
27 level change hydrographs show that in the central and southern San Joaquin  
28 Valley subbasins, groundwater levels can fluctuate up to 200 feet in some areas  
29 due to climatic variations under Alternative 1 compared to the No Action  
30 Alternative.

31 The change in groundwater pumping in the Sacramento Valley is less than  
32 5 percent. Therefore, groundwater pumping in the Sacramento Valley is similar  
33 under Alternative 1 as compared to the No Action Alternative.

34 Groundwater pumping in the San Joaquin and Tulare Basins would decrease by  
35 approximately 8 percent under Alternative 1 as compared to the No Action  
36 Alternative. Figure 7.32 shows that the biggest change in groundwater pumping  
37 under the Alternative 1 compared to the No Action Alternative occurs in the  
38 Westside subbasin with an average July decrease close to 40 TAF.

### 39 *Land Subsidence*

40 Land subsidence due to groundwater withdrawals historically occurred in the  
41 Yolo subbasin of the Sacramento Valley Groundwater Basin. CVP and SWP  
42 water supplies are not used extensively in this area. The conditions under  
43 Alternative 1 would be similar as conditions under the No Action Alternative.

1 Under Alternative 1, potential for land subsidence due to groundwater  
2 withdrawals in the Delta-Mendota and Westside subbasins of the San Joaquin  
3 Valley Groundwater Basin would decrease under Alternative 1 as compared to the  
4 No Action Alternative due to the decreased groundwater withdrawals.

5 Groundwater level-induced land subsidence has the highest potential to occur in  
6 the San Joaquin Valley Groundwater Basin, based on historical data, if  
7 groundwater pumping substantially increases. Under Alternative 1 CVP and  
8 SWP water supplies are expected to increase in the San Joaquin Valley as  
9 compared to the No Action Alternative. Increased surface water deliveries could  
10 result in a decrease in groundwater pumping. The decreased groundwater  
11 pumping would result in higher groundwater levels, and therefore, the potential  
12 for groundwater level-induced land subsidence is reduced under Alternative 1 as  
13 compared to the No Action Alternative.

14 *Groundwater Quality*

15 Under Alternative 1, groundwater conditions, including groundwater quality, in  
16 areas that do not use CVP and SWP water supplies would be the same as under  
17 the No Action Alternative.

18 In areas that use CVP and SWP water supplies, groundwater quality under  
19 Alternative 1 could be improved as compared to the No Action Alternative in the  
20 central and southern San Joaquin Valley Groundwater Basin due to decreased  
21 groundwater withdrawals. As described above, it is assumed that measures  
22 implemented in accordance with the CV-SALTS program or future sustainable  
23 groundwater management plans implemented in accordance with SGMA would  
24 not be fully implemented by 2030. However, due to the increased availability of  
25 CVP and SWP water supplies and related reduction in groundwater use, the  
26 groundwater quality would be improved under Alternative 1 as compared to the  
27 No Action Alternative.

28 *Effects Related to Water Transfers*

29 Potential effects to groundwater resources could be similar to those identified in a  
30 recent environmental analysis conducted by Reclamation for long-term water  
31 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c), as  
32 described above under the No Action Alternative compared to the Second Basis  
33 of Comparison. For the purposes of this EIS, it is anticipated that similar  
34 conditions would occur during implementation of cross Delta water transfers  
35 under Alternative 1 and the No Action Alternative, and that groundwater impacts  
36 would not be substantial in the seller's service area due implementation  
37 requirements of the transfer programs.

38 Groundwater use in areas that purchase the transferred water could be reduced if  
39 additional surface water is provided. However, if the transferred water is used to  
40 meet water demands that would not have been met (e.g., crops that had been  
41 idled), groundwater conditions would be similar with or without water transfers.

42 Under Alternative 1, water could be transferred throughout the year without an  
43 annual volumetric limit. Under the No Action Alternative, the timing of cross

1 Delta water transfers would be limited to July through September and include  
2 annual volumetric limits, in accordance with the 2008 USFWS BO and 2009  
3 NMFS BO. Overall, the potential for cross Delta water transfers would be greater  
4 under Alternative 1 as compared to the No Action Alternative.

5 *San Francisco Bay Area, Central Coast, and Southern California Regions*  
6 *Groundwater Use and Elevation*

7 Under Alternative 1, it is anticipated that CVP and SWP water supplies in the San  
8 Francisco Bay Area, Central Coast, and Southern California regions would be  
9 increased as compared to CVP and SWP water supplies under the No Action  
10 Alternative, as discussed in Chapter 5, Surface Water Resources and Water  
11 Supplies. The increase in surface water supplies could result in decreased  
12 groundwater withdrawals by CVP and SWP water users, resulting in increased  
13 groundwater recharge, and increased groundwater levels in areas with CVP and  
14 SWP water users.

15 *Land Subsidence*

16 Decreased use of groundwater and higher groundwater levels would result in a  
17 decreased potential for additional land subsidence under Alternative 1 as  
18 compared to the No Action Alternative in the Santa Clara Valley Groundwater  
19 Basin in the San Francisco Bay Area Region, and the Antelope Valley and  
20 Lucerne Valley groundwater basins in the Southern California Region.

21 *Groundwater Quality*

22 As described in Section 7.3, Affected Environment, there are localized areas of  
23 moderate to high salinity due to natural geologic formations and/or seawater  
24 intrusion in the San Francisco Bay Area, Central Coast, and Southern California  
25 regions. Under Alternative 1 as compared to the No Action Alternative, it is  
26 anticipated that the decreased groundwater withdrawals would cause improved  
27 groundwater quality, especially near the coast.

28 **7.4.3.2.2 Alternative 1 Compared to the Second Basis of Comparison**

29 Alternative 1 is identical to the Second Basis of Comparison.

30 **7.4.3.3 Alternative 2**

31 The CVP and SWP operations under Alternative 2 are identical to the CVP and  
32 SWP operations under the No Action Alternative; therefore, the groundwater  
33 conditions under Alternative 2 is only compared to the Second Basis of  
34 Comparison.

35 **7.4.3.3.1 Alternative 2 Compared to the Second Basis of Comparison**

36 Changes to groundwater resources under Alternatives 2 as compared to the  
37 Second Basis of Comparison would be the same as the impacts described in  
38 Section 7.4.3.1, No Action Alternative.

39 **7.4.3.4 Alternative 3**

40 As described in Chapter 3, Description of Alternatives, CVP and SWP operations  
41 under Alternative 3 are similar to the Second Basis of Comparison and

1 Alternative 1 with modified Old and Middle River flow criteria. Alternative 3 is  
2 compared to the No Action Alternative and the Second Basis of Comparison.

3 **7.4.3.4.1 Alternative 3 Compared to the No Action Alternative**

4 *Trinity River Region*

5 Groundwater conditions in the Trinity River Region are not directly related to  
6 CVP and SWP water supplies or operations. Therefore, groundwater use, related  
7 groundwater levels, potential for land use subsidence, and groundwater quality  
8 under Alternative 3 would be the same as under the No Action Alternative.

9 *Central Valley Region*

10 *Groundwater Use and Elevation*

11 In areas of the Central Valley Region that do not use CVP and SWP water  
12 supplies, areas that use CVP water under Sacramento River Exchange Settlement  
13 Contracts, and areas that use San Joaquin River Exchange Contracts under  
14 Alternative 3 water supplies would be the same as under the No Action  
15 Alternative. Therefore, in these areas of the Central Valley Region, groundwater  
16 use and groundwater levels under Alternative 3 would be the same as under the  
17 No Action Alternative. The CVHM simulation primarily focuses on changes in  
18 agricultural groundwater use in response to changes in the availability of CVP and  
19 SWP water. However, it is recognized that in the vicinity of some communities,  
20 such as in the area in the American River watershed served with CVP water  
21 supplies, groundwater use also would increase with the reduction in surface water  
22 availability. However, these changes are not considered to be substantial under  
23 Alternative 3 as compared to the No Action Alternative because the long-term  
24 increases in CVP municipal water supplies are anticipated to be up to 7,000 acre-  
25 feet (up to 7 percent) in dry years, and similar (or 5 percent or less) in long-term  
26 conditions and critical dry years. The water demands are consistent between  
27 Alternative 3 and the No Action Alternative; therefore, it is anticipated that  
28 increased surface water supplies would result in reduced groundwater use.

29 In areas of the Central Valley Region that use CVP water service contract and  
30 SWP entitlement contract water supplies, the CVP and SWP water supplies would  
31 be greater under Alternative 3 as compared to the No Action Alternative. The  
32 differences would result in decreased groundwater use and increased groundwater  
33 levels in the San Joaquin Valley Groundwater Basin under Alternative 3 as  
34 compared to the No Action Alternative. Results of CVHM simulation indicate  
35 that groundwater levels would be similar in the Redding and Sacramento Valley  
36 groundwater basins and the northern portion of the San Joaquin Valley  
37 Groundwater Basin (changes would be plus/minus 2 feet), as shown in  
38 Figures 7.33 through 7.37.

39 Groundwater levels increase under Alternative 3 in the central and southern San  
40 Joaquin Valley Groundwater Basin as compared to the No Action  
41 Alternative with greater increases occurring in wet years than in critical dry years.  
42 Figures 7.38 and 7.39 present the simulated changes in groundwater levels over  
43 the 42-year CVHM model study period. Simulated average July agricultural

1 groundwater pumping under Alternative 3 as compared to the No Action  
2 Alternative is presented in Figures 7.31 and 7.32.

3 Overall, under Alternative 3 as compared to the No Action Alternative, July  
4 average groundwater levels increase approximately 2 to 10 feet in most of the  
5 central and southern San Joaquin Valley Groundwater Basin in all water year  
6 types. July average groundwater levels increase 10 to 50 feet in the  
7 Delta-Mendota, Tulare Lake, and Kern County subbasins; and 50 to 200 feet in  
8 the Westside subbasin in most water year types. In critical dry years,  
9 groundwater levels increase by up to 50 feet on average in the Westside subbasin.  
10 The groundwater level change hydrographs show that in the central and southern  
11 San Joaquin Valley, groundwater levels can fluctuate up to 200 feet in some areas  
12 due to climatic variations under Alternative 3 compared to the No Action  
13 Alternative.

14 The change in groundwater pumping in the Sacramento Valley is less than  
15 5 percent. Therefore, groundwater pumping in the Sacramento Valley is similar  
16 under Alternative 3 compared to the No Action Alternative.

17 Groundwater pumping in the San Joaquin and Tulare Basins decreases by  
18 approximately 6 percent under Alternative 3 as compared to the No Action  
19 Alternative. Figure 7.32 shows that the largest change in groundwater pumping  
20 under Alternative 3 as compared to the No Action Alternative occurs in the  
21 Westside subbasin with an average July decrease of approximately 35 TAF.

#### 22 *Land Subsidence*

23 Land subsidence due to groundwater withdrawals historically occurred in the  
24 Yolo subbasin of the Sacramento Valley Groundwater Basin. CVP and SWP  
25 water supplies are not used extensively in this area. The conditions under  
26 Alternative 3 would be similar as conditions under the No Action Alternative.

27 Under Alternative 3, potential for land subsidence due to groundwater  
28 withdrawals in the Delta-Mendota and Westside subbasins of the San Joaquin  
29 Valley Groundwater Basin would decrease under Alternative 3 as compared to the  
30 No Action Alternative due to the decreased groundwater withdrawals.

31 Groundwater level-induced land subsidence has the highest potential to occur in  
32 the San Joaquin Valley Groundwater Basin, based on historical data, if  
33 groundwater pumping substantially increases. Under Alternative 3 CVP and  
34 SWP water supplies are expected to increase in the San Joaquin Valley as  
35 compared to the No Action Alternative. Increased surface water deliveries could  
36 result in a decrease in groundwater pumping. The decreased groundwater  
37 pumping would result in higher groundwater levels, and therefore, the potential  
38 for groundwater level-induced land subsidence is reduced under Alternative 3 as  
39 compared to the No Action Alternative.

#### 40 *Groundwater Quality*

41 Under Alternative 3, groundwater conditions, including groundwater quality, in  
42 areas that do not use CVP and SWP water supplies would be the same as under  
43 the No Action Alternative.

1 In areas that use CVP and SWP water supplies, groundwater quality under  
 2 Alternative 3 could be improved as compared to the No Action Alternative in the  
 3 central and southern San Joaquin Valley Groundwater Basin due to decreased  
 4 groundwater withdrawals. As described above, it is assumed that measures  
 5 implemented in accordance with the CV-SALTS program or future sustainable  
 6 groundwater management plans implemented in accordance with SGMA would  
 7 not be fully implemented by 2030. However, due to the increased availability of  
 8 CVP and SWP water supplies and related reduction in groundwater use, the  
 9 groundwater quality would be improved under Alternative 3 as compared to the  
 10 No Action Alternative.

11 *Effects Related to Water Transfers*

12 Potential effects to groundwater resources could be similar to those identified in a  
 13 recent environmental analysis conducted by Reclamation for long-term water  
 14 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c), as  
 15 described above under the No Action Alternative compared to the Second Basis  
 16 of Comparison. For the purposes of this EIS, it is anticipated that similar  
 17 conditions would occur during implementation of cross Delta water transfers  
 18 under Alternative 3 and the No Action Alternative, and that groundwater impacts  
 19 would not be substantial in the seller’s service area due implementation  
 20 requirements of the transfer programs.

21 Groundwater use in areas that purchase the transferred water could be reduced if  
 22 additional surface water is provided. However, if the transferred water is used to  
 23 meet water demands that would not have been met (e.g., crops that had been  
 24 idled), groundwater conditions would be similar with or without water transfers.

25 Under Alternative 3, water could be transferred throughout the year without an  
 26 annual volumetric limit. Under the No Action Alternative, the timing of cross  
 27 Delta water transfers would be limited to July through September and include  
 28 annual volumetric limits, in accordance with the 2008 USFWS BO and 2009  
 29 NMFS BO. Overall, the potential for cross Delta water transfers would be greater  
 30 under Alternative 3 as compared to the No Action Alternative.

31 *San Francisco Bay Area, Central Coast, and Southern California Regions*  
 32 *Groundwater Use and Elevation*

33 Under Alternative 3, it is anticipated that CVP and SWP water supplies in the San  
 34 Francisco Bay Area, Central Coast, and Southern California regions would be  
 35 increased as compared to CVP and SWP water supplies under the No Action  
 36 Alternative, as discussed in Chapter 5, Surface Water Resources and Water  
 37 Supplies. The increase in surface water supplies could result in decreased  
 38 groundwater withdrawals by CVP and SWP water users, resulting in increased  
 39 groundwater recharge, and increased groundwater levels. It may be legally  
 40 impossible to extract additional groundwater in adjudicated basins without  
 41 gaining the permission of watermasters and accounting for groundwater pumping  
 42 entitlements and various parties under their adjudicated rights.



1        *Land Subsidence*

2        Decreased use of groundwater and higher groundwater levels would result in a  
3        decreased potential for additional land subsidence under Alternative 3 as  
4        compared to the No Action Alternative in the Santa Clara Valley Groundwater  
5        Basin in the San Francisco Bay Area Region, and the Antelope Valley and  
6        Lucerne Valley groundwater basins in the Southern California Region.

7        *Groundwater Quality*

8        As described in Section 7.3, Affected Environment, there are localized areas of  
9        moderate to high salinity due to natural geologic formations and/or seawater  
10       intrusion in the San Francisco Bay Area, Central Coast, and Southern California  
11       regions. Under Alternative 3 as compared to the No Action Alternative, it is  
12       anticipated that the decreased groundwater withdrawals would cause improved  
13       groundwater quality, especially near the coast.

14       **7.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison**

15       *Trinity River Region*

16       Groundwater conditions in the Trinity River Region are not directly related to  
17       CVP and SWP water supplies or operations. Therefore, groundwater use, related  
18       groundwater levels, potential for land use subsidence, and groundwater quality  
19       under Alternative 3 would be the same as under the Second Basis of Comparison.

20       *Central Valley Region*

21       *Groundwater Use and Elevation*

22       In areas of the Central Valley Region that do not use CVP and SWP water  
23       supplies, areas that use CVP water under Sacramento River Exchange Settlement  
24       Contracts, and areas that use San Joaquin River Exchange Contracts under  
25       Alternative 3 water supplies would be the same as under the Second Basis of  
26       Comparison. Therefore, in these areas of the Central Valley Region, groundwater  
27       use and groundwater levels under Alternative 3 would be the same as under the  
28       Second Basis of Comparison. The CVHM simulation primarily focuses on  
29       changes in agricultural groundwater use in response to changes in the availability  
30       of CVP and SWP water. However, it is recognized that in the vicinity of some  
31       communities, such as in the area in the American River watershed served with  
32       CVP water supplies, groundwater use also would increase with the reduction in  
33       surface water availability. However, these changes are considered to be similar  
34       under Alternative 3 as compared to the Second Basis of Comparison because the  
35       CVP municipal water supplies are similar (or 5 percent or less) in long-term  
36       conditions, dry years, and critical dry years. The water demands are consistent  
37       between Alternative 3 and the Second Basis of Comparison; therefore, it is  
38       anticipated that similar surface water supplies would result in similar groundwater  
39       use.

40       In areas of the Central Valley Region that use CVP water service contract and  
41       SWP entitlement contract water supplies, the CVP and SWP water supplies would  
42       be less under Alternative 3 as compared to the Second Basis of Comparison. The  
43       differences would result in increased groundwater use and decreased groundwater

1 levels in the San Joaquin Valley Groundwater Basin under Alternative 3 as  
 2 compared to the Second Basis of Comparison. Results of CVHM simulation  
 3 indicate that groundwater levels would be similar in the Redding and Sacramento  
 4 Valley groundwater basins and the northern portion of the San Joaquin Valley  
 5 Groundwater Basin, as shown in Figures 7.40 through 7.44.

6 Groundwater levels generally decrease under Alternative 3 in the central and  
 7 southern San Joaquin Valley Groundwater Basin as compared to the Second Basis  
 8 of Comparison. Figures 7.45 and 7.46 present the simulated change in  
 9 groundwater levels over the 42-year CVHM study period. Simulated average July  
 10 agricultural groundwater pumping under Alternative 3 as compared to the Second  
 11 Basis of Comparison is presented in Figures 7.22 and 7.23.

12 Overall, under Alternative 3 as compared to the Second Basis of Comparison,  
 13 July average groundwater levels decrease approximately 2 to 10 feet areas of the  
 14 western and southern San Joaquin Valley Groundwater Basin in all water year  
 15 types. July average groundwater levels decline up to 25 feet in the Delta-  
 16 Mendota, Tulare Lake, and Kern County subbasins; and decline up to 25 feet in  
 17 Westside subbasin, in most water year types. However, groundwater levels in the  
 18 Westside subbasin increase by up to 10 feet on average in wet years, due to  
 19 increased CVP water deliveries to this region in wet years. Groundwater level  
 20 changes in the Sacramento Valley are forecast to be less than 2 feet. The  
 21 groundwater level change hydrographs show that in the central and southern San  
 22 Joaquin Valley, groundwater levels can fluctuate up to 200 feet in some areas due  
 23 to climatic variations under Alternative 3 compared to the Second Basis of  
 24 Comparison.

25 The change in groundwater pumping in the Sacramento Valley is less than  
 26 5 percent. Therefore, groundwater pumping in the Sacramento Valley is similar  
 27 under Alternative 3 compared to the Second Basis of Comparison.

28 Groundwater pumping in the San Joaquin and Tulare Basins changes by less than  
 29 5 percent under Alternative 3 as compared to the Second Basis of Comparison,  
 30 and is therefore considered similar. Figure 7.23 shows that the biggest change in  
 31 groundwater pumping under Alternative 3 compared to the Second Basis of  
 32 Comparison occurs in WBS 18, with an average July increase close to 10 TAF.

33 *Land Subsidence*

34 Groundwater pumping would be similar in the Sacramento and San Joaquin  
 35 valleys, therefore, the potential for groundwater level-induced land subsidence  
 36 would be similar under Alternative 3 as compared to the Second Basis of  
 37 Comparison.

38 *Groundwater Quality*

39 Groundwater pumping would be similar in the Sacramento and San Joaquin  
 40 valleys, therefore, groundwater quality would be similar under Alternative 3 as  
 41 compared to the Second Basis of Comparison.

1           *Effects Related to Water Transfers*

2 Potential effects to groundwater resources could be similar to those identified in a  
3 recent environmental analysis conducted by Reclamation for long-term water  
4 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c), as  
5 described above under the No Action Alternative compared to the Second Basis  
6 of Comparison. For the purposes of this EIS, it is anticipated that similar  
7 conditions would occur during implementation of cross Delta water transfers  
8 under Alternative 3 and the Second Basis of Comparison, and that groundwater  
9 impacts would not be substantial in the seller's service area due implementation  
10 requirements of the transfer programs.

11 Groundwater use in areas that purchase the transferred water could be reduced if  
12 additional surface water is provided. However, if the transferred water is used to  
13 meet water demands that would not have been met (e.g., crops that had been  
14 idled), groundwater conditions would be similar with or without water transfers.

15 Under Alternative 3 and the Second Basis of Comparison, water could be  
16 transferred throughout the year without an annual volumetric limit. Therefore, the  
17 potential for cross Delta water transfers would be similar under Alternative 3 and  
18 the Second Basis of Comparison.

19           *San Francisco Bay Area, Central Coast, and Southern California Regions*  
20           *Groundwater Use and Elevation*

21 Under Alternative 3, it is anticipated that CVP and SWP water supplies in the San  
22 Francisco Bay Area, Central Coast, and Southern California regions would be  
23 decreased as compared to CVP and SWP water supplies under the Second Basis  
24 of Comparison, as discussed in Chapter 5, Surface Water Resources and Water  
25 Supplies. The decrease in surface water supplies could result in increased  
26 groundwater withdrawals by CVP and SWP water users, resulting in decreased  
27 groundwater recharge, and decreased groundwater levels in areas with CVP and  
28 SWP water users.

29           *Land Subsidence*

30 Increased use of groundwater and lower groundwater levels would result in an  
31 increased potential for additional land subsidence under Alternative 3 as  
32 compared to the Second Basis of Comparison in the Santa Clara Valley  
33 Groundwater Basin in the San Francisco Bay Area Region, and the Antelope  
34 Valley and Lucerne Valley groundwater basins in the Southern California Region.

35           *Groundwater Quality*

36 As described in Section 7.3, Affected Environment, there are localized areas of  
37 moderate to high salinity due to natural geologic formations and/or seawater  
38 intrusion in the San Francisco Bay Area, Central Coast, and Southern California  
39 regions. Under Alternative 3 as compared to the Second Basis of Comparison, it  
40 is anticipated that the increased groundwater withdrawals would cause poorer  
41 groundwater quality, especially near the coast.

1 **7.4.3.5 Alternative 4**

2 Groundwater conditions under Alternative 4 would be identical to groundwater  
3 conditions under the Second Basis of Comparison; therefore, Alternative 4 is only  
4 compared to the No Action Alternative.

5 **7.4.3.5.1 Alternative 4 Compared to the No Action Alternative**

6 Changes in groundwater conditions under Alternative 4 as compared to the No  
7 Action Alternative would be the same as the impacts described in  
8 Section 7.4.3.2.1, Alternative 1 Compared to the No Action Alternative.

9 **7.4.3.6 Alternative 5**

10 CVP and SWP operations under Alternative 5 are similar to the No Action  
11 Alternative with modified Old and Middle River flow criteria and New Melones  
12 Reservoir operations. As described in Chapter 4, Approach to Environmental  
13 Analysis, Alternative 5 is compared to the No Action Alternative and the Second  
14 Basis of Comparison.

15 **7.4.3.6.1 Alternative 5 Compared to the No Action Alternative**

16 *Trinity River Region*

17 Groundwater conditions in the Trinity River Region are not directly related to  
18 CVP and SWP water supplies or operations. Therefore, groundwater use, related  
19 groundwater levels, potential for land use subsidence, and groundwater quality  
20 under Alternative 5 would be the same as under the No Action Alternative.

21 *Central Valley Region*

22 *Groundwater Use and Elevation*

23 In areas of the Central Valley Region that do not use CVP and SWP water  
24 supplies, areas that use CVP water under Sacramento River Exchange Settlement  
25 Contracts, and areas that use San Joaquin River Exchange Contracts under  
26 Alternative 5 water supplies would be the same as under the No Action  
27 Alternative. Therefore, in these areas of the Central Valley Region, groundwater  
28 use and groundwater levels under Alternative 5 would be the same as under the  
29 No Action Alternative. The CVHM simulation primarily focuses on changes in  
30 agricultural groundwater use in response to changes in the availability of CVP and  
31 SWP water. However, it is recognized that in the vicinity of some communities,  
32 such as in the area in the American River watershed served with CVP water  
33 supplies, groundwater use also would increase with the reduction in surface water  
34 availability. However, these changes are not considered to be substantial under  
35 Alternative 5 as compared to the No Action Alternative because the CVP  
36 municipal water supplies are anticipated to be similar in long-term conditions, dry  
37 years, and critical dry years. The water demands are consistent between  
38 Alternative 5 and the No Action Alternative; therefore, it is anticipated that  
39 similar surface water supplies would result in similar groundwater use.

40 In areas of the Central Valley Region that use CVP water service contract and  
41 SWP entitlement contract water supplies, the CVP and SWP water supplies would  
42 be slightly lower under Alternative 5 as compared to the No Action Alternative.

1 The differences would result in increased groundwater use and decreased  
2 groundwater levels in the San Joaquin Valley Groundwater Basin under  
3 Alternative 5 as compared to the No Action Alternative. Results of CVHM  
4 simulations indicate that groundwater levels would be similar in the Redding and  
5 Sacramento Valley groundwater basins and the northern portion of the San  
6 Joaquin Valley Groundwater Basin, as shown in Figures 7.47 through 7.51.

7 Groundwater levels decrease under Alternative 5 in the central and southern San  
8 Joaquin Valley Groundwater Basin as compared to the No Action  
9 Alternative with the greatest decreases occurring in above normal years.  
10 Figures 7.52 and 7.53 present the simulated change in groundwater levels over the  
11 42-year CVHM study period. Simulated average July agricultural groundwater  
12 pumping under Alternative 5 as compared to the No Action Alternative is  
13 presented in Figures 7.31 and 7.32.

14 Overall, under Alternative 5 as compared to the No Action Alternative, July  
15 average groundwater levels decrease approximately 2 to 10 feet on average in  
16 some of the Westside subbasin and the northern portion of the Kern County  
17 subbasin in most water year types, and decrease approximately by up to 25 feet in  
18 dry and above normal water years in the Westside subbasin. The groundwater  
19 level change hydrographs show that in the central and southern San Joaquin  
20 Valley, groundwater levels usually fluctuate by no more than 50 feet in some  
21 areas due to seasonal and climatic variations under Alternative 5 compared to the  
22 No Action Alternative.

23 The change in groundwater pumping in the Sacramento Valley is less than  
24 5 percent. Therefore, groundwater pumping in the Sacramento Valley is similar  
25 under Alternative 5 compared to the No Action Alternative.

26 Groundwater pumping in the San Joaquin and Tulare Basins changes by less than  
27 5 percent under Alternative 5 as compared to the No Action Alternative, and is  
28 therefore considered similar. Figure 7.32 shows that the biggest change in  
29 groundwater pumping under Alternative 5 compared to the No Action  
30 Alternative occurs in the Western San Joaquin Valley.

31 *Land Subsidence*

32 Groundwater pumping would be similar in the Sacramento and San Joaquin  
33 valleys, therefore, the potential for groundwater level-induced land subsidence  
34 would be similar under Alternative 5 as compared to the No Action Alternative.

35 *Groundwater Quality*

36 Groundwater pumping would be similar in the Sacramento and San Joaquin  
37 valleys, therefore, groundwater quality would be similar under Alternative 5 as  
38 compared to the No Action Alternative.

39 *Effects Related to Water Transfers*

40 Potential effects to groundwater resources could be similar to those identified in a  
41 recent environmental analysis conducted by Reclamation for long-term water  
42 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c), as  
43 described above under the No Action Alternative compared to the Second Basis

1 of Comparison. For the purposes of this EIS, it is anticipated that similar  
2 conditions would occur during implementation of cross Delta water transfers  
3 under Alternative 5 and the No Action Alternative, and that groundwater impacts  
4 would not be substantial in the seller's service area due implementation  
5 requirements of the transfer programs.

6 Groundwater use in areas that purchase the transferred water could be reduced if  
7 additional surface water is provided. However, if the transferred water is used to  
8 meet water demands that would not have been met (e.g., crops that had been  
9 idled), groundwater conditions would be similar with or without water transfers.

10 Under Alternative 5 and the No Action Alternative, the timing of cross Delta  
11 water transfers would be limited to July through September and include annual  
12 volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO.  
13 Overall, the potential for cross Delta water transfers would be similar under  
14 Alternative 5 as compared to the No Action Alternative.

15 *San Francisco Bay Area, Central Coast, and Southern California Regions*  
16 *Groundwater Use and Elevation*

17 Under Alternative 5, it is anticipated that CVP and SWP water supplies in the San  
18 Francisco Bay Area, Central Coast, and Southern California regions would be  
19 similar to CVP and SWP water supplies under the No Action Alternative, as  
20 discussed in Chapter 5, Surface Water Resources and Water Supplies. Therefore,  
21 groundwater pumping would be similar.

22 *Land Subsidence*

23 Because the groundwater pumping would be similar under Alternative 5 as  
24 compared to the No Action Alternative; therefore, the potential for additional land  
25 subsidence would be similar.

26 *Groundwater Quality*

27 Because the groundwater pumping would be similar under Alternative 5 as  
28 compared to the No Action Alternative; therefore, groundwater quality would be  
29 similar.

30 **7.4.3.6.2 Alternative 5 Compared to the Second Basis of Comparison**

31 *Trinity River Region*

32 Groundwater conditions in the Trinity River Region are not directly related to  
33 CVP and SWP water supplies or operations. Therefore, groundwater use, related  
34 groundwater levels, potential for land use subsidence, and groundwater quality  
35 under Alternative 5 would be the same as under the Second Basis of Comparison.

36 *Central Valley Region*

37 *Groundwater Use and Elevation*

38 In areas of the Central Valley Region that do not use CVP and SWP water  
39 supplies, areas that use CVP water under Sacramento River Exchange Settlement  
40 Contracts, and areas that use San Joaquin River Exchange Contracts under  
41 Alternative 5 water supplies would be the same as under the Second Basis of

1 Comparison. Therefore, in these areas of the Central Valley Region, groundwater  
2 use and groundwater levels under Alternative 5 would be the same as under the  
3 Second Basis of Comparison. The CVHM simulation primarily focuses on  
4 changes in agricultural groundwater use in response to changes in the availability  
5 of CVP and SWP water. However, it is recognized that in the vicinity of some  
6 communities, such as in the area in the American River watershed served with  
7 CVP water supplies, groundwater use also would increase with the reduction in  
8 surface water availability. However, these changes are not considered to be  
9 substantial under Alternative 5 as compared to the Second Basis of Comparison  
10 because the long-term reductions in CVP municipal water supplies are anticipated  
11 to be up to 7,000 acre-feet per year (up to 6 percent) over the long-term condition,  
12 up to 9,000 acre-feet per year (up to 9 percent) in dry years, and up to 6,000 acre-  
13 feet per year (up to 8 percent) in critical dry years. The water demands are  
14 consistent between Alternative 5 and the Second Basis of Comparison; therefore,  
15 it is anticipated that reduced surface water supplies would result in increased  
16 groundwater use.

17 In areas of the Central Valley Region that use CVP water service contract and  
18 SWP entitlement contract water supplies, the CVP and SWP water supplies would  
19 be lower under Alternative 5 as compared to the Second Basis of Comparison.  
20 The differences would result in increased groundwater use and decreased  
21 groundwater levels in the San Joaquin Valley Groundwater Basin under  
22 Alternative 5 as compared to the Second Basis of Comparison. Results of CVHM  
23 simulations indicate that groundwater levels would be similar in the Redding and  
24 Sacramento Valley groundwater basins and the northern portion of the San  
25 Joaquin Valley Groundwater Basin, as shown in Figures 7.54 through 7.58.

26 Groundwater levels generally decrease under Alternative 5 in the central and  
27 southern San Joaquin Valley Groundwater Basin as compared to the Second Basis  
28 of Comparison. Figures 7.59 and 7.60 present the simulated change in  
29 groundwater levels over the 42-year CVHM study period. Simulated average July  
30 agricultural groundwater pumping under Alternative 5 as compared to the Second  
31 Basis of Comparison is presented in Figures 7.22 and 7.23.

32 Overall, under Alternative 5 as compared to the Second Basis of Comparison,  
33 July average groundwater levels decrease approximately 2 to 10 feet in most of  
34 the central and southern San Joaquin Valley Groundwater Basin in all water year  
35 types. July average groundwater levels decline 10 to 50 feet in the Delta-  
36 Mendota, Tulare Lake, and Kern County subbasins; and can decline up to 200 feet  
37 in the Westside subbasin, in below normal, above normal and dry water year  
38 types. Groundwater level changes in the Sacramento Valley are forecast to be  
39 less than 2 feet. The groundwater level change hydrographs show that in the  
40 central and southern San Joaquin Valley, groundwater levels can fluctuate up to  
41 200 feet in some areas due to seasonal and climatic variations under Alternative 5  
42 compared to the Second Basis of Comparison.

43 The change in groundwater pumping in the Sacramento Valley is less than  
44 5 percent. Therefore, groundwater pumping in the Sacramento Valley is similar  
45 under Alternative 5 compared to the Second Basis of Comparison.

1 Groundwater pumping in the San Joaquin and Tulare Basins increases by  
2 approximately 8 percent under the Alternative 5 as compared to the Second Basis  
3 of Comparison. Figure 7.23 shows that the biggest change in groundwater  
4 pumping under Alternative 5 compared to the Second Basis of Comparison occurs  
5 in WBS 14, with an average July increase of almost 40 TAF.

6 *Land Subsidence*

7 Land subsidence due to groundwater withdrawals historically occurred in the  
8 Yolo subbasin of the Sacramento Valley Groundwater Basin. CVP and SWP  
9 water supplies are not used extensively in this area. The conditions under  
10 Alternative 5 would be similar as conditions under the Second Basis of  
11 Comparison.

12 Under Alternative 5, potential for land subsidence due to groundwater  
13 withdrawals in the Delta-Mendota and Westside subbasins of the San Joaquin  
14 Valley Groundwater Basin would increase under Alternative 5 as compared to the  
15 Second Basis of Comparison due to the increased groundwater withdrawals.

16 Groundwater level-induced land subsidence has the highest potential to occur in  
17 the San Joaquin Groundwater Basin, based on historical data, if groundwater  
18 pumping substantially increases. Under Alternative 5, CVP and SWP water  
19 supplies are expected to decrease in the San Joaquin Valley as compared to the  
20 Second Basis of Comparison. Decreased surface water deliveries could result in  
21 an increase in groundwater pumping. The increased groundwater pumping would  
22 result in lower groundwater levels, and therefore, the potential for groundwater  
23 level-induced land subsidence is increased under Alternative 5 as compared to the  
24 Second Basis of Comparison.

25 *Groundwater Quality*

26 Under Alternative 5, groundwater conditions, including groundwater quality, in  
27 areas that do not use CVP and SWP water supplies would be the same as under  
28 the Second Basis of Comparison.

29 In areas that use CVP and SWP water supplies, groundwater quality under  
30 Alternative 5 could be reduced as compared to the Second Basis of Comparison in  
31 the central and southern San Joaquin Valley Groundwater Basin due to increased  
32 groundwater withdrawals and resulting potential changes in groundwater flow  
33 patterns. As described above, it is assumed that measures implemented in  
34 accordance with the CV-SALTS program or future sustainable groundwater  
35 management plans implemented in accordance with SGMA would not be fully  
36 implemented by 2030. Therefore, groundwater quality may be affected under  
37 Alternative 5 as compared to the Second Basis of Comparison.

38 *Effects Related to Water Transfers*

39 Potential effects to groundwater resources could be similar to those identified in a  
40 recent environmental analysis conducted by Reclamation for long-term water  
41 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c), as  
42 described above under the No Action Alternative compared to the Second Basis  
43 of Comparison. For the purposes of this EIS, it is anticipated that similar



1 conditions would occur during implementation of cross Delta water transfers  
2 under Alternative 5 and the Second Basis of Comparison, and that groundwater  
3 impacts would not be substantial in the seller's service area due implementation  
4 requirements of the transfer programs.

5 Groundwater use in areas that purchase the transferred water could be reduced if  
6 additional surface water is provided. However, if the transferred water is used to  
7 meet water demands that would not have been met (e.g., crops that had been  
8 idled), groundwater conditions would be similar with or without water transfers.

9 Under Alternative 5 and the Second Basis of Comparison, water could be  
10 transferred throughout the year without an annual volumetric limit. Therefore, the  
11 potential for cross Delta water transfers would be similar under Alternative 5 and  
12 the Second Basis of Comparison.

13 *San Francisco Bay Area, Central Coast, and Southern California Regions*  
14 *Groundwater Use and Elevation*

15 Under Alternative 5, it is anticipated that CVP and SWP water supplies in the San  
16 Francisco Bay Area, Central Coast, and Southern California regions would be  
17 decreased as compared to CVP and SWP water supplies under the Second Basis  
18 of Comparison, as discussed in Chapter 5, Surface Water Resources and Water  
19 Supplies. The decrease in surface water supplies could result in increased  
20 groundwater withdrawals by CVP and SWP water users, resulting in decreased  
21 groundwater recharge, and decreased groundwater levels in areas with CVP and  
22 SWP water users. It may be legally impossible to extract additional groundwater  
23 in adjudicated basins without gaining the permission of watermasters and  
24 accounting for groundwater pumping entitlements and various parties under their  
25 adjudicated rights.

26 *Land Subsidence*

27 Increased use of groundwater and lower groundwater levels would result in a  
28 decreased potential for additional land subsidence would increase under  
29 Alternative 5 as compared to the Second Basis of Comparison in the Santa Clara  
30 Valley Groundwater Basin in the San Francisco Bay Area Region, and the  
31 Antelope Valley and Lucerne Valley groundwater basins in the Southern  
32 California Region.

33 *Groundwater Quality*

34 As described in Section 7.3, Affected Environment, there are localized areas of  
35 moderate to high salinity due to natural geologic formations and/or seawater  
36 intrusion in the San Francisco Bay Area, Central Coast, and Southern California  
37 regions. Under Alternative 5 as compared to the Second Basis of Comparison, it  
38 is anticipated that the increased groundwater withdrawals would cause poorer  
39 groundwater quality, especially near the coast.

40 **7.4.3.7 Summary of Impact Analysis**

41 The results of the impact analysis of implementation of Alternatives 1 through 5  
42 as compared to the No Action Alternative and the Second Basis of Comparison  
43 are presented in Tables 7.3 and 7.4.

1 **Table 7.3 Comparison of Alternatives 1 through 5 to No Action Alternative**

<b>Alternative</b>	<b>Potential Change</b>	<b>Consideration for Mitigation Measures</b>
Alternative 1	<p><b>Trinity River Region</b> Groundwater conditions would be similar.</p> <p><b>Central Valley Region</b> Groundwater pumping and levels in the Sacramento Valley would be similar. Groundwater pumping in the San Joaquin Valley would decrease by approximately 8 percent. July groundwater levels in all water year types would be higher by approximately 2 to 10 feet in most of the central and southern San Joaquin Valley; 10 to 50 feet in the Delta-Mendota, Tulare Lake, and Kern County subbasins; and 50 to 200 feet in the Westside subbasin. The higher groundwater levels would reduce the potential for land subsidence. Groundwater quality in the San Joaquin Valley Groundwater Basin could decline.</p> <p><b>San Francisco Bay Area, Central Coast, and Southern California Regions</b> Increases in CVP and SWP water supplies, could decrease groundwater pumping and decrease the potential for land subsidence.</p>	None needed
Alternative 2	No effects on groundwater resources or water supplies.	None needed
Alternative 3	<p><b>Trinity River Region</b> Groundwater conditions would be similar.</p> <p><b>Central Valley Region</b> Groundwater pumping and levels in the Sacramento Valley would be similar. Groundwater pumping in the San Joaquin Valley would decrease by approximately 6 percent. July groundwater levels in all water year types would be higher by approximately 2 to 10 feet in most of the central and southern San Joaquin Valley; 10 to 50 feet in the Delta-Mendota, Tulare Lake, and Kern County subbasins; and 50 to 200 feet in the Westside subbasin. The higher groundwater levels would reduce the potential for land subsidence. Groundwater quality in the San Joaquin Valley Groundwater Basin could decline.</p> <p><b>San Francisco Bay Area, Central Coast, and Southern California Regions</b> Increases in CVP and SWP water supplies, could decrease groundwater pumping and decrease the potential for land subsidence.</p>	None needed

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 4	Same effects as described for Alternative 1 compared to the No Action Alternative.	None needed
Alternative 5	<p><b>Trinity River Region</b> Groundwater conditions would be similar.</p> <p><b>Central Valley Regions</b> Groundwater pumping and levels in the Sacramento Valley would be similar. Groundwater pumping, levels, and quality in the San Joaquin Valley would be similar. July groundwater levels in all water year types would decline approximately 2 to 10 feet in most of the central and southern San Joaquin Valley; and up to 25 feet in the Westside subbasin.</p> <p><b>San Francisco Bay Area, Central Coast, and Southern California Regions</b> Because the CVP and SWP water deliveries would be similar; groundwater pumping would be similar the potential for land subsidence would be similar.</p>	None needed

- 1 Note:
- 2 \*Due to the limitations and uncertainty in the CalSim II monthly model and other
- 3 analytical tools, incremental differences of 5 percent or less between alternatives and the
- 4 Second Basis of Comparison are considered to be “similar.”

1 **Table 7.4 Comparison of No Action Alternative and Alternatives 1 through 5 to**  
 2 **Second Basis of Comparison**

Alternative	Potential Change	Consideration for Mitigation Measures
No Action Alternative	<p><b>Trinity River Region</b>                      Groundwater conditions would be similar.</p> <p><b>Central Valley Regions</b>                      Groundwater pumping and levels in the Sacramento Valley would be similar.                      Groundwater pumping in the San Joaquin Valley would increase by approximately 8 percent. July groundwater levels in all water year types would decline approximately 2 to 10 feet in most of the central and southern San Joaquin Valley; 10 to 50 feet in the Delta-Mendota, Tulare Lake, and Kern County subbasins; and 100 to 200 feet in the Westside subbasin. The reduction in groundwater levels could cause additional land subsidence.                      Groundwater quality in the San Joaquin Valley Groundwater Basin could decline.</p> <p><b>San Francisco Bay Area, Central Coast, and Southern California Regions</b>                      Reductions in CVP and SWP water supplies, could increase groundwater pumping and increase the potential for land subsidence.</p>	Not considered for this comparison.
Alternative 1	No effects on groundwater resources or water supplies.	None needed.
Alternative 2	Same effects as described for No Action Alternative as compared to the Second Basis of Comparison.	Not considered for this comparison.
Alternative 3	<p><b>Trinity River Region</b>                      Groundwater conditions would be similar.</p> <p><b>Central Valley Regions</b>                      Groundwater pumping and levels in the Sacramento Valley would be similar.                      Groundwater pumping, levels, and quality in the San Joaquin Valley would be similar. July groundwater levels in all water year types would decline approximately 2 to 10 feet in the areas of the western and southern San Joaquin Valley; up to 25 feet in the Delta-Mendota, Tulare Lake, Kern County and in Westside subbasins.</p> <p><b>San Francisco Bay Area, Central Coast, and Southern California Regions</b>                      Reductions in CVP and SWP water supplies, could increase groundwater pumping and increase the potential for land subsidence.</p>	Not considered for this comparison.

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 4	No effects on groundwater resources or water supplies.	None needed
Alternative 5	<p><b>Trinity River Region</b> Groundwater conditions would be similar.</p> <p><b>Central Valley Regions</b> Groundwater pumping and levels in the Sacramento Valley would be similar.</p> <p>Groundwater pumping in the San Joaquin Valley would increase by approximately 8 percent. July groundwater levels in all water year types would decline approximately 2 to 10 feet in most of the central and southern San Joaquin Valley; 10 to 50 feet in the Delta-Mendota, Tulare Lake and Kern County subbasins; and up to 200 feet in the Westside subbasin. The reduction in groundwater levels could cause additional land subsidence.</p> <p>Groundwater quality in the San Joaquin Valley Groundwater Basin could decline.</p> <p><b>San Francisco Bay Area, Central Coast, and Southern California Regions</b> Reductions in CVP and SWP water supplies, could increase groundwater pumping and increase the potential for land subsidence.</p>	Not considered for this comparison.

1 Note:  
 2 \*Due to the limitations and uncertainty in the CalSim II monthly model and other  
 3 analytical tools, incremental differences of 5 percent or less between alternatives and the  
 4 Second Basis of Comparison are considered to be “similar.”

5 **7.4.3.8 Potential Mitigation Measures**

6 Mitigation measures are presented in this section to avoid, minimize, rectify,  
 7 reduce, eliminate, or compensate for adverse environmental effects of  
 8 Alternatives 1 through 5 as compared to the No Action Alternative. Mitigation  
 9 measures were not included to address adverse impacts under the alternatives as  
 10 compared to the Second Basis of Comparison because this analysis was included  
 11 in this EIS for information purposes only.

12 As described above and summarized in Table 7.3, implementation of  
 13 Alternatives 1 through 5 as compared to the No Action Alternative would result in  
 14 either similar or less groundwater pumping and potential for land subsidence; and  
 15 similar groundwater quality conditions. Therefore, there would be no adverse  
 16 impacts to groundwater; and no mitigation measures are needed.

1 **7.4.3.9 Cumulative Effects Analysis**

2 As described in Chapter 3, the cumulative effects analysis considers projects,  
 3 programs, and policies that are not speculative; and are based upon known or  
 4 reasonably foreseeable long-range plans, regulations, operating agreements, or  
 5 other information that establishes them as reasonably foreseeable.

6 The cumulative effects analysis for Alternatives 1 through 5 for Groundwater  
 7 Resources are summarized in Table 7.5.

8 **Table 7.5 Summary of Cumulative Effects on Groundwater Resources of**  
 9 **Alternatives 1 through 5 as Compared to the No Action Alternative**

Scenarios	Actions	Cumulative Effects of Actions
Past & Present, and Future Actions included in the No Action Alternative in All Alternatives in Year 2030	Consistent with Affected Environment conditions plus: Actions in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives), including climate change and sea level rise Actions not included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives): - Implementation of Federal and state policies and programs, including Clean Water Act (e.g., Total Maximum Daily Loads); Safe Drinking Water Act; Clean Air Act; and flood management programs - General plans for 2030. - Trinity River Restoration Program. - Central Valley Project Improvement Act programs - Iron Mountain Mine Superfund Site - Nimbus Fish Hatchery Fish Passage Project - Folsom Dam Water Control Manual Update	These effects would be the same in all alternatives. Climate change and sea level rise, development under the general plans, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce availability of CVP and SWP water supplies; and therefore, increase groundwater use, reduce groundwater elevations, and increase potential subsidence. Future water supply projects are anticipated to both increase surface water supply reliability due to increased surface water supplies and to accommodate planned growth in the general plans. Most of these programs were initiated prior to implementation of the 2008 USFWS BO and 2009 NMFS BO which reduced CVP and SWP water supply reliability. Developments under the general plans and future water supply, water quality improvement, and restoration projects are anticipated to potentially affect future groundwater resources.

<b>Scenarios</b>	<b>Actions</b>	<b>Cumulative Effects of Actions</b>
	<ul style="list-style-type: none"> <li>- FERC Relicensing for the Middle Fork of the American River Project</li> <li>- Lower Mokelumne River Spawning Habitat Improvement Project</li> <li>- Dutch Slough Tidal Marsh Restoration</li> </ul>	<p>However, development of these future programs would include preparation of environmental documentation that would identify methods to minimize adverse impacts to groundwater resources.</p>
	<ul style="list-style-type: none"> <li>- Suisun Marsh Habitat Management, Preservation, and Restoration Plan Implementation</li> <li>- Tidal Wetland Restoration: Yolo Ranch, Northern Liberty Island Fish Restoration Project, Prospect Island Restoration Project, and Calhoun Cut/Lindsey Slough Tidal Habitat Restoration Project</li> <li>- San Joaquin River Restoration Program</li> <li>- Stockton Deep Water Ship Channel Dissolved Oxygen Project</li> <li>- Grasslands Bypass Project</li> <li>- Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS)</li> <li>- Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects with completed environmental documents)</li> </ul>	<p>Some of the future actions would reduce the effects of agricultural drainage and/or reduce salinity in the San Joaquin River and the Delta. These programs would result in a beneficial impact to groundwater quality.</p>

Scenarios	Actions	Cumulative Effects of Actions
<p>Future Actions considered as Cumulative Effects Actions in All Alternatives in Year 2030</p>	<p>Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives):</p> <ul style="list-style-type: none"> <li>- Bay-Delta Water Quality Control Plan Update</li> <li>- FERC Relicensing Projects</li> <li>- Bay Delta Conservation Plan (including California WaterFix alternative)</li> <li>- Shasta Lake Water Resources, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations</li> <li>- El Dorado Water and Power Authority Supplemental Water Rights Project</li> <li>- Sacramento River Water Reliability Project</li> </ul>	<p>These effects would be the same in all alternatives.</p> <p>Most of the future reasonably foreseeable actions are anticipated to reduce water supply impacts due to climate change, sea level rise, increased water allocated to improve habitat conditions, and future growth.</p> <p>Some of the future reasonably foreseeable actions related to improved water quality and habitat conditions (e.g., Water Quality Control Plan Update and FERC Relicensing Projects), could in further reductions in CVP and SWP water deliveries.</p>
	<ul style="list-style-type: none"> <li>- Semitropic Water Storage District Delta Wetlands</li> <li>- North Bay Aqueduct Alternative Intake</li> <li>- Irrigated Lands Regulatory Program</li> <li>- San Luis Reservoir Low Point Improvement Project</li> <li>- Westlands Water District v. United States Settlement</li> <li>- Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects that did not have completed environmental documents during preparation of the EIS)</li> </ul>	<p>Developments under the future projects are anticipated to potentially affect groundwater resources. However, development of these future programs would include preparation of environmental documentation that would identify methods to minimize adverse impacts to groundwater resources.</p> <p>Some of the future reasonably foreseeable actions would reduce the effects of agricultural drainage and/or reduce salinity in the San Joaquin River and the Delta. These programs would result in a beneficial impact to groundwater quality.</p>



<b>Scenarios</b>	<b>Actions</b>	<b>Cumulative Effects of Actions</b>
<p>No Action Alternative with Associated Cumulative Effects Actions in Year 2030</p>	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS</p>	<p>Climate change and sea level rise, development under the general plans, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce availability of CVP and SWP water supplies, and increase groundwater use as compared to past conditions. Future water supply projects are anticipated to both increase water supply reliability due to increased surface water supplies and to accommodate planned growth in the general plans. Some of the future actions would reduce the effects of agricultural drainage and/or reduce salinity in the San Joaquin River and the Delta, and improve groundwater quality.</p>
		<p>Groundwater substitution water transfers could result in reduced groundwater levels and potential subsidence in areas that sell water using groundwater substitution practices. Because all water transfers would be required to avoid adverse impacts to other water users and biological resources, including impacts to other groundwater users, it is anticipated that water transfers would not result in substantial changes in groundwater conditions</p>
<p>Alternative 1 with Associated Cumulative Effects Actions in Year 2030</p>	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)</p>	<p>Implementation of Alternative 1 with future reasonably foreseeable would result in increased surface water availability and reduced groundwater use as compared to the No Action Alternative with the added actions.</p>

Scenarios	Actions	Cumulative Effects of Actions
Alternative 2 with Associated Cumulative Effects in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions No implementation of structural improvements or other actions that require further study to develop a more detailed action description.	Implementation of Alternative 2 with future reasonably foreseeable would result in similar surface water availability and similar groundwater use as compared to the No Action Alternative with the added actions.
Alternative 3 with Associated Cumulative Effects in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant) Slight increase in positive Old and Middle River flows in the winter and spring months	Implementation of Alternative 3 with future reasonably foreseeable would result in increased surface water availability and reduced groundwater use as compared to the No Action Alternative with the added actions.
Alternative 4 with Associated Cumulative Effects in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternative 4 with future reasonably foreseeable would result in increased surface water availability and reduced groundwater use as compared to the No Action Alternative with the added actions.
Alternative 5 with Associated Cumulative Effects in Year 20530	Full implementation of the 2008 USFWS BO and 2009 NMFS BO Positive Old and Middle River flows and increased Delta outflow in spring months	Implementation of Alternative 5 with future reasonably foreseeable would result in similar surface water availability and similar groundwater use as compared to the No Action Alternative with the added actions.

1 There would be no adverse impacts associated with implementation of the  
2 alternatives as compared to the No Action Alternative. Therefore, Alternatives 1  
3 through 5 would not contribute cumulative impacts to groundwater as compared  
4 to the No Action Alternative. However, implementation of No Action  
5 Alternative and Alternative 5 (in the Central Valley, San Francisco Bay Area,  
6 Central Coast, and Southern California regions) and Alternative 3 (in the San  
7 Francisco Bay Area, Central Coast, and Southern California regions) as compared  
8 to the Second Basis of Comparison would result in increased groundwater  
9 pumping and associated potential for land subsidence and poorer groundwater  
10 quality; and could contribute to cumulative impacts related to groundwater  
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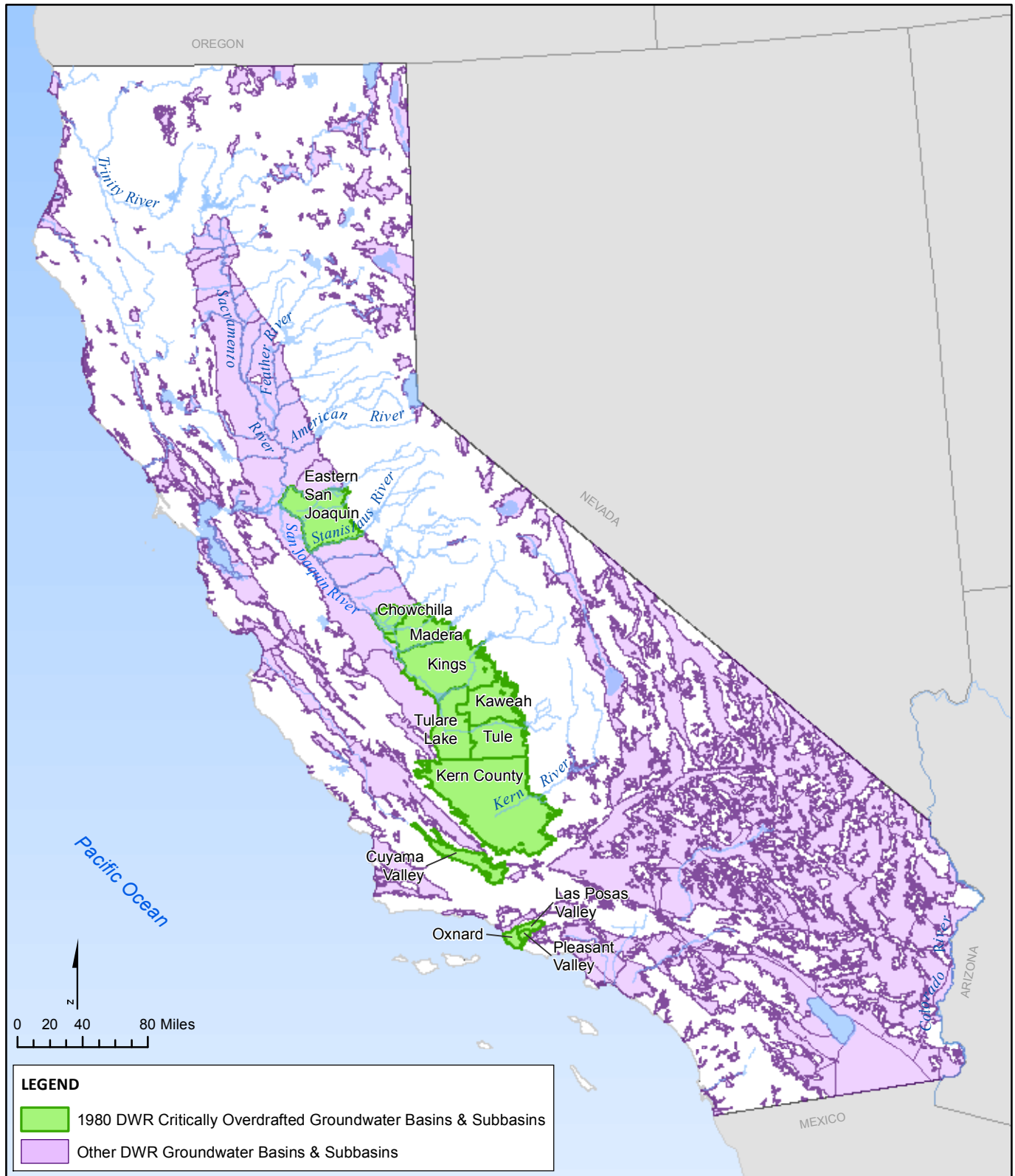
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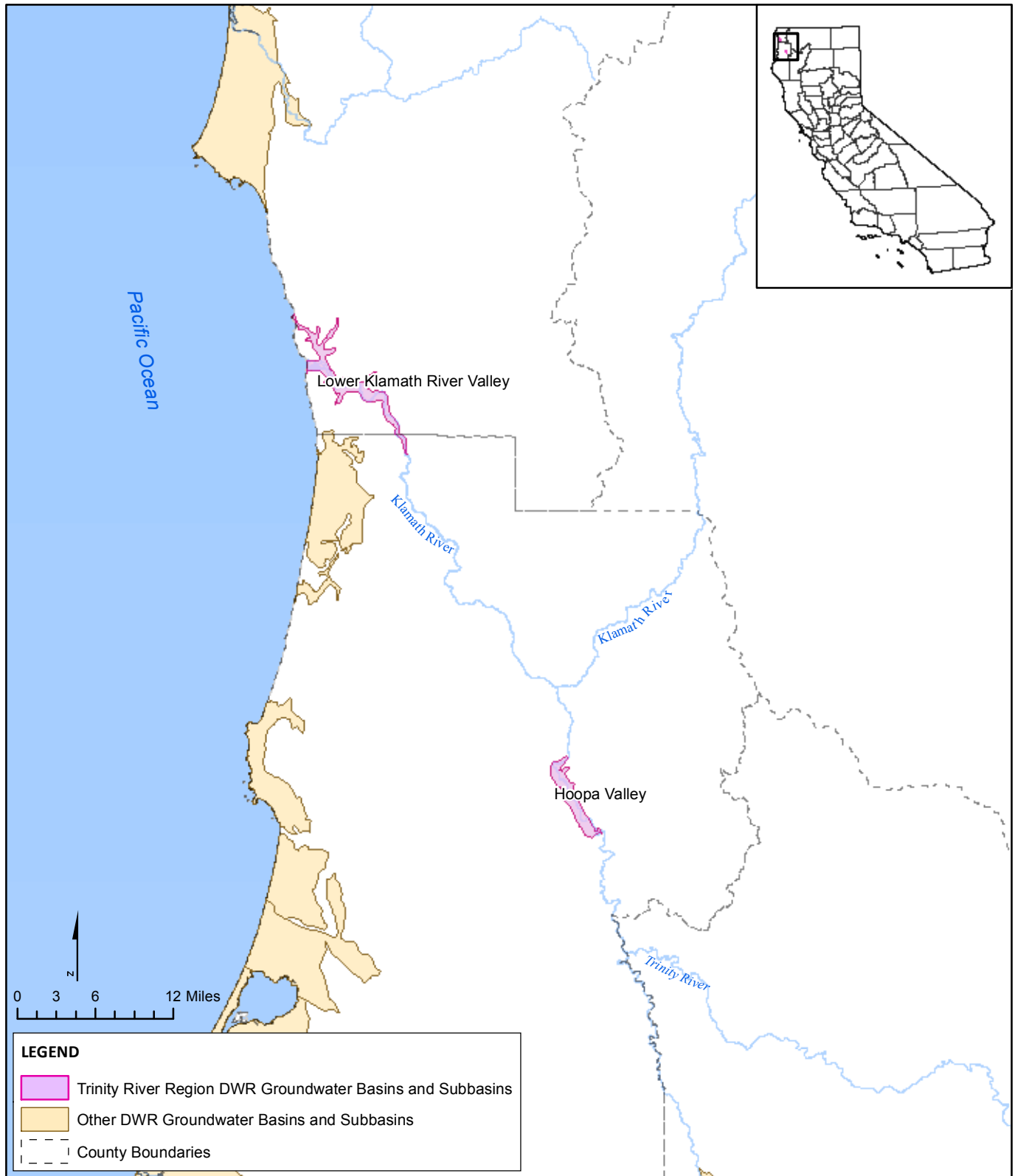
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**Figure 7.1 California Groundwater Basins and Subbasins Defined in DWR Bulletin 118**

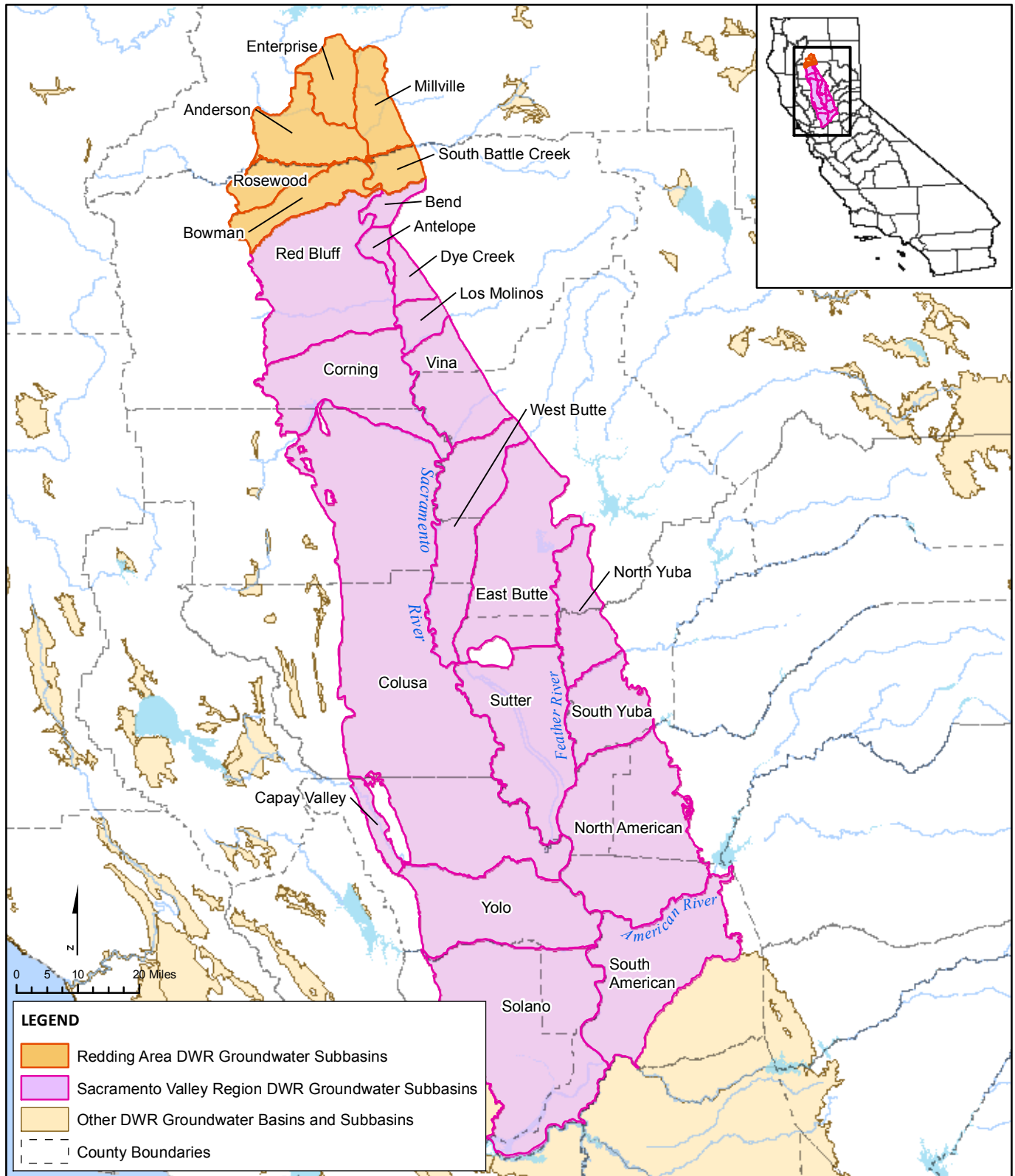


**Figure 7.2 Overdrafted Groundwater Basins Defined in DWR Bulletin 118**

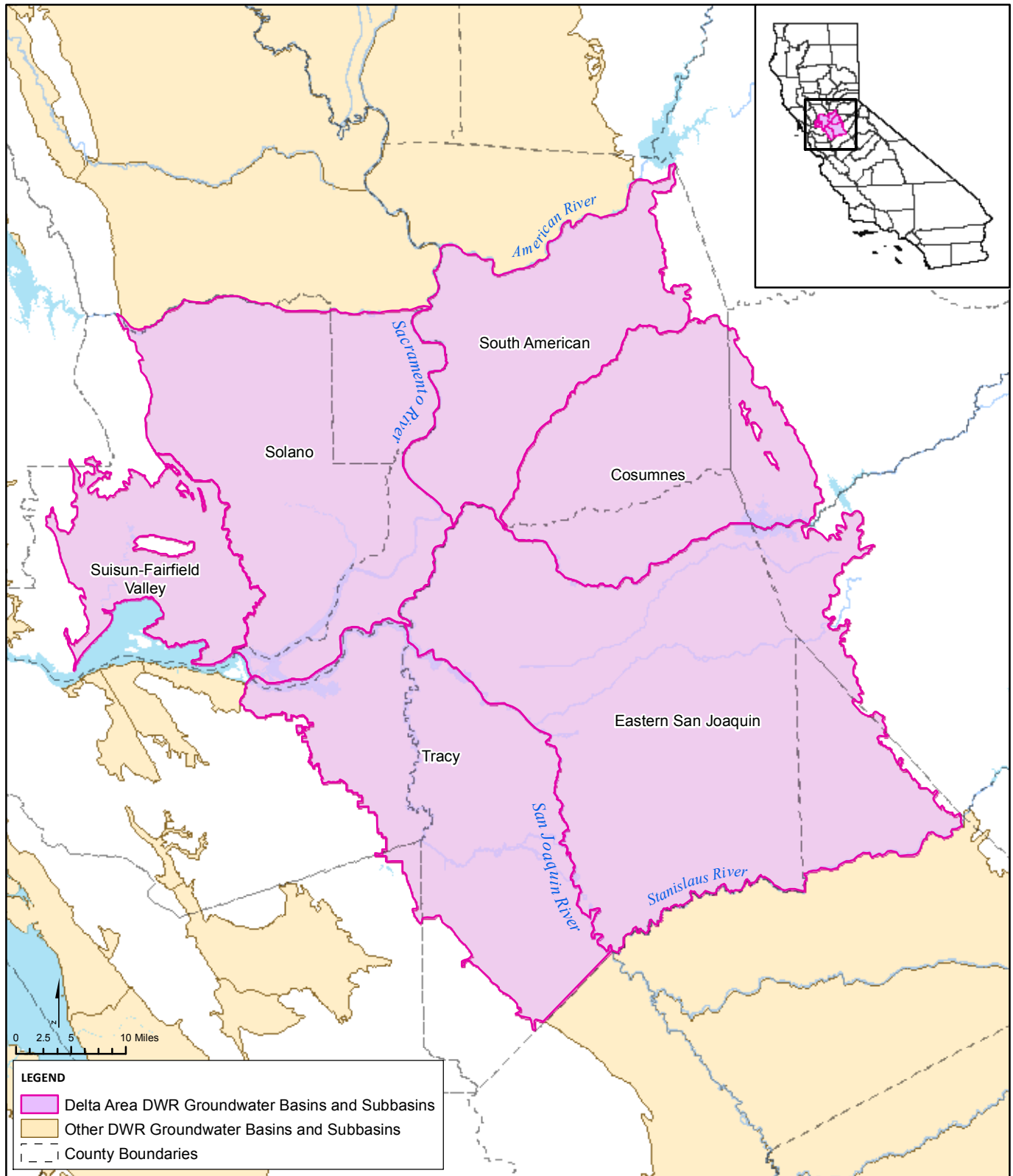


**Figure 7.3 North Coast Groundwater Basins Defined in DWR Bulletin 118**

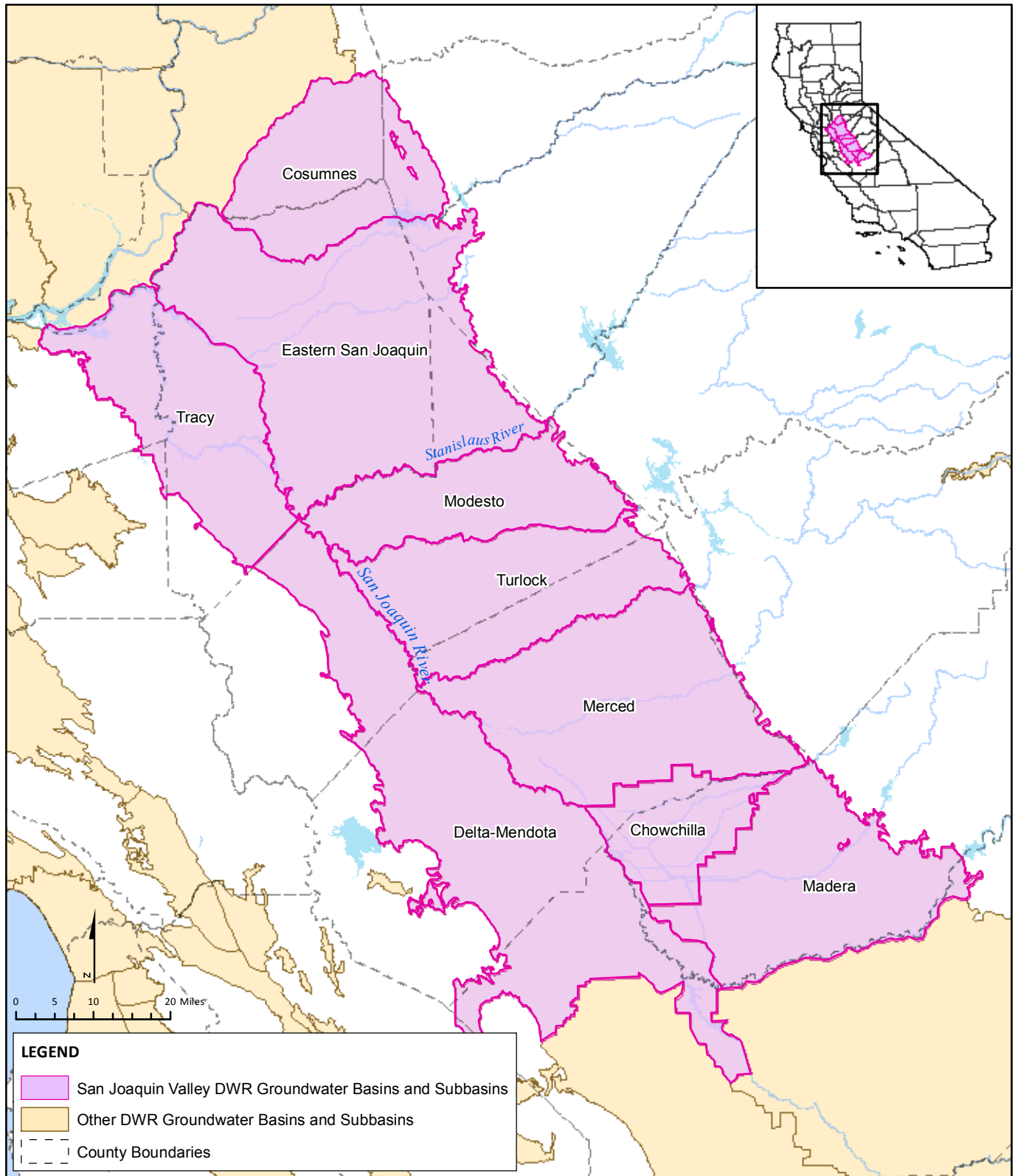




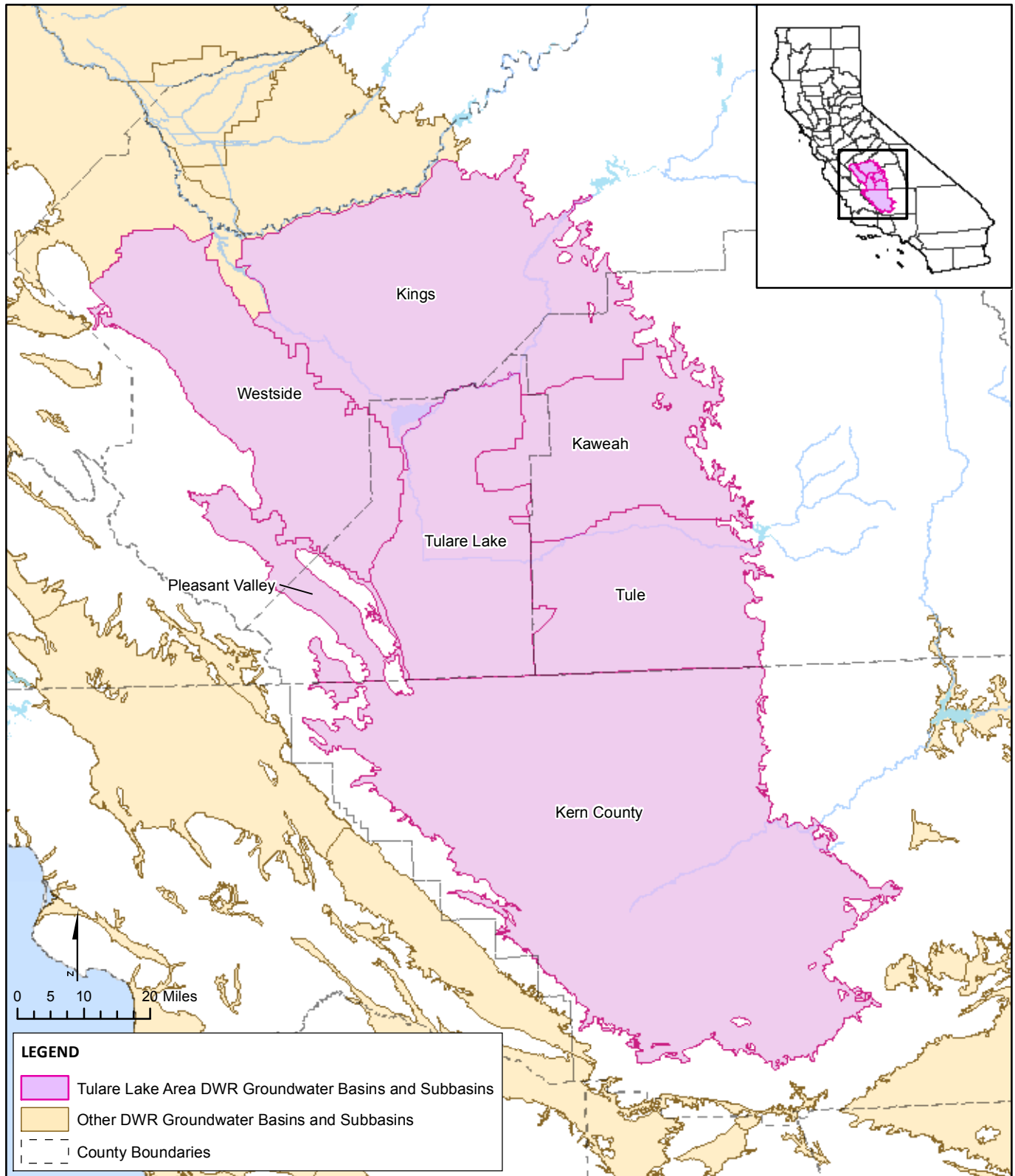
**Figure 7.4 Sacramento Valley Groundwater Basin Defined in DWR Bulletin 118**



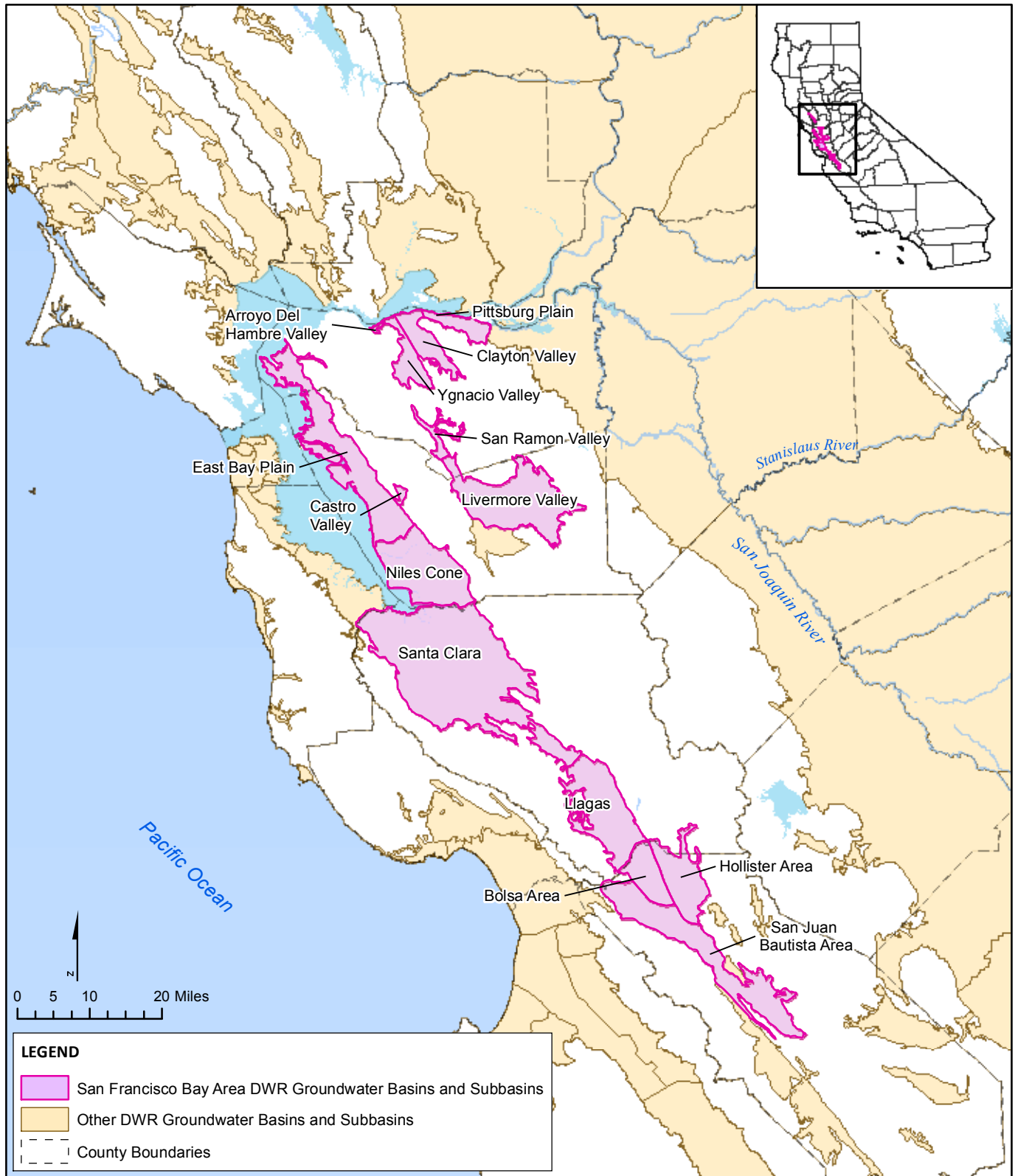
**Figure 7.5 Groundwater Subbasins in the Delta Area Defined in DWR Bulletin 118**



**Figure 7.6 San Joaquin Valley Region Groundwater Basin Defined in DWR Bulletin 118**



**Figure 7.7 Tulare Lake Area Groundwater Basin Defined in DWR Bulletin 118**



**Figure 7.8 San Francisco Bay Area Groundwater Basins Defined in DWR Bulletin 118**

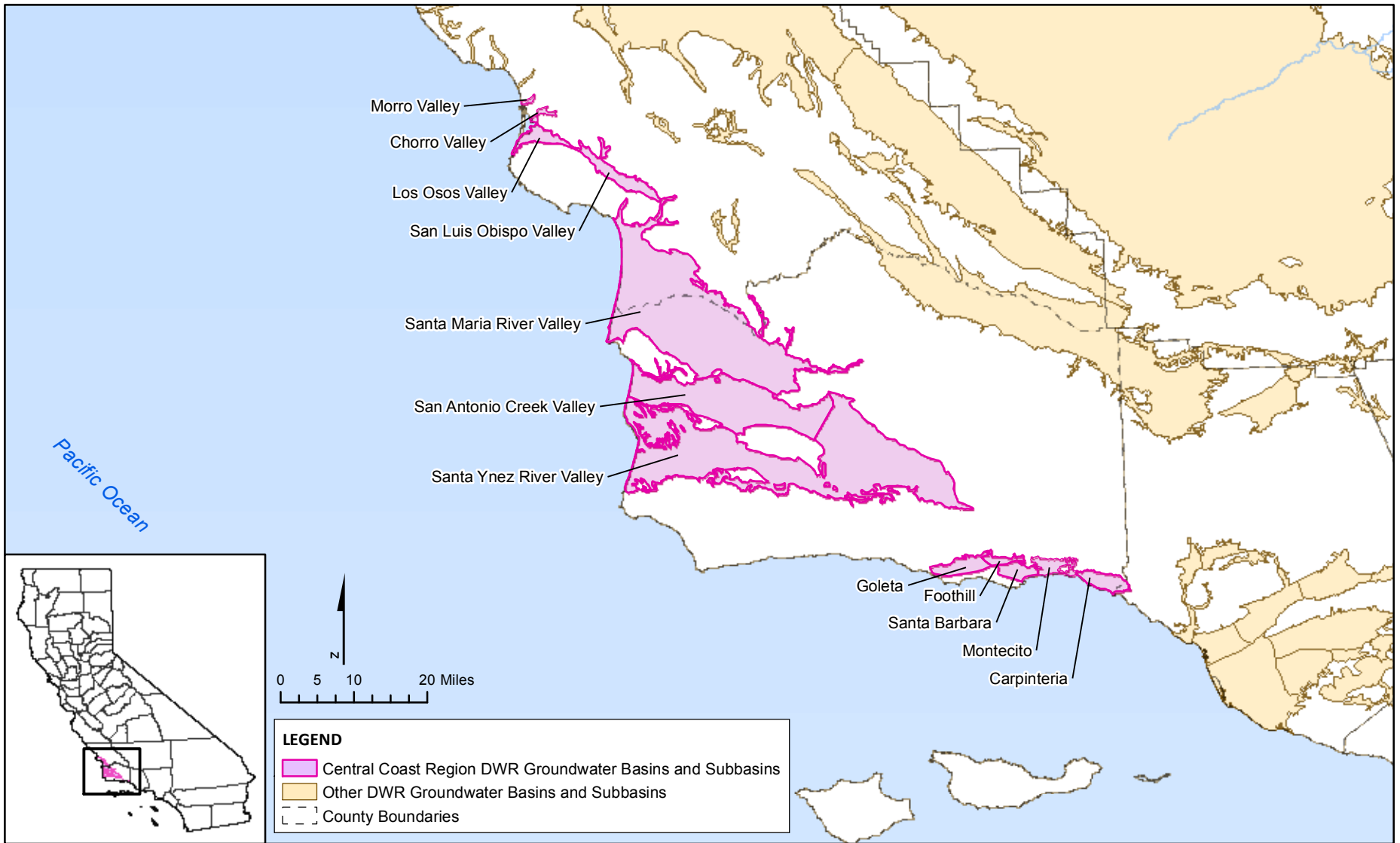


Figure 7.9 Central Coast Region Groundwater Basins defined in DWR Bulletin 118

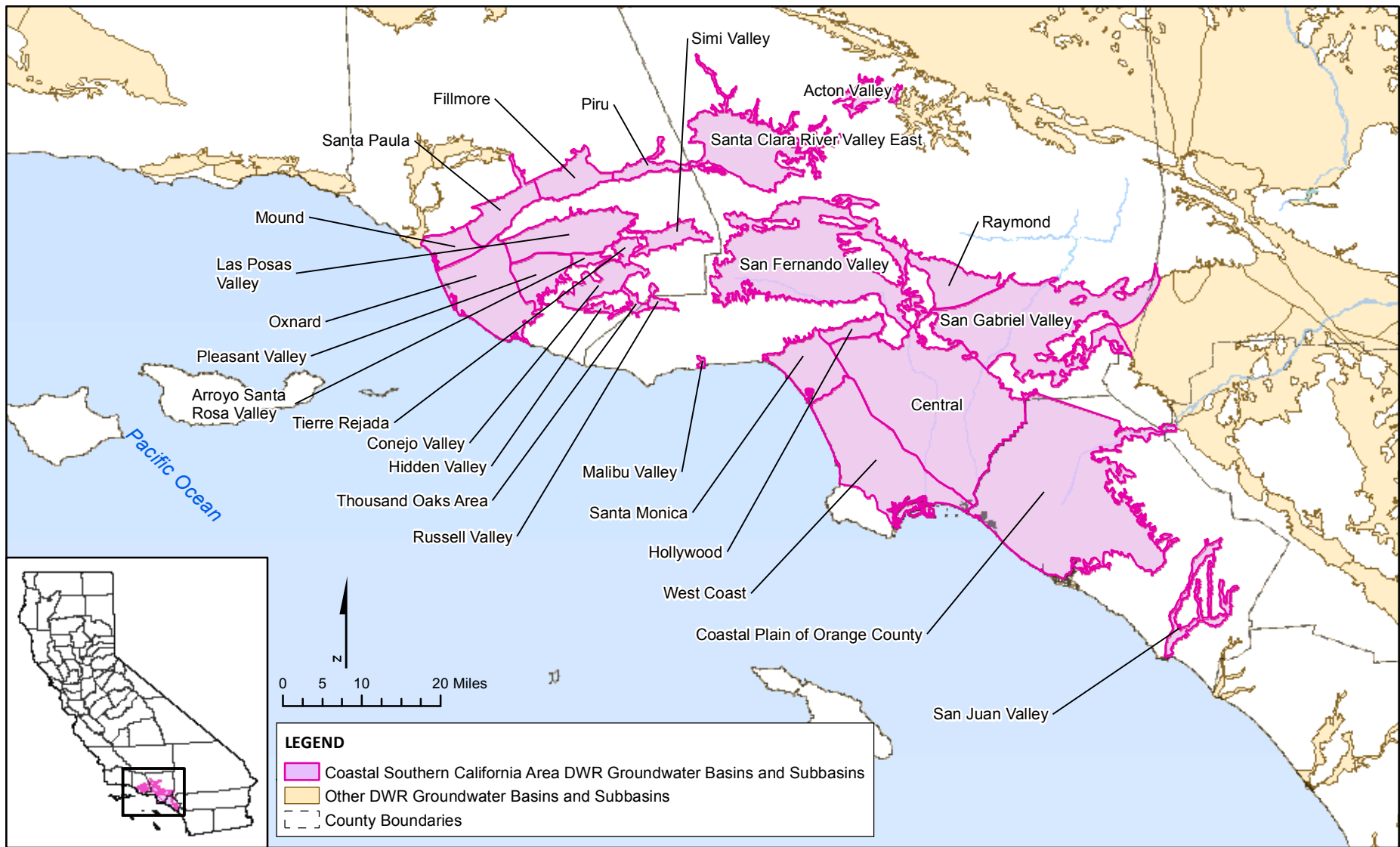


Figure 7.10 Coastal Southern California Area Groundwater Basins Defined in DWR Bulletin 118

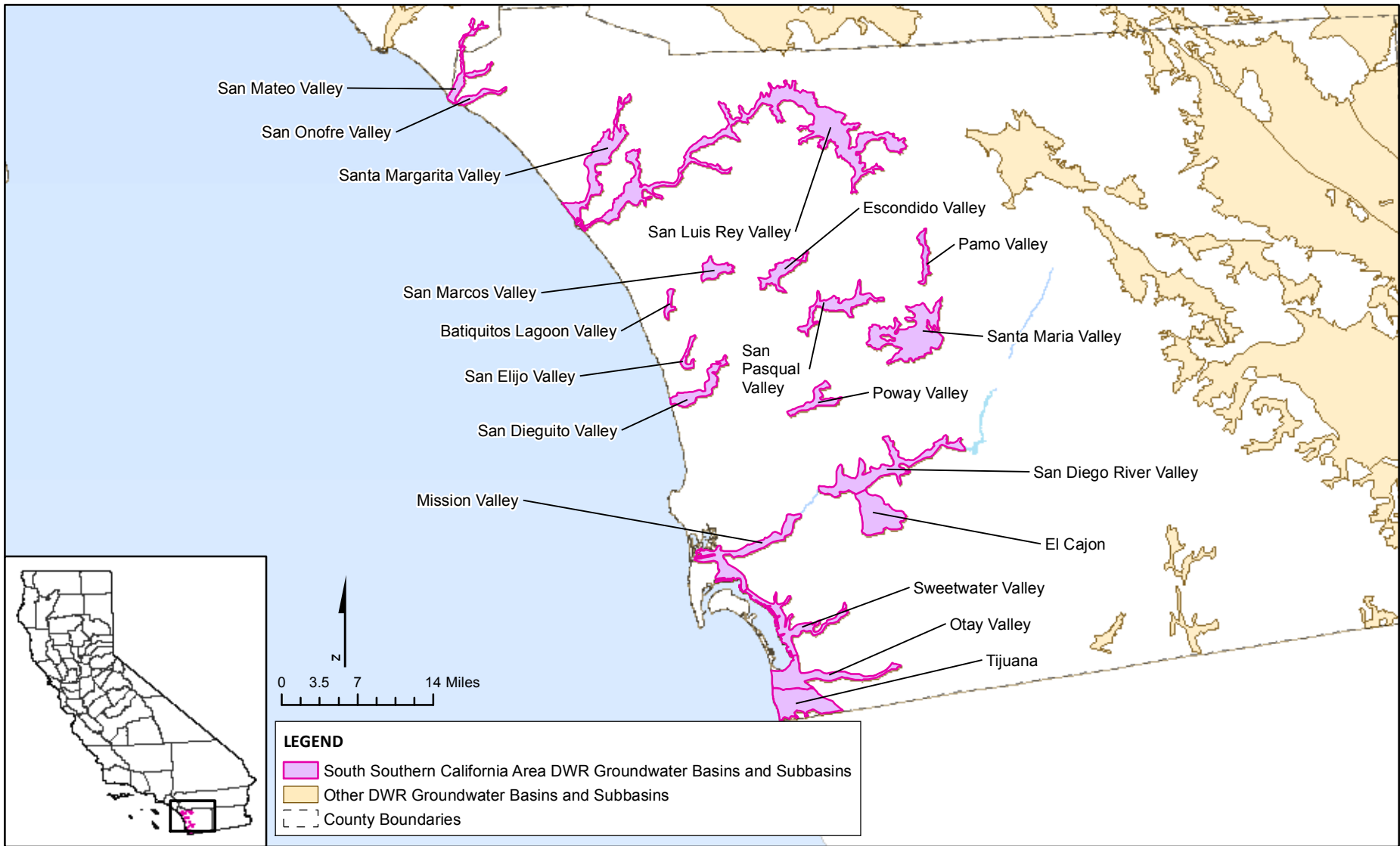


Figure 7.11 San Diego Area Groundwater Basins Defined in DWR Bulletin 118



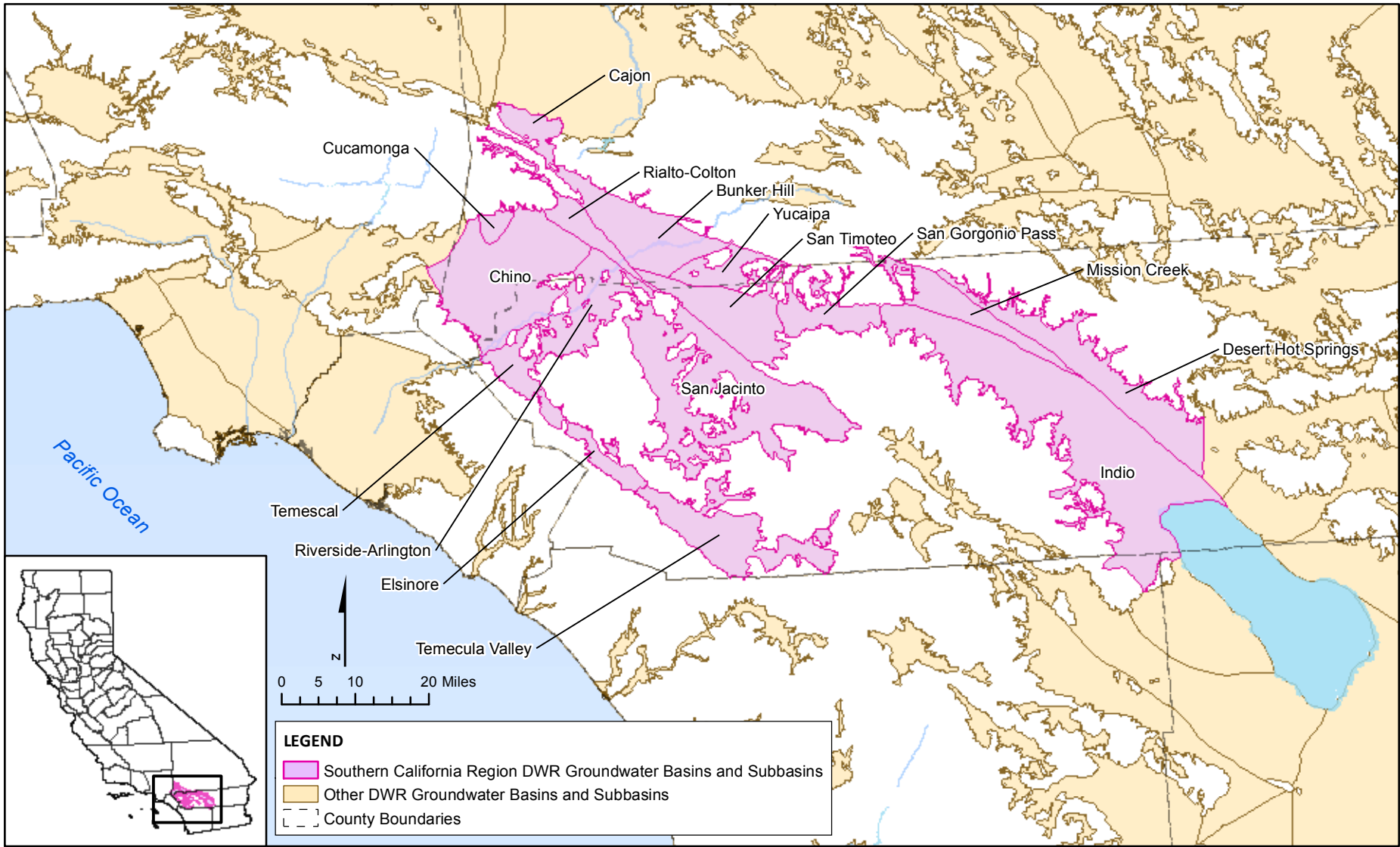


Figure 7.12 Southern California Region Groundwater Basins Defined in DWR Bulletin 118

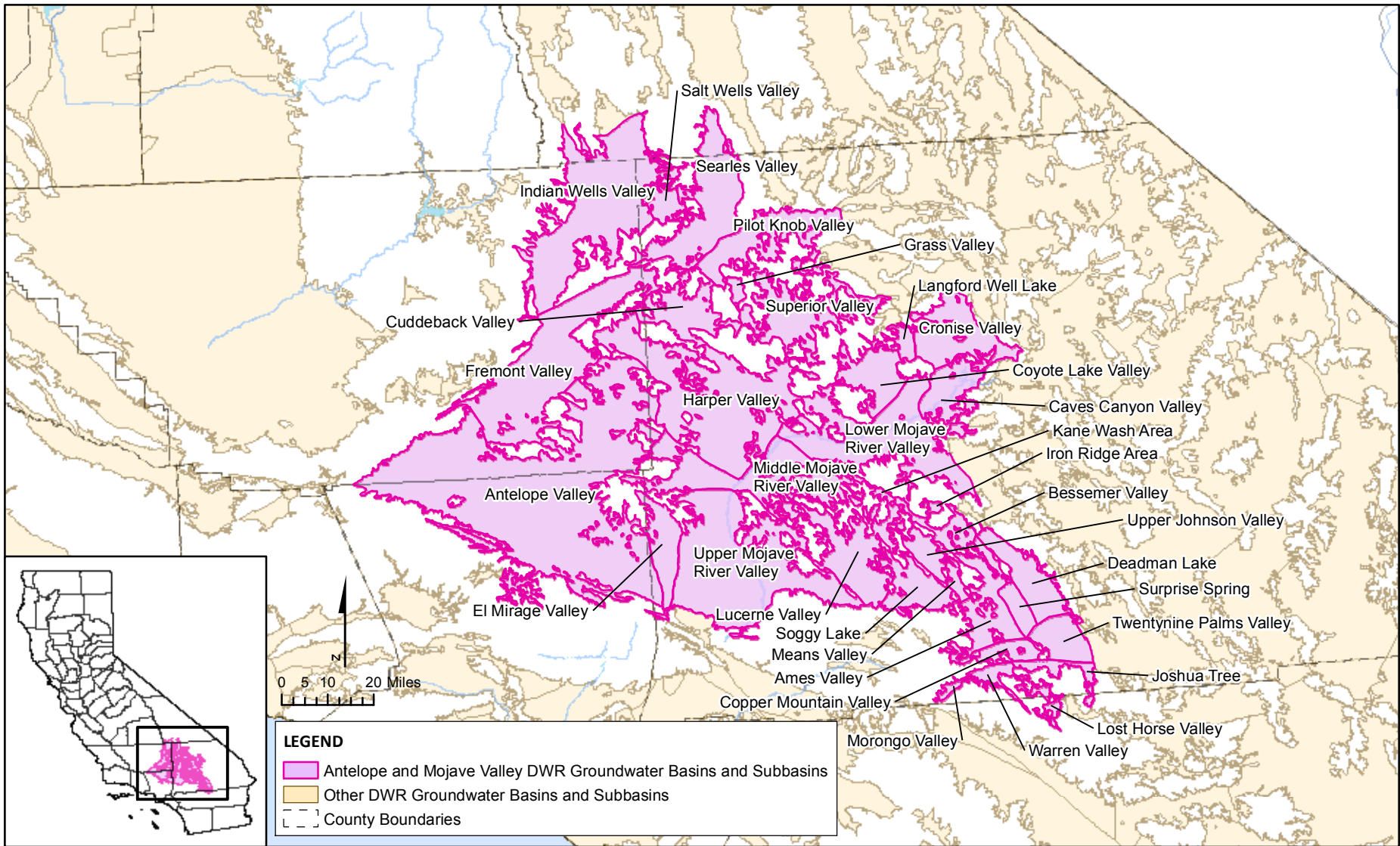
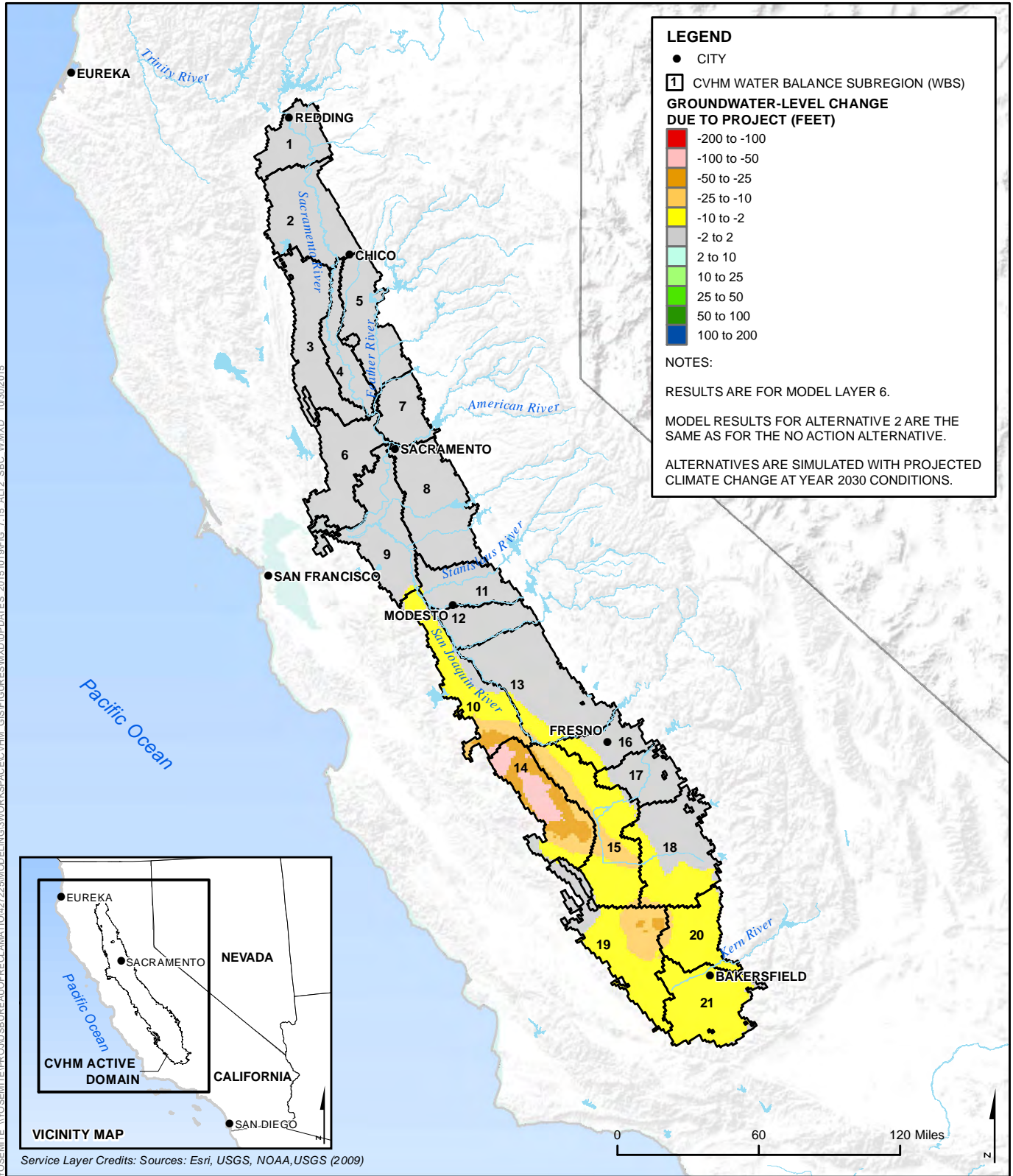


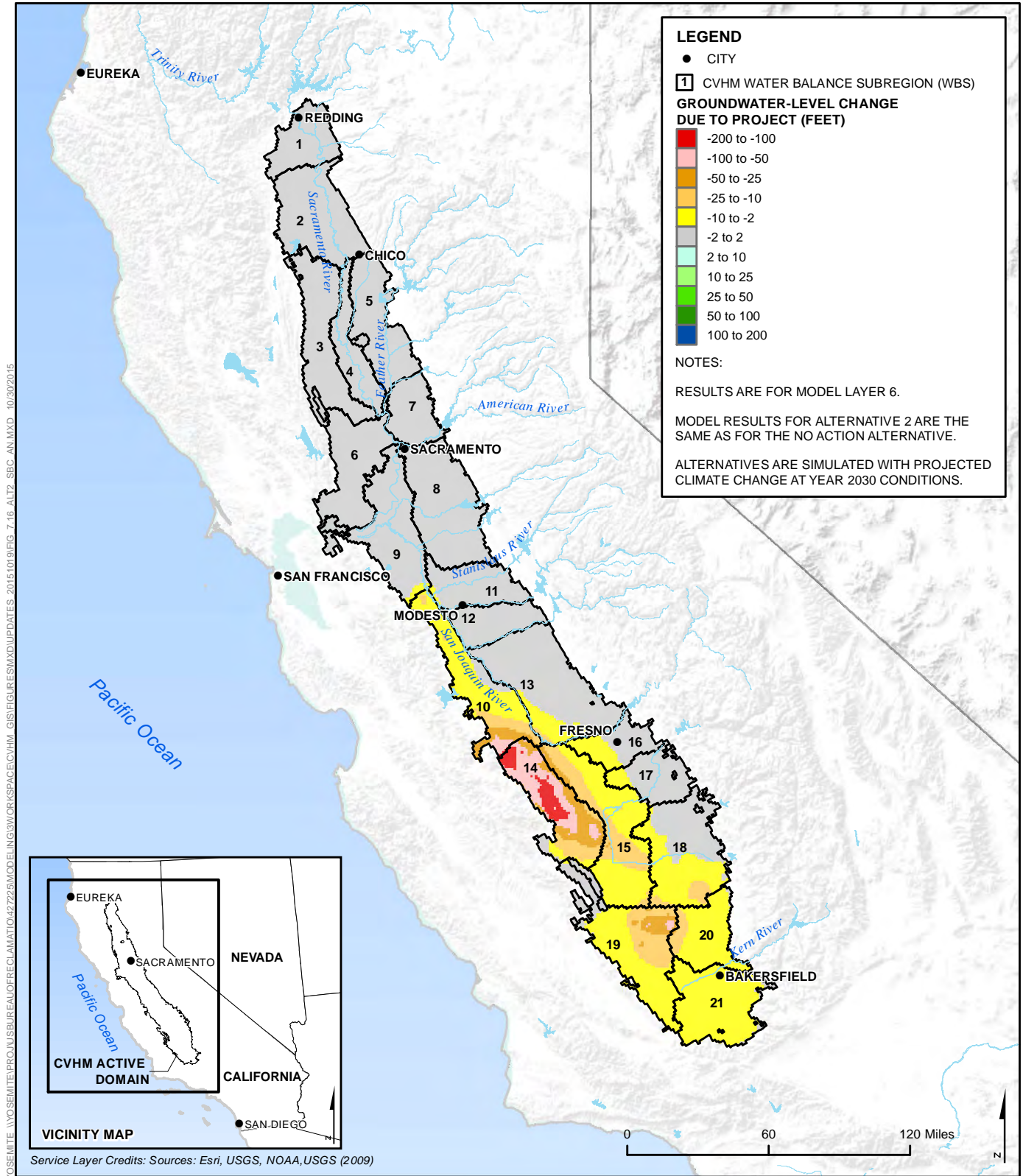
Figure 7.13 Antelope Valley and Mojave Valley Groundwater Basins Defined in DWR Bulletin 118



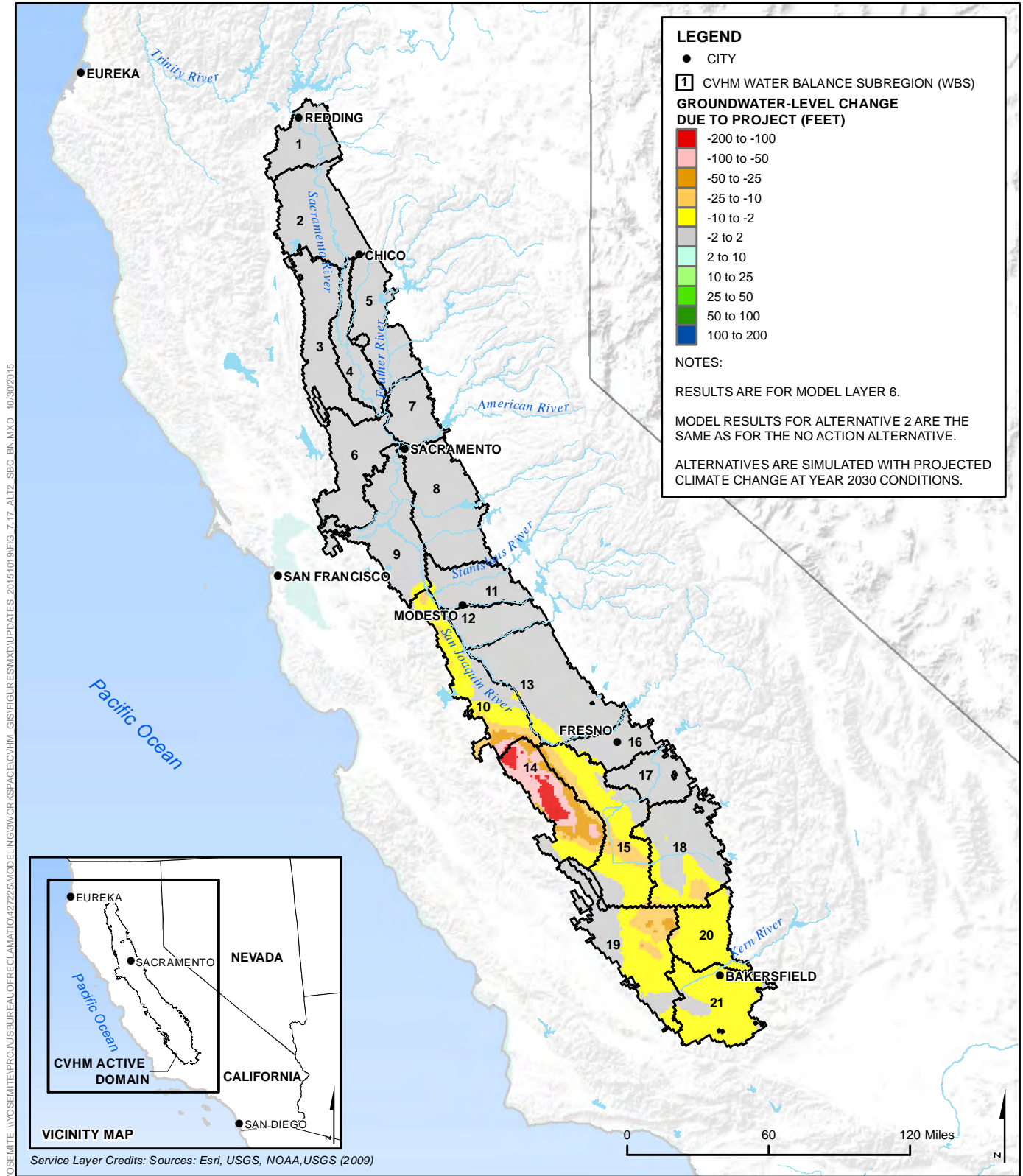
**Figure 7.14 Groundwater Model Domain and Water Balance Subregions in the Central Valley**



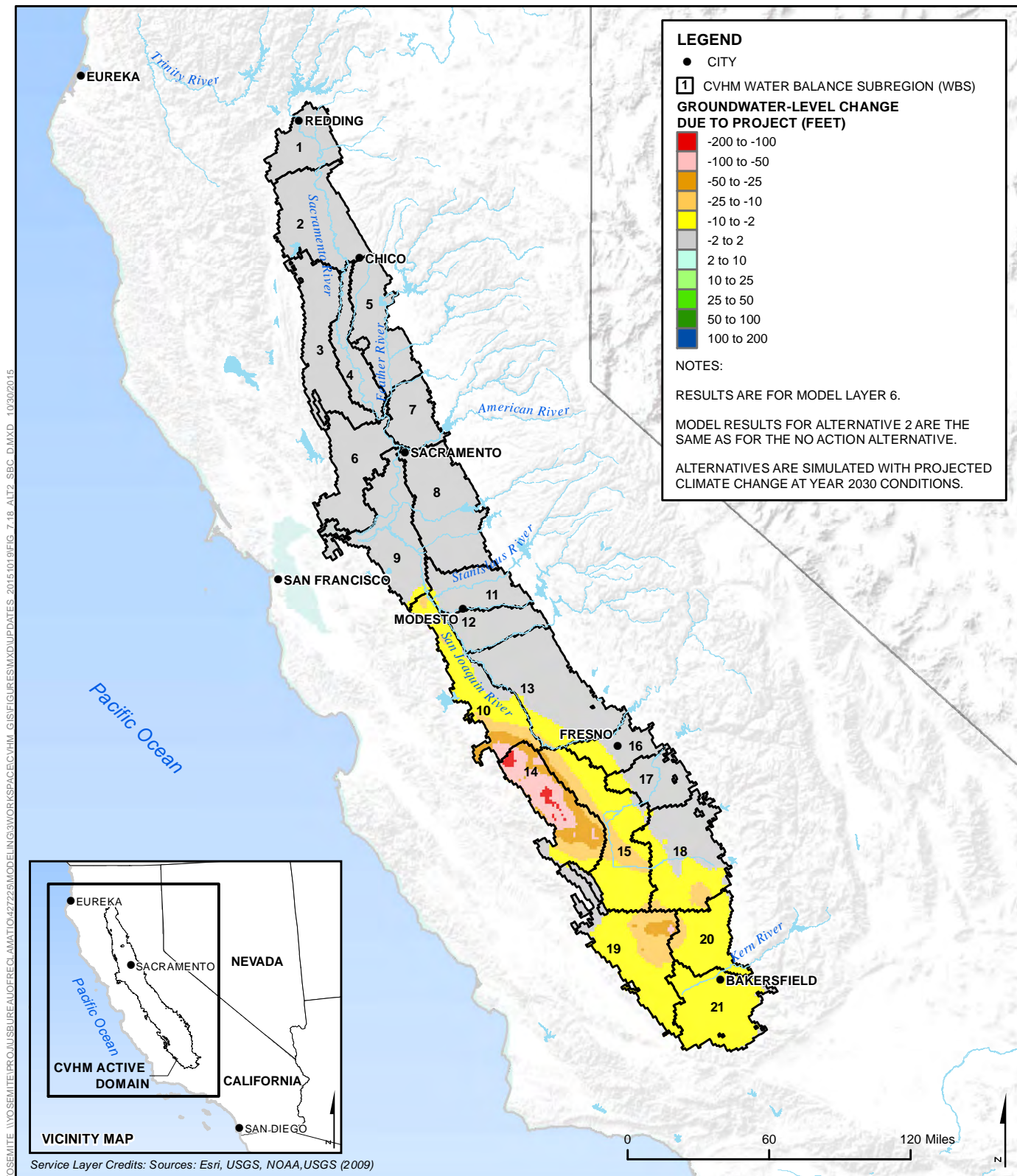
**Figure 7.15 Forecast Groundwater-Level Changes for Alternative 2 and No Action Alternative Compared to Second Basis of Comparison for Average July in a Future Wet Year**



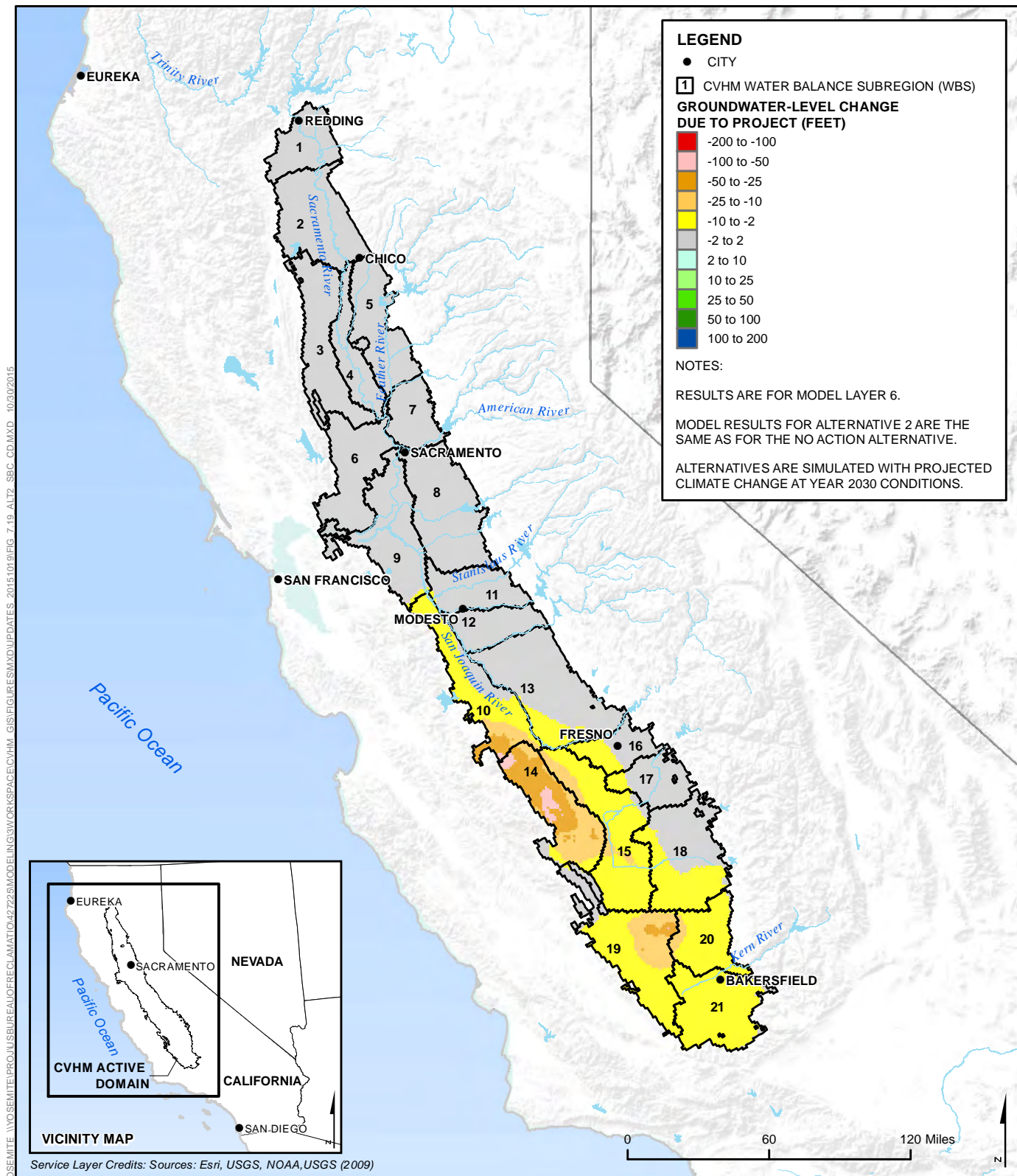
**Figure 7.16 Forecast Groundwater-Level Changes for Alternative 2 and No Action Alternative Compared to Second Basis of Comparison for Average July in a Future Above-Normal Year**



**Figure 7.17 Forecast Groundwater-Level Changes for Alternative 2 and No Action Alternative Compared to Second Basis of Comparison for Average July in a Future Below-Normal Year**



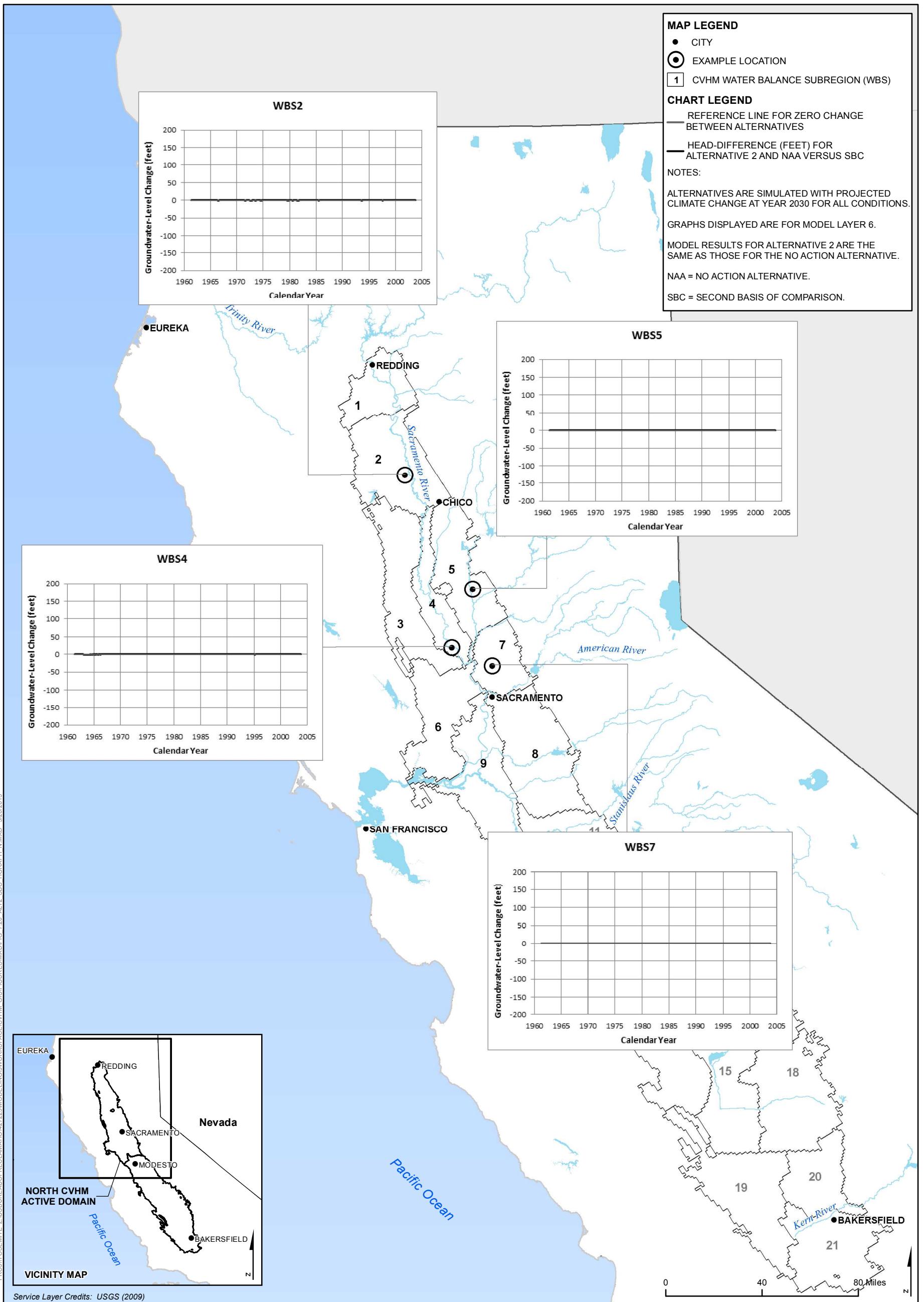
**Figure 7.18 Forecast Groundwater-Level Changes for Alternative 2 and No Action Alternative Compared to Second Basis of Comparison for Average July in a Future Dry Year**



**Figure 7.19 Forecast Groundwater-Level Changes for Alternative 2 and No Action Alternative Compared to Second Basis of Comparison for Average July in a Future Critically-Dry Year**



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**Figure 7.20 Forecast Groundwater-Level Change Hydrographs for Alternative 2 and No Action Alternative Compared to Second Basis of Comparison at Example Locations in the Sacramento Valley**

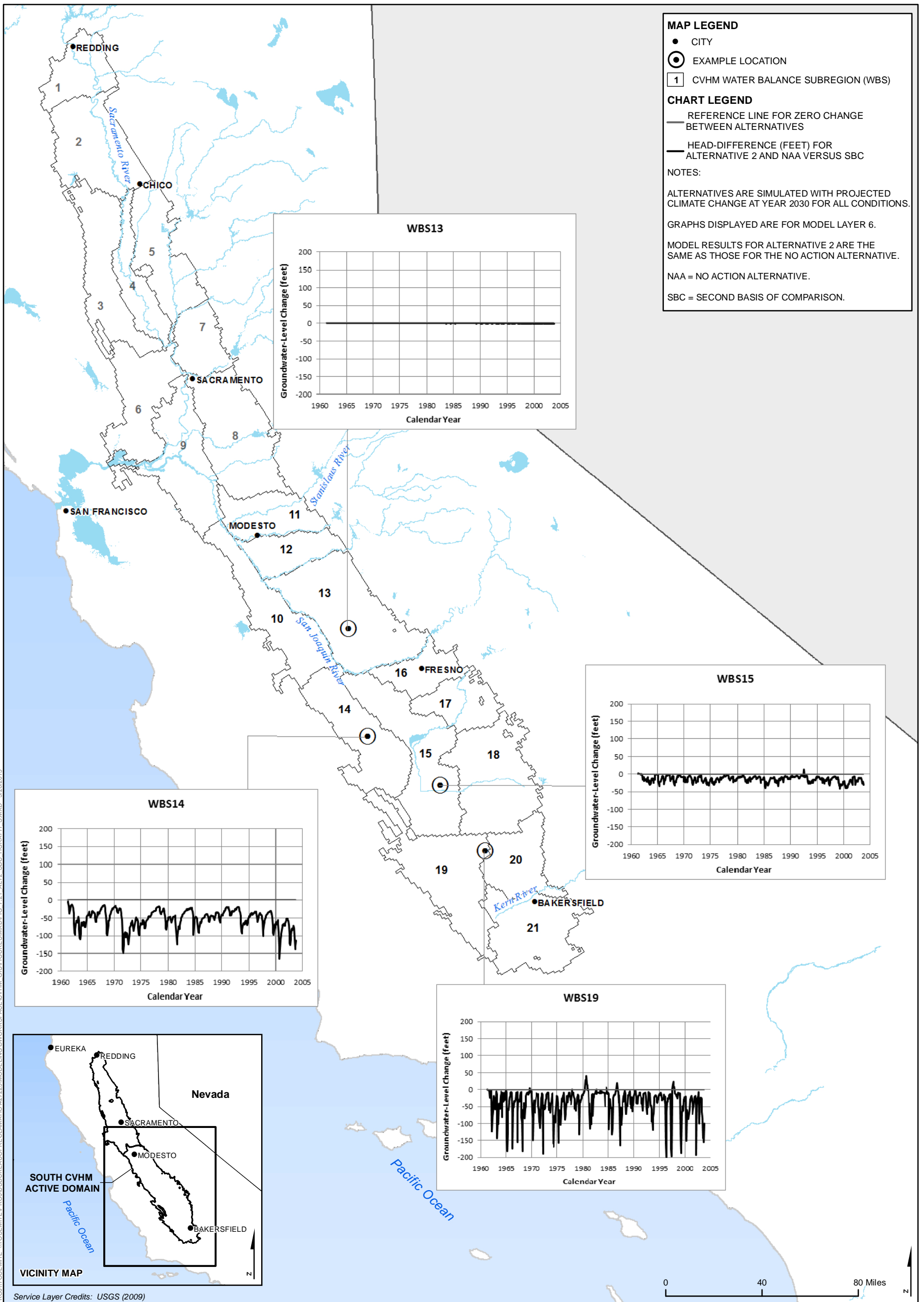


Figure 7.21 Forecast Groundwater-Level Change Hydrographs for Alternative 2 and No Action Alternative Compared to Second Basis of Comparison at Example Locations in the San Joaquin Valley

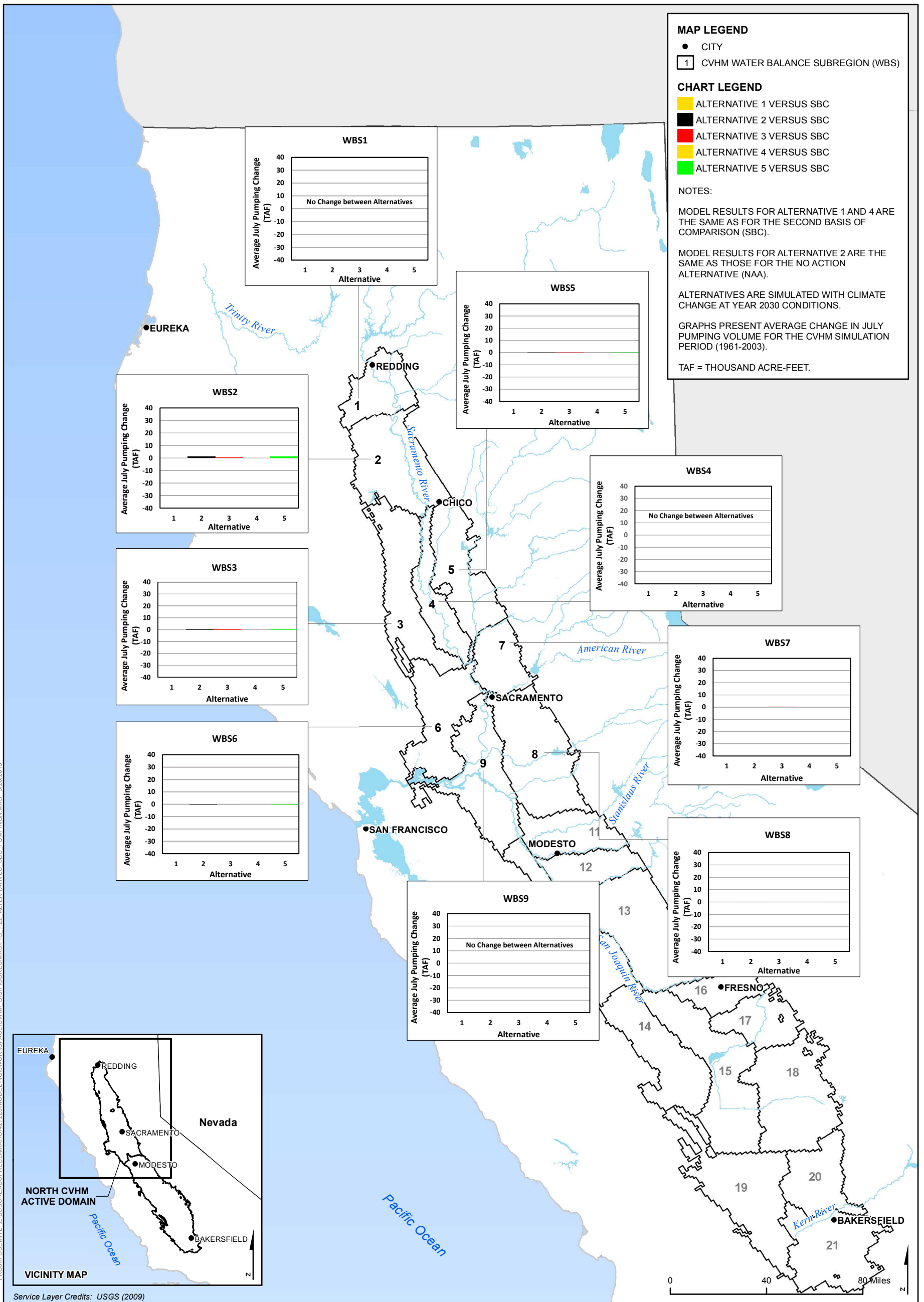
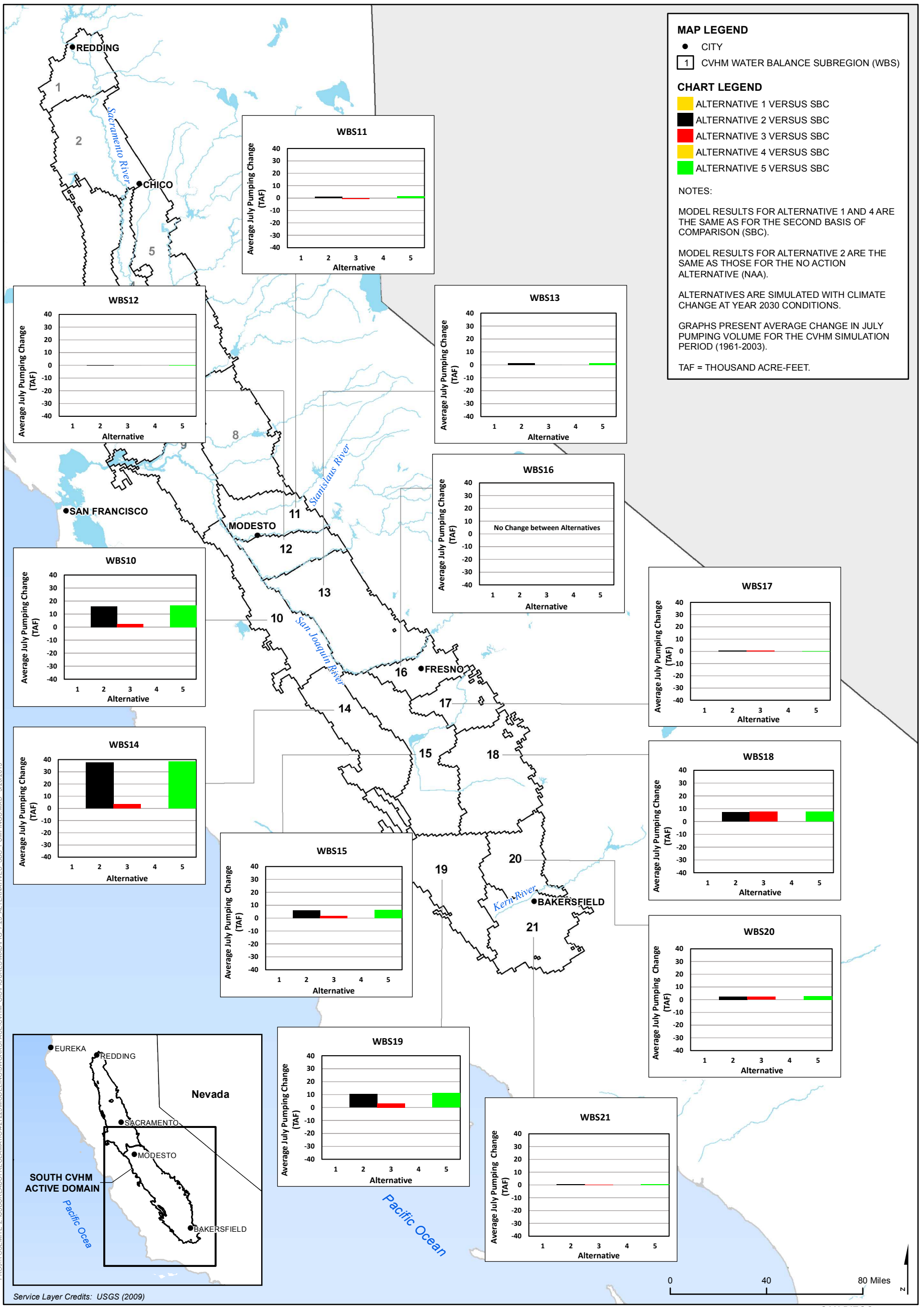


Figure 7.22 Long-term Average Change in July Agricultural Groundwater Pumping for Alternatives Compared to the Second Basis of Comparison in the Sacramento Valley

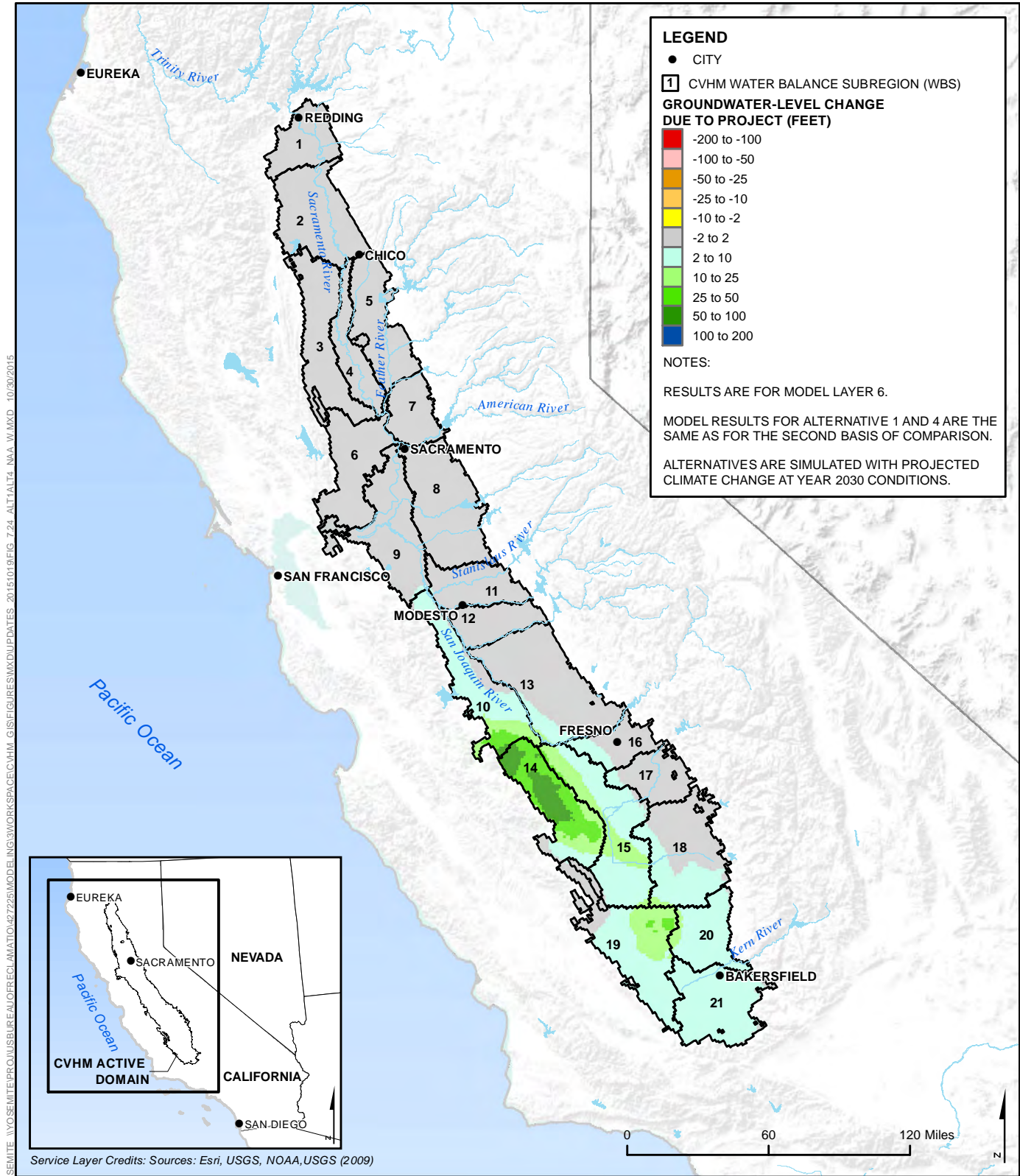


**Figure 7.23 Long-term Average Change in July Agricultural Groundwater Pumping for Alternatives Compared to the Second Basis of Comparison in the San Joaquin Valley**

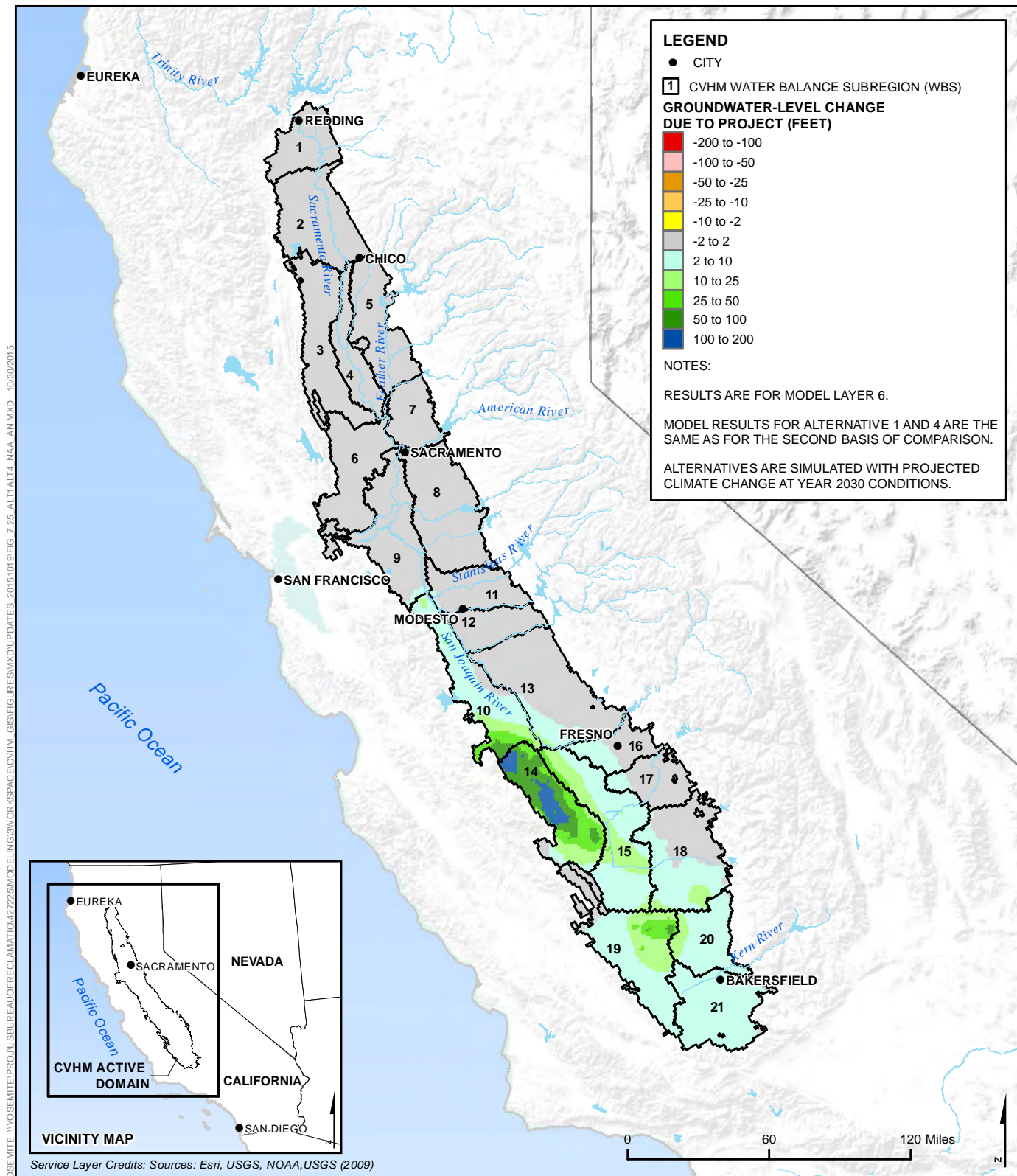
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Service Layer Credits: USGS (2009)

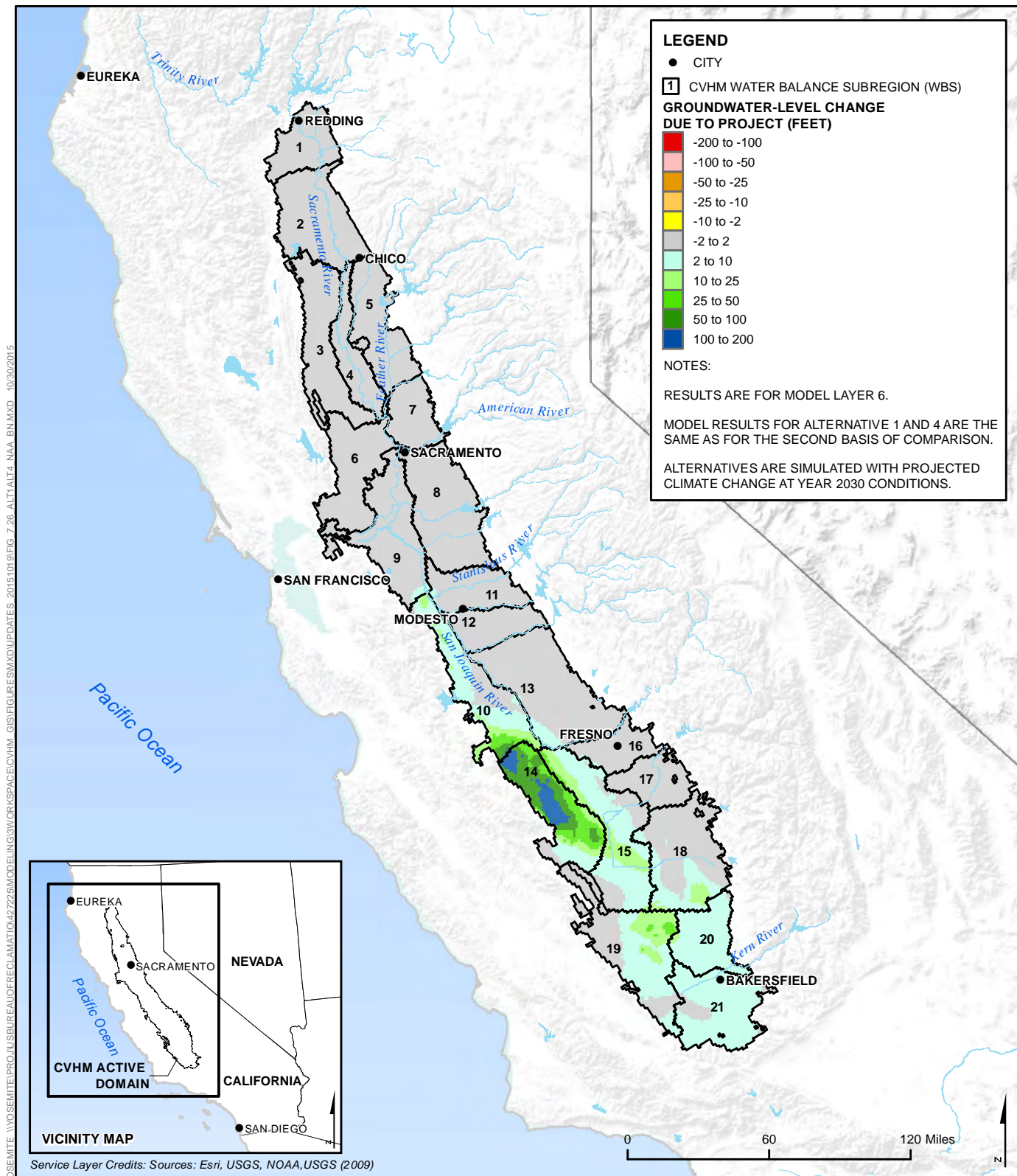
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**Figure 7.24 Forecast Groundwater-Level Changes for Alternative 1, Alternative 4, and Second Basis of Comparison Compared to No Action Alternative For Average July in a Future Wet Year**

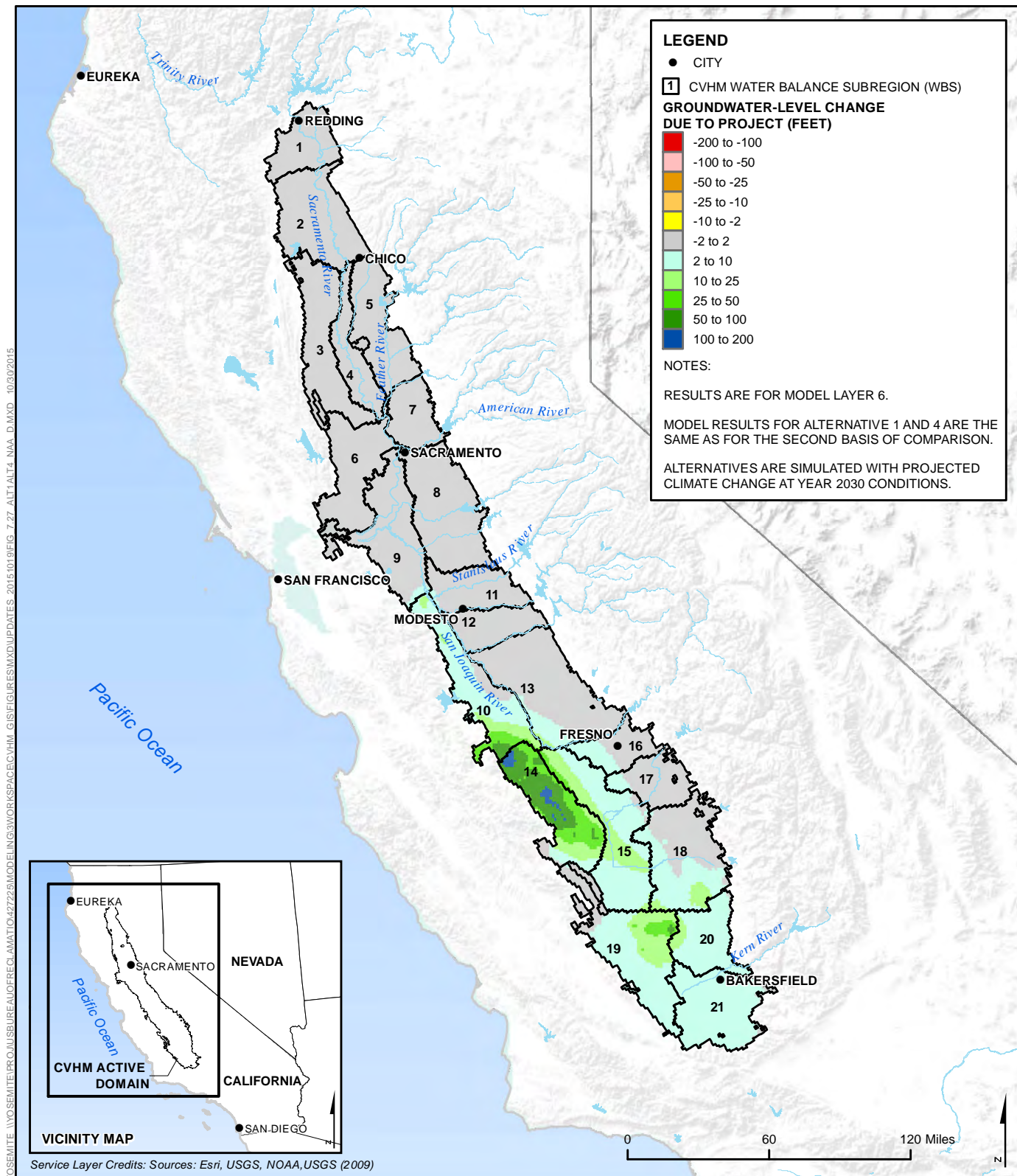


**Figure 7.25 Forecast Groundwater-Level Changes for Alternative 1, Alternative 4, and Second Basis of Comparison Compared to No Action Alternative for Average July in a Future Above-Normal Year**

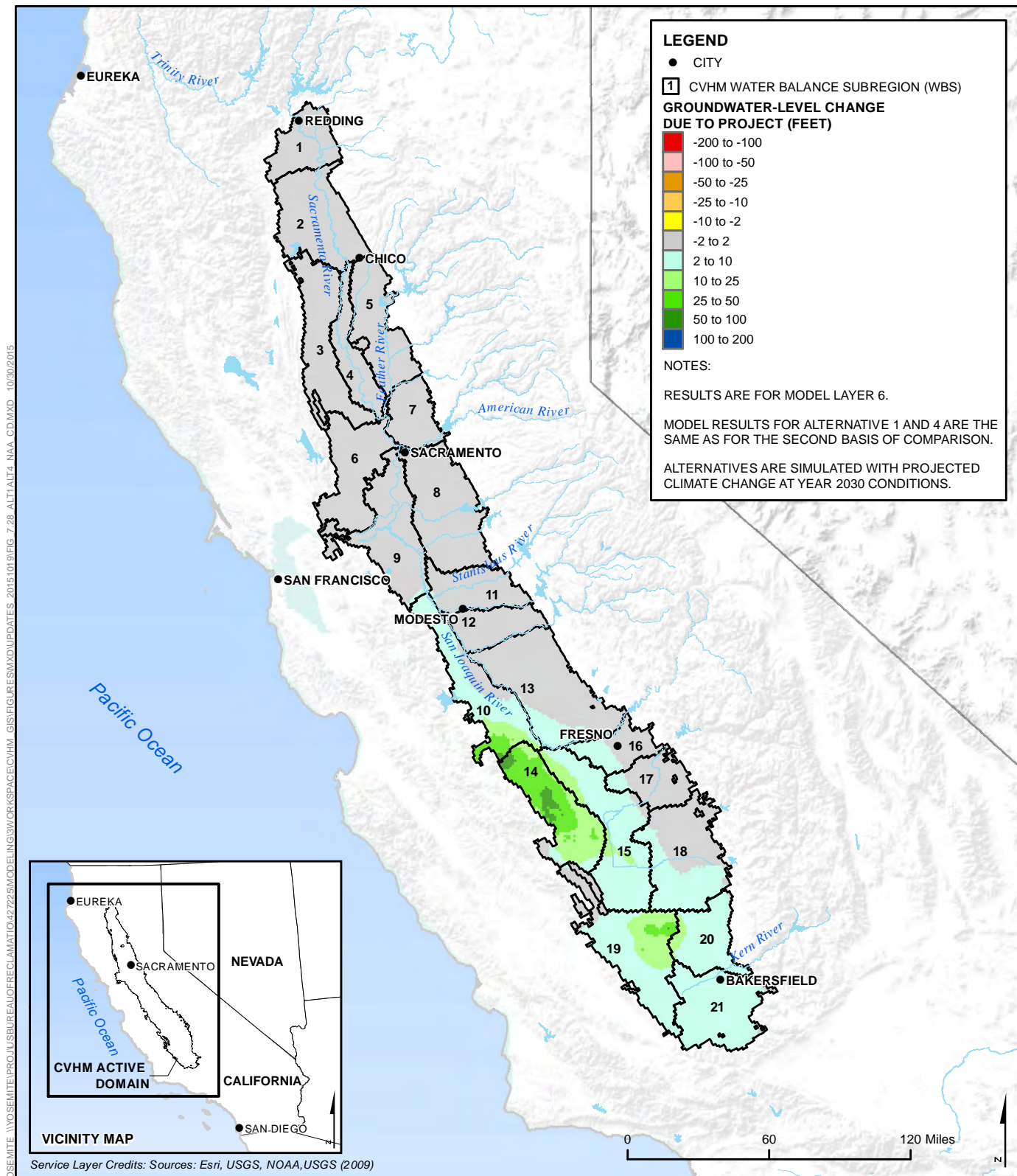


**Figure 7.26 Forecast Groundwater-Level Changes for Alternative 1, Alternative 4, and Second Basis of Comparison Compared to No Action Alternative For Average July in a Future Below-Normal Year**





**Figure 7.27 Forecast Groundwater-Level Changes for Alternative 1, Alternative 4, and Second Basis of Comparison Compared to No Action Alternative For Average July in a Future Dry Year**



**Figure 7.28 Forecast Groundwater-Level Changes for Alternative 1, Alternative 4, and Second Basis of Comparison Compared to No Action Alternative For Average July in a Future Critically-Dry Year**

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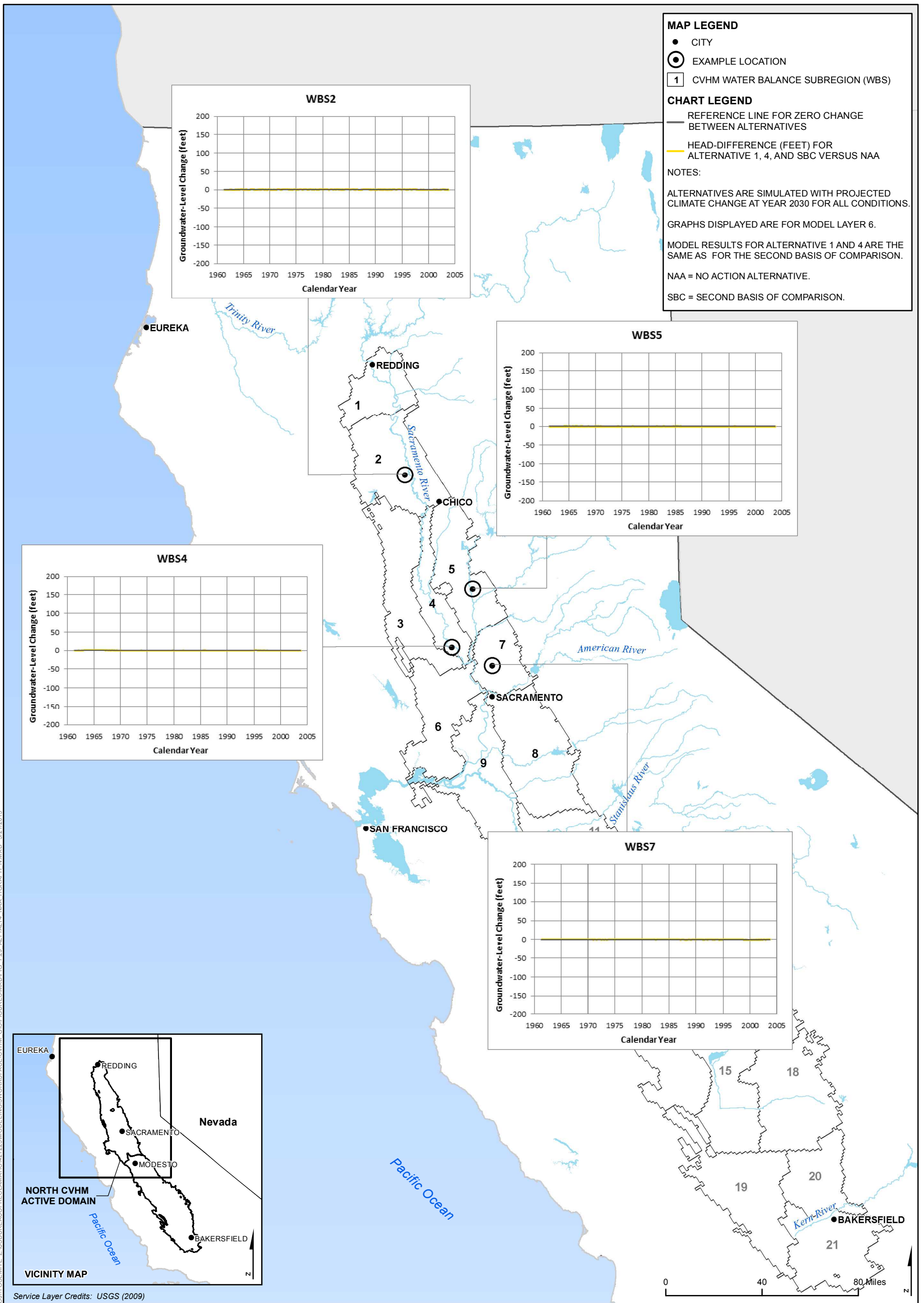


Figure 7.29 Forecast Groundwater-Level Change Hydrographs for Alternative 1, Alternative 4, and Second Basis of Comparison Compared to No Action Alternative at Example Locations in the Sacramento Valley

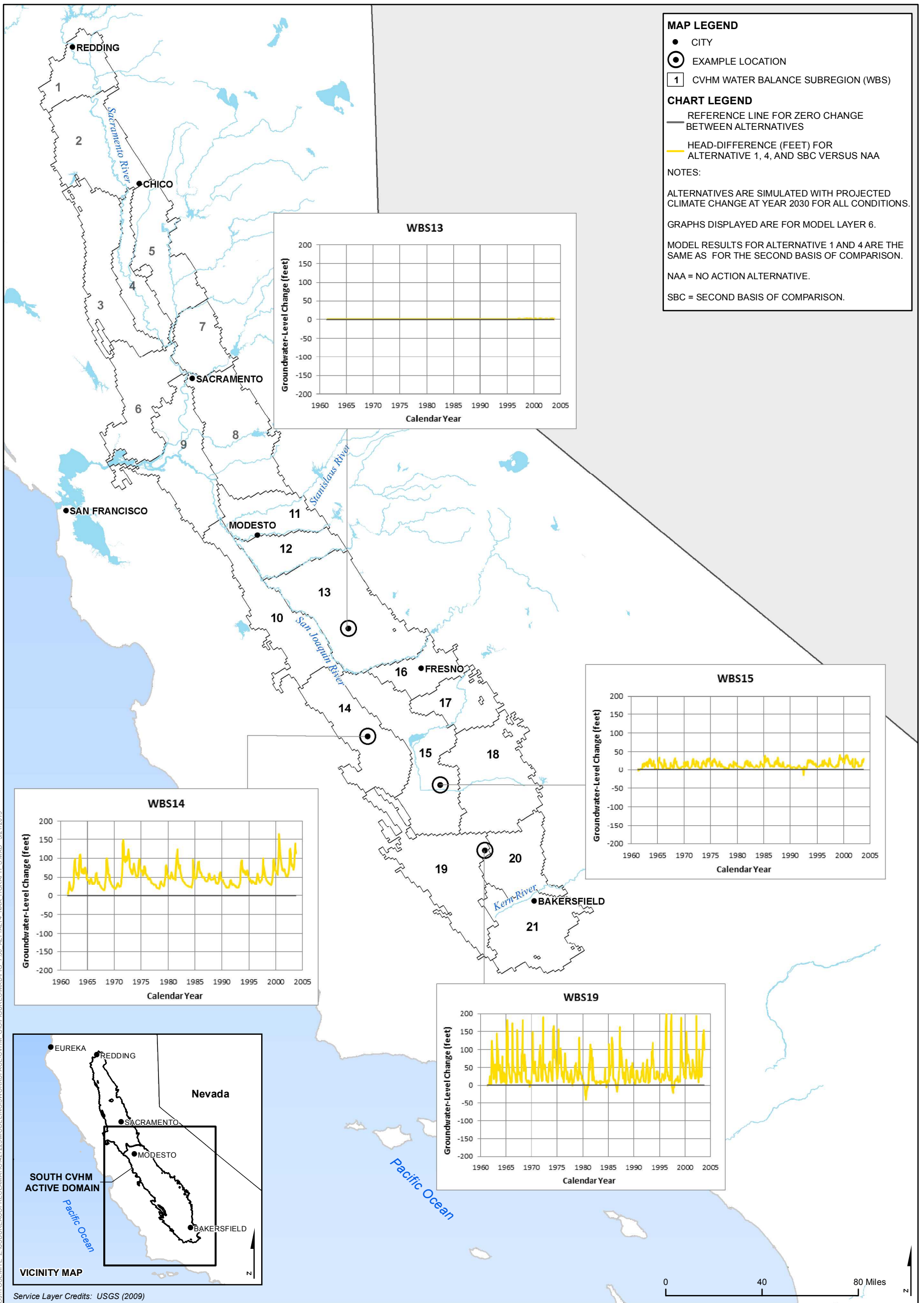
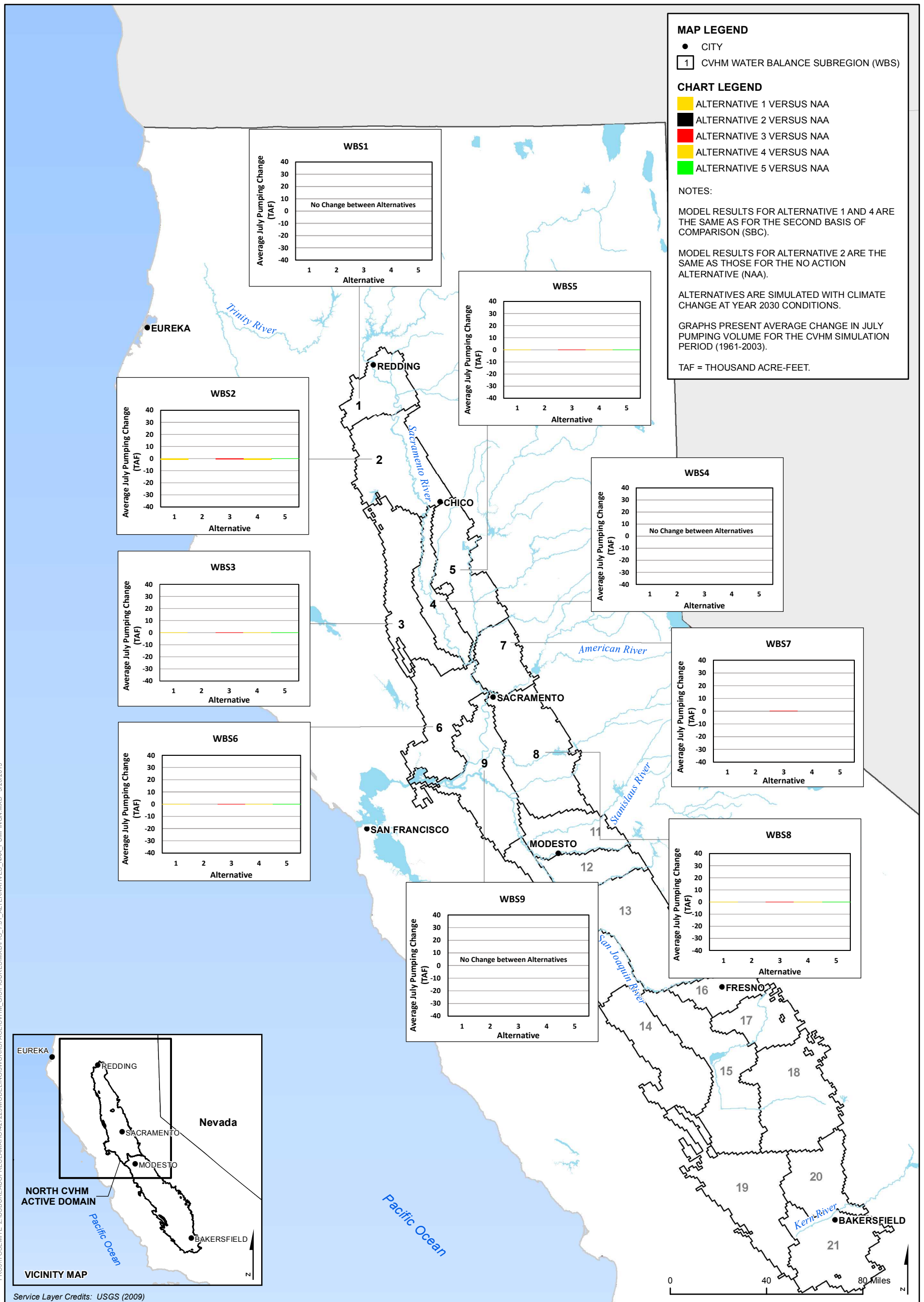


Figure 7.30 Forecast Groundwater-Level Change Hydrographs for Alternative 1, Alternative 4, and Second Basis of Comparison Compared to No Action Alternative at Example Locations in the San Joaquin Valley



**Figure 7.31 Long-term Average Change in July Agricultural Groundwater Pumping for Alternatives Compared to the No Action Alternative in the Sacramento Valley**

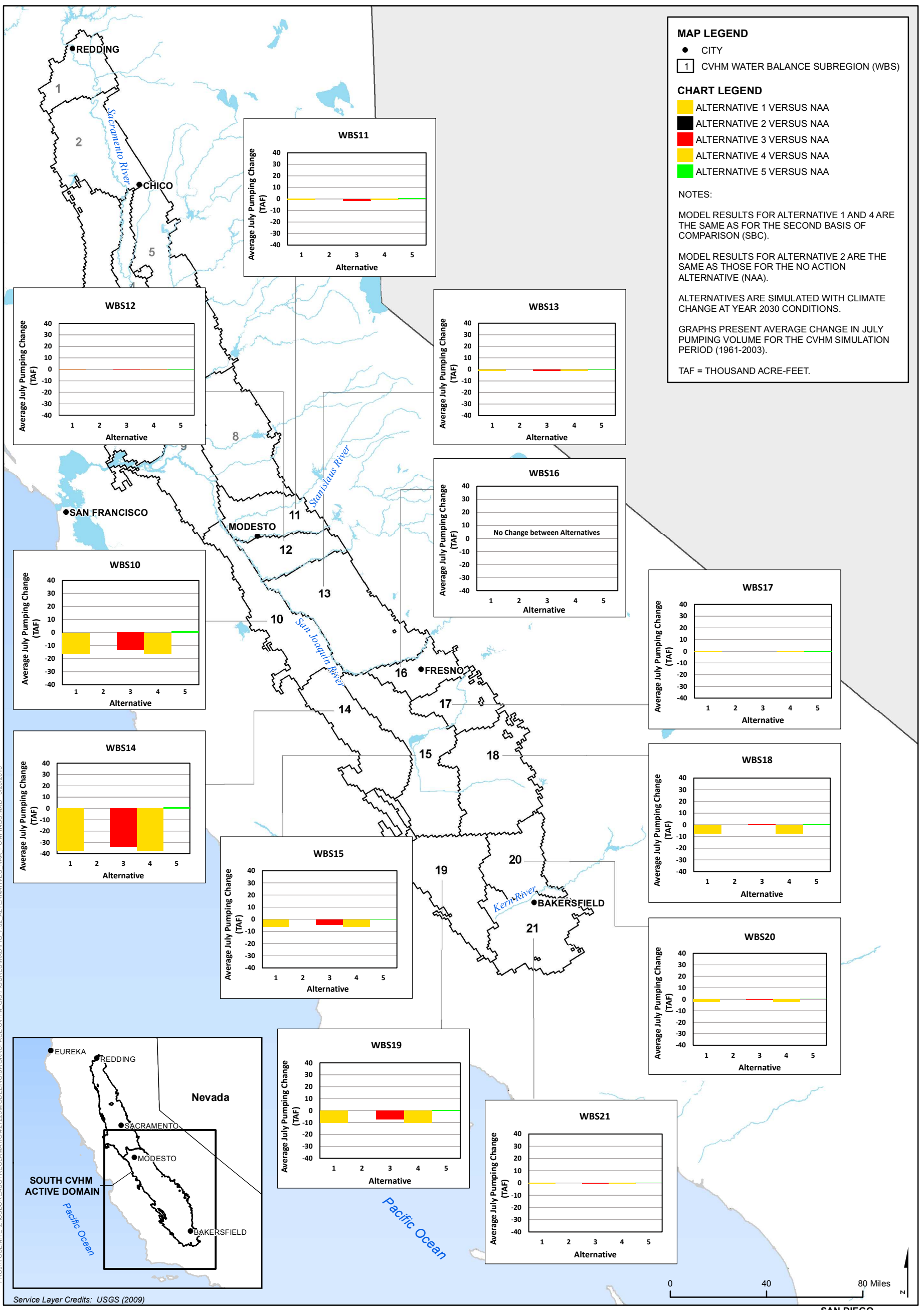
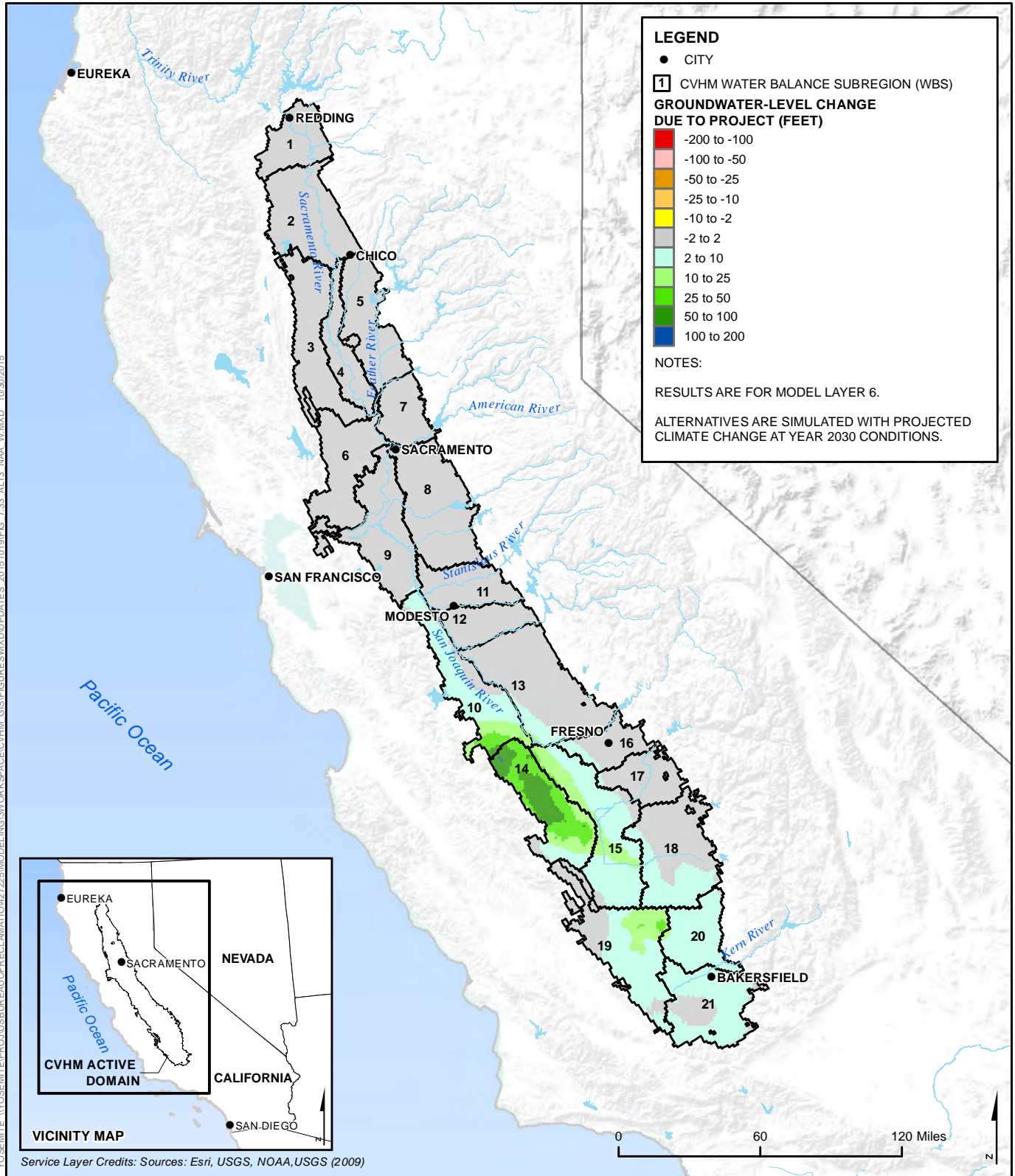


Figure 7.32 Long-term Average Change in July Agricultural Groundwater Pumping for Alternatives Compared to the No Action Alternative in the San Joaquin Valley

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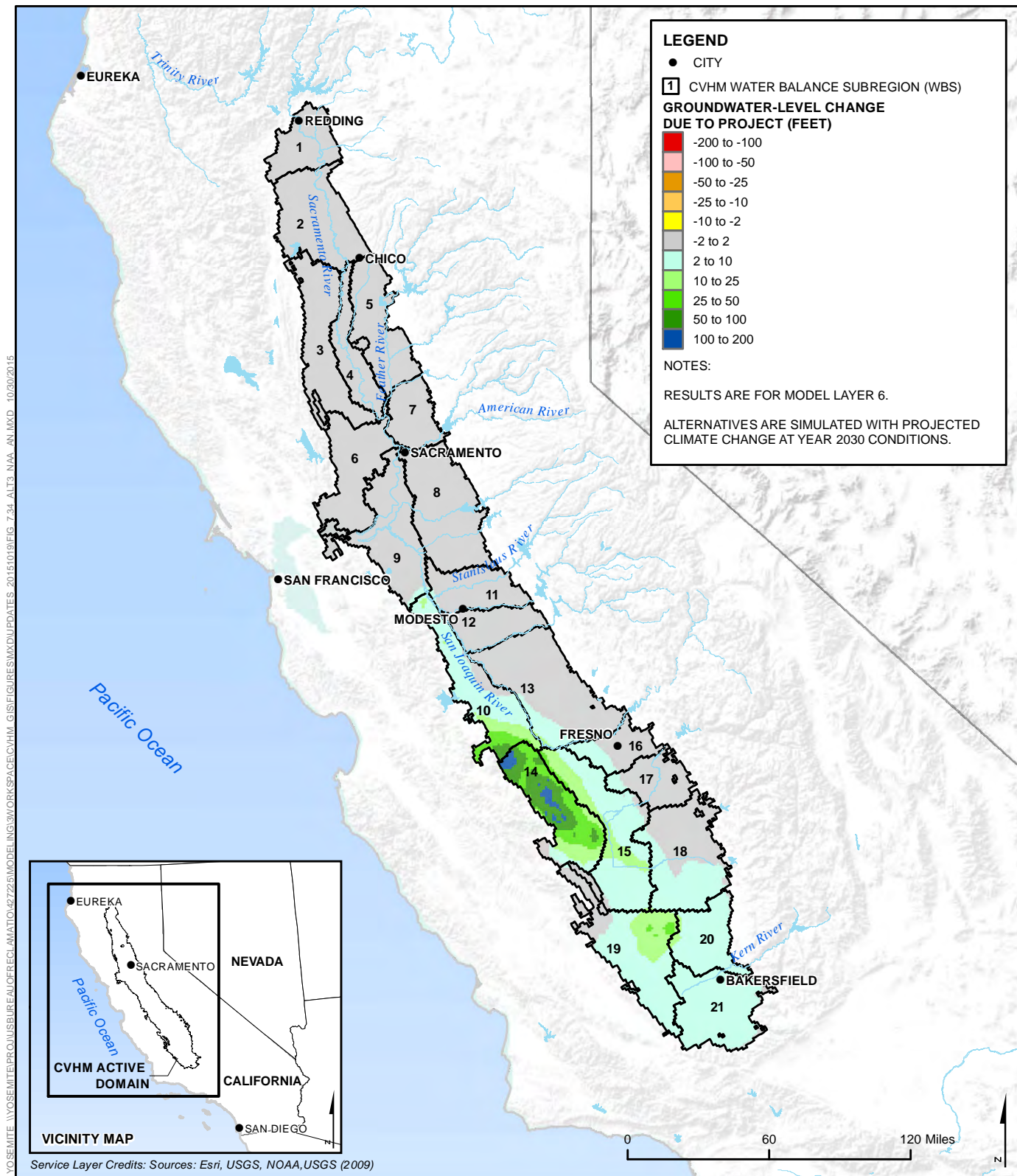
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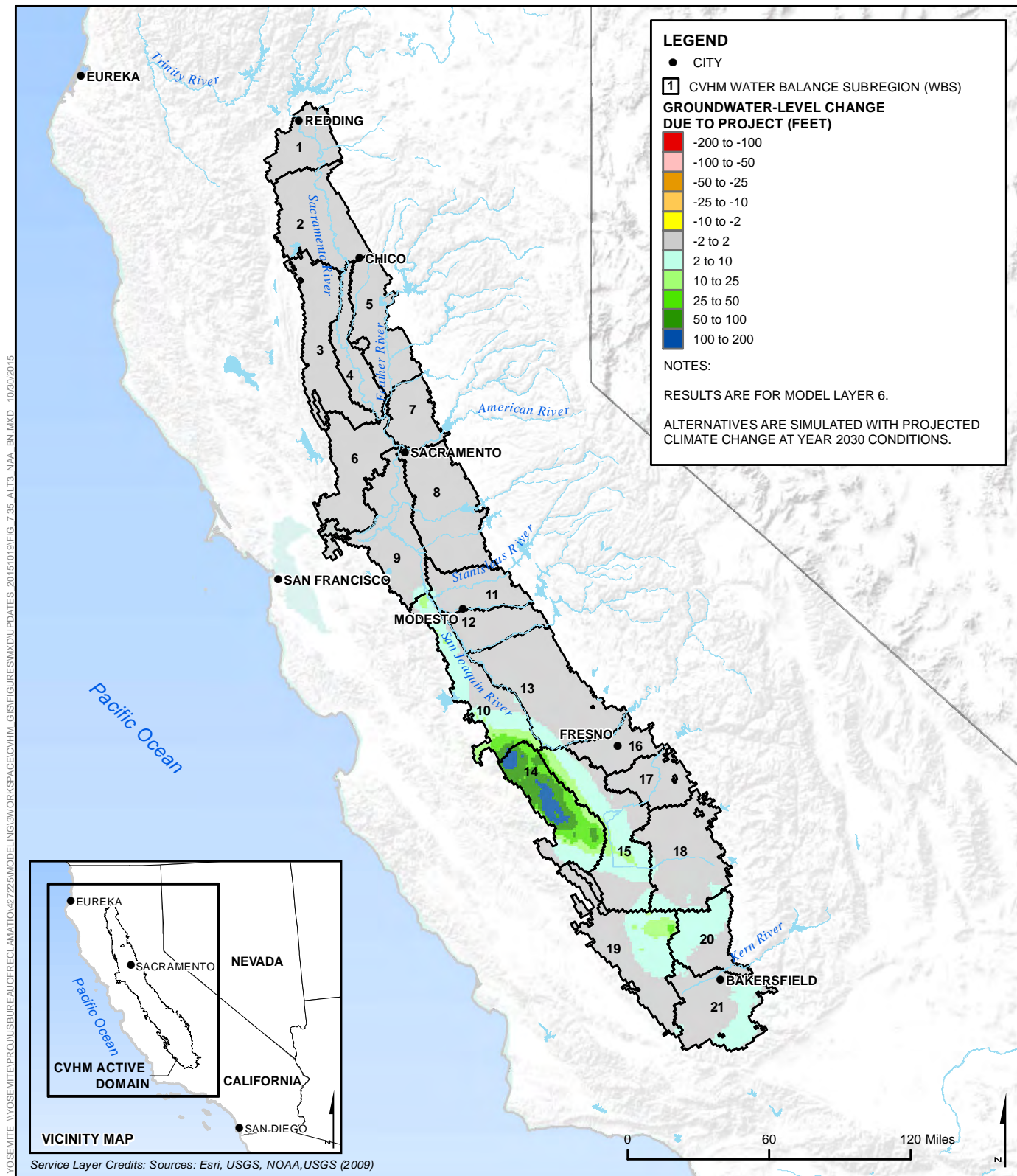


**Figure 7.33 Forecast Groundwater-Level Changes for Alternative 3 Compared to No Action Alternative for Average July in a Future Wet Year**

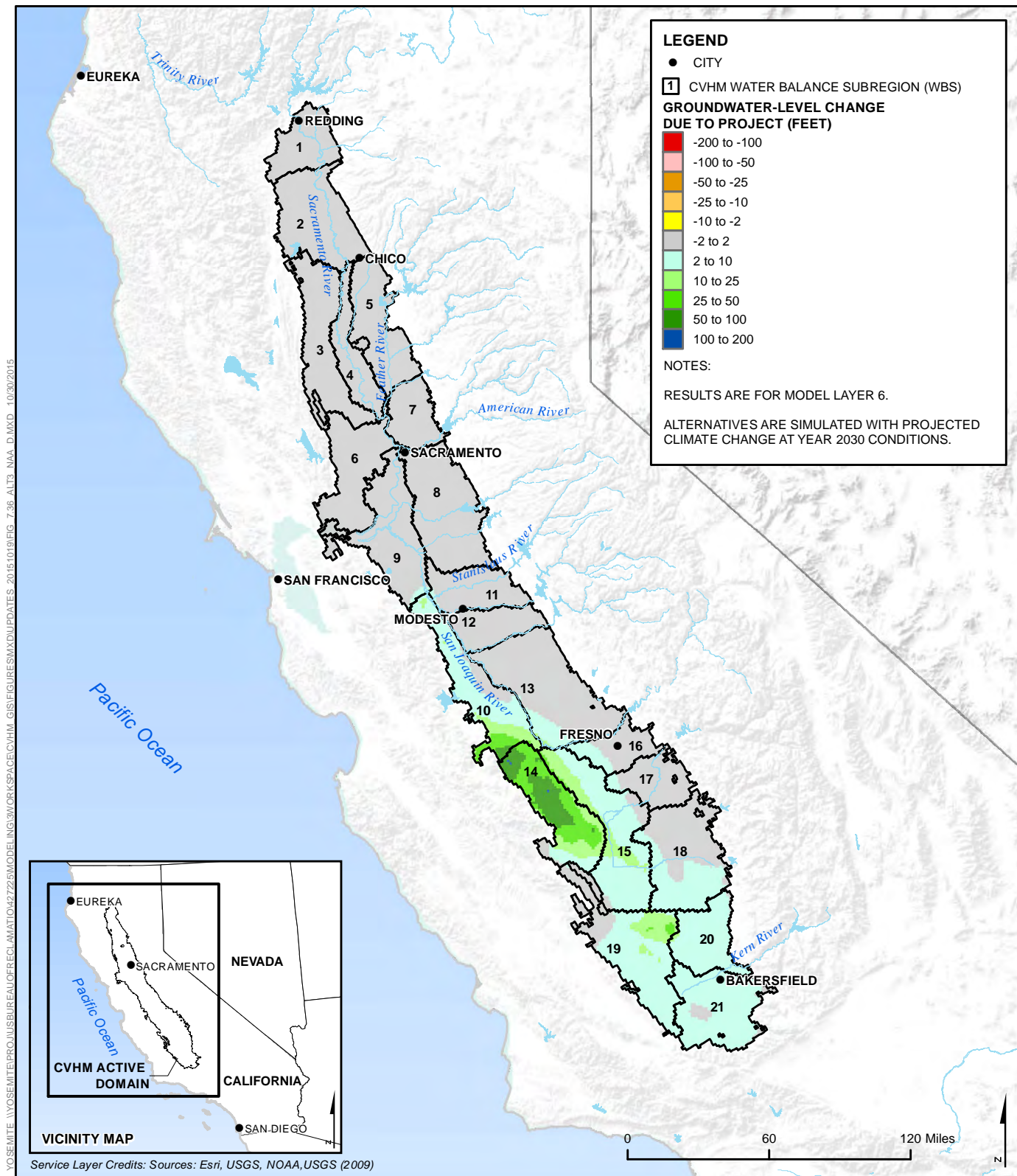




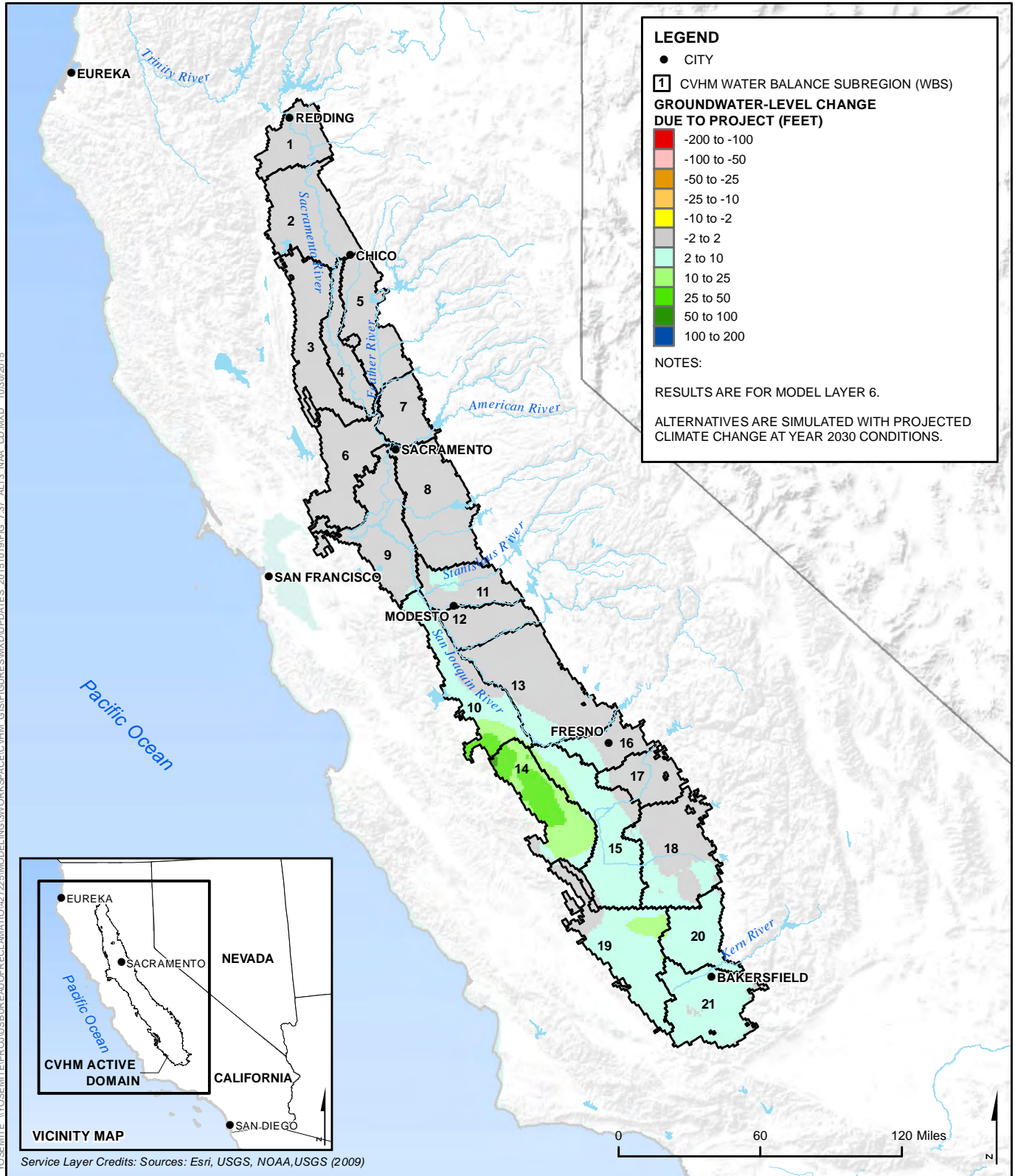
**Figure 7.34 Forecast Groundwater-Level Changes for Alternative 3 Compared to No Action Alternative for Average July in a Future Above-Normal Year**



**Figure 7.35 Forecast Groundwater-Level Changes for Alternative 3 Compared to No Action Alternative for Average July in a Future Below-Normal Year**



**Figure 7.36 Forecast Groundwater-Level Changes for Alternative 3 Compared to No Action Alternative for Average July in a Future Dry Year**



**Figure 7.37 Forecast Groundwater-Level Changes for Alternative 3 Compared to No Action Alternative for Average July in a Future Critically-Dry Year**

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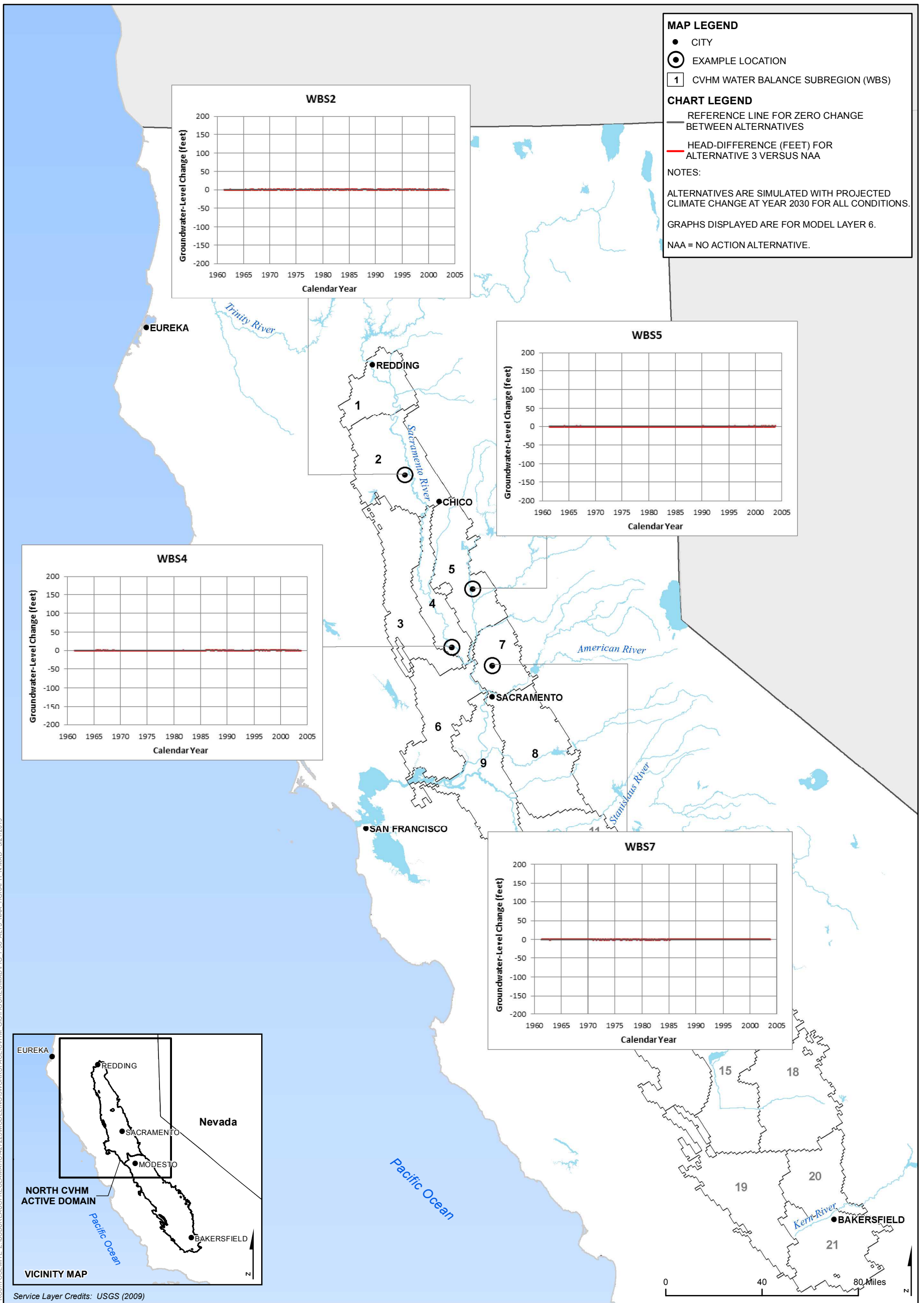


Figure 7.38 Forecast Groundwater-Level Change Hydrographs for Alternative 3 Compared to No Action Alternative at Example Locations in the Sacramento Valley

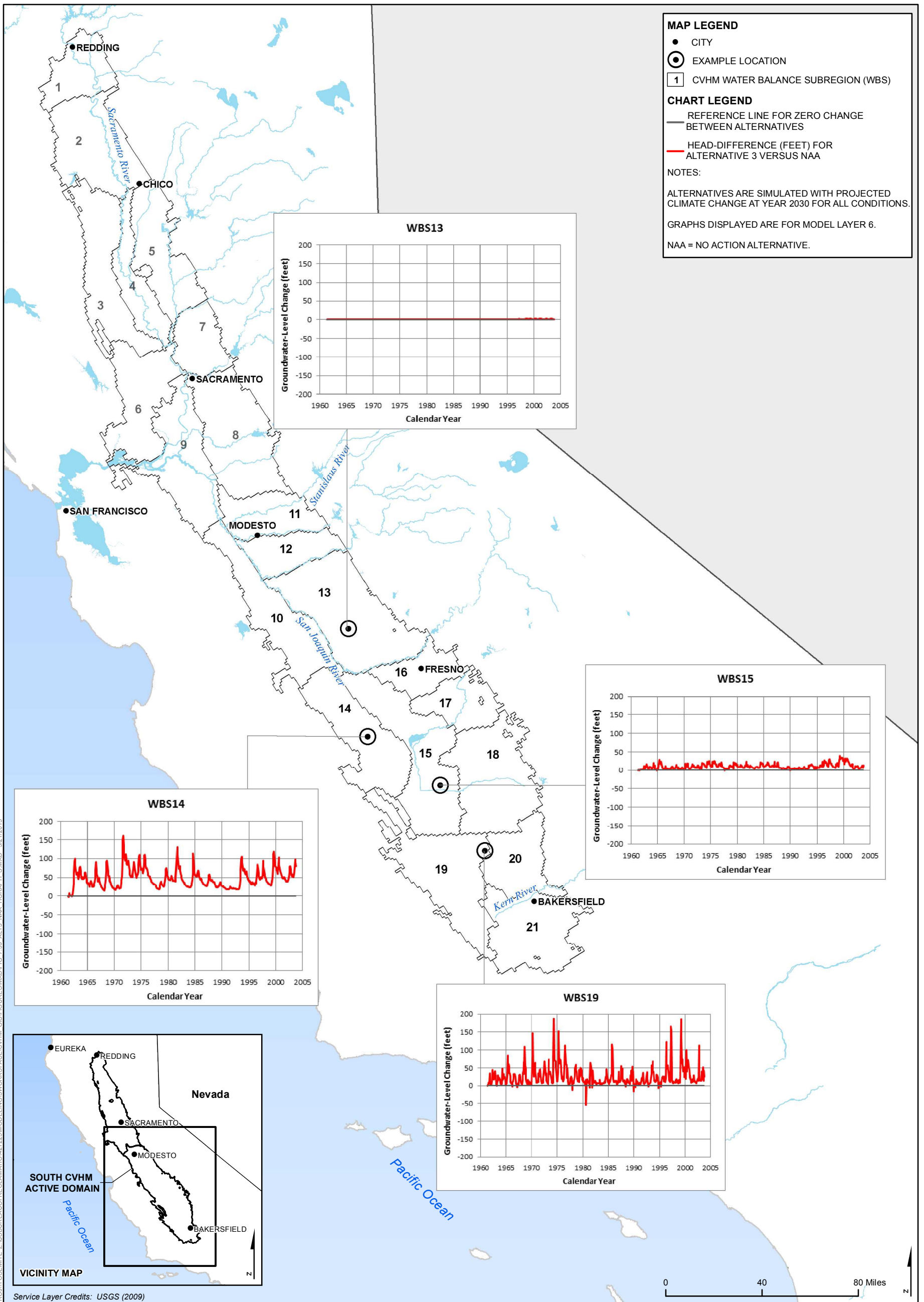
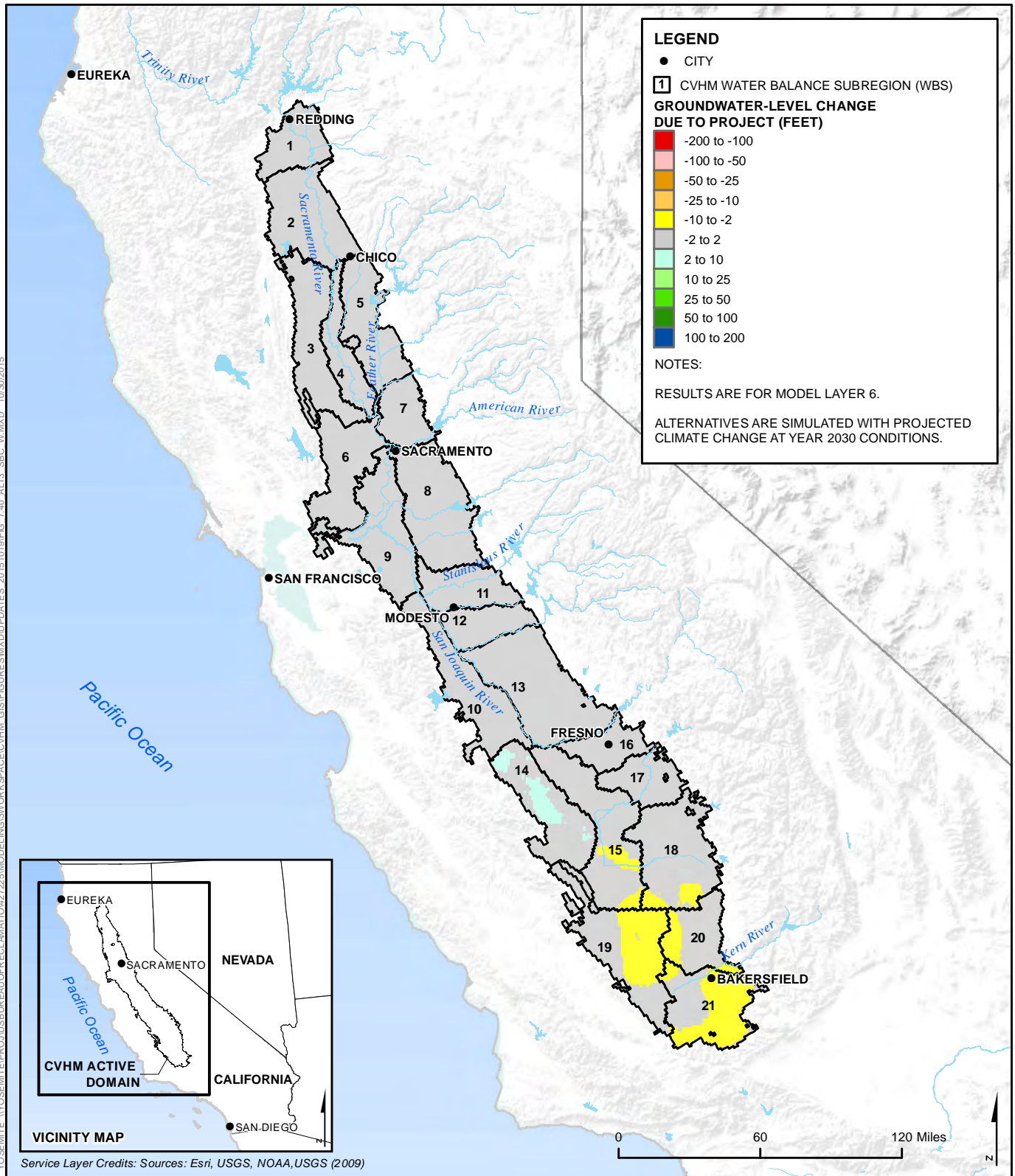
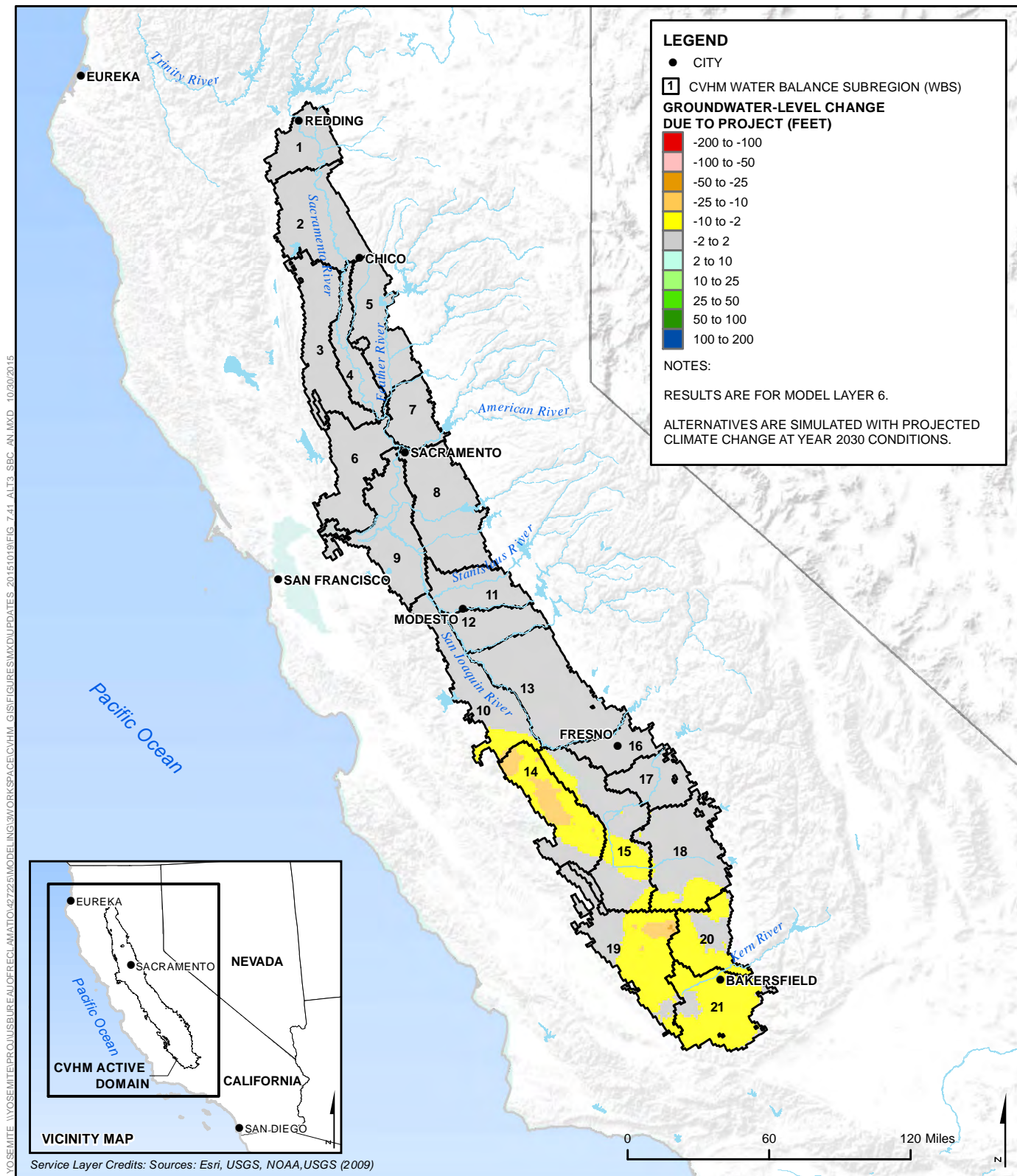


Figure 7.39 Forecast Groundwater-Level Change Hydrographs for Alternative 3 Compared to No Action Alternative at Example Locations in the San Joaquin Valley

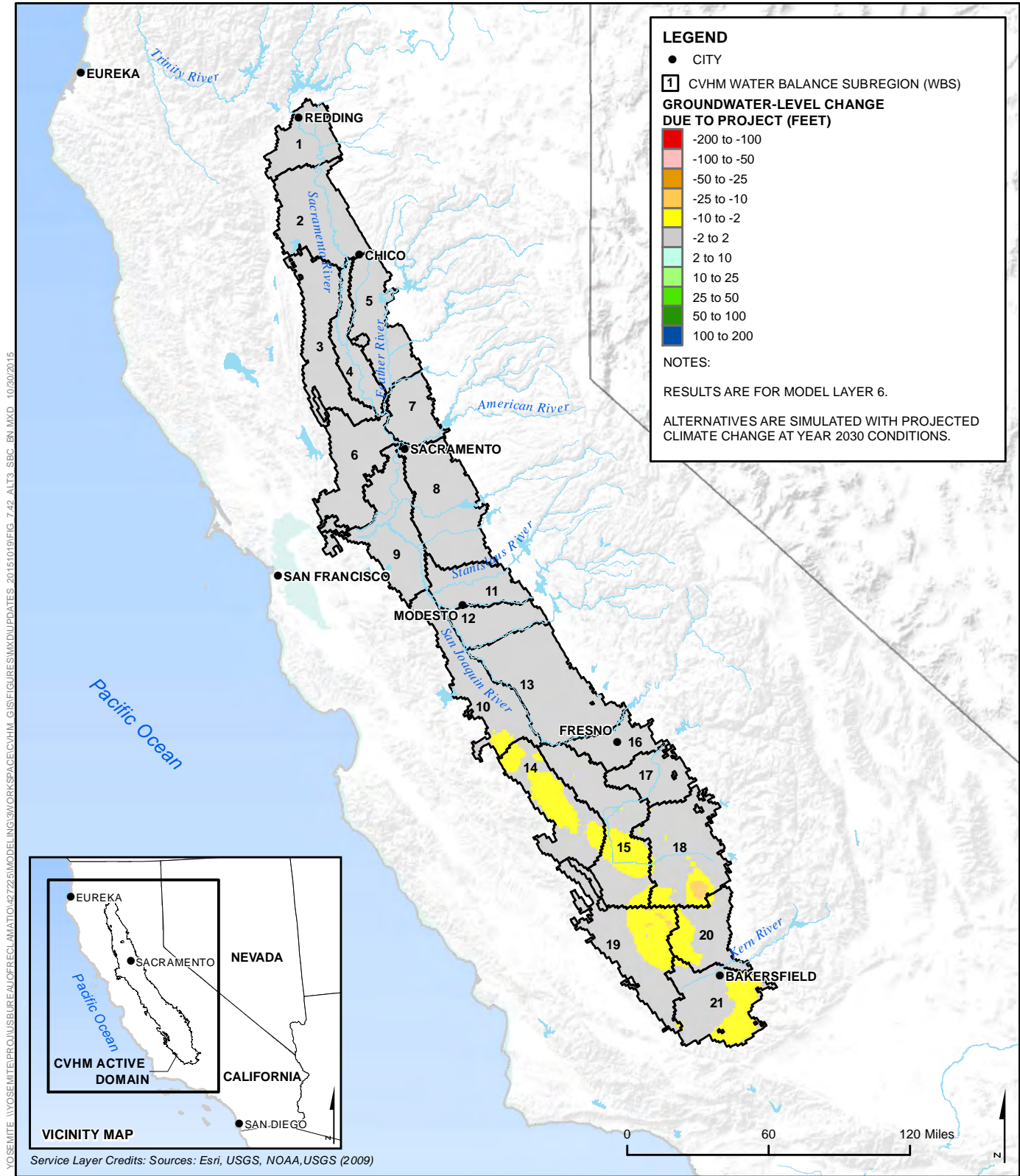


**Figure 7.40 Forecast Groundwater-Level Changes for Alternative 3 Compared to Second Basis of Comparison for Average July in a Future Wet Year**

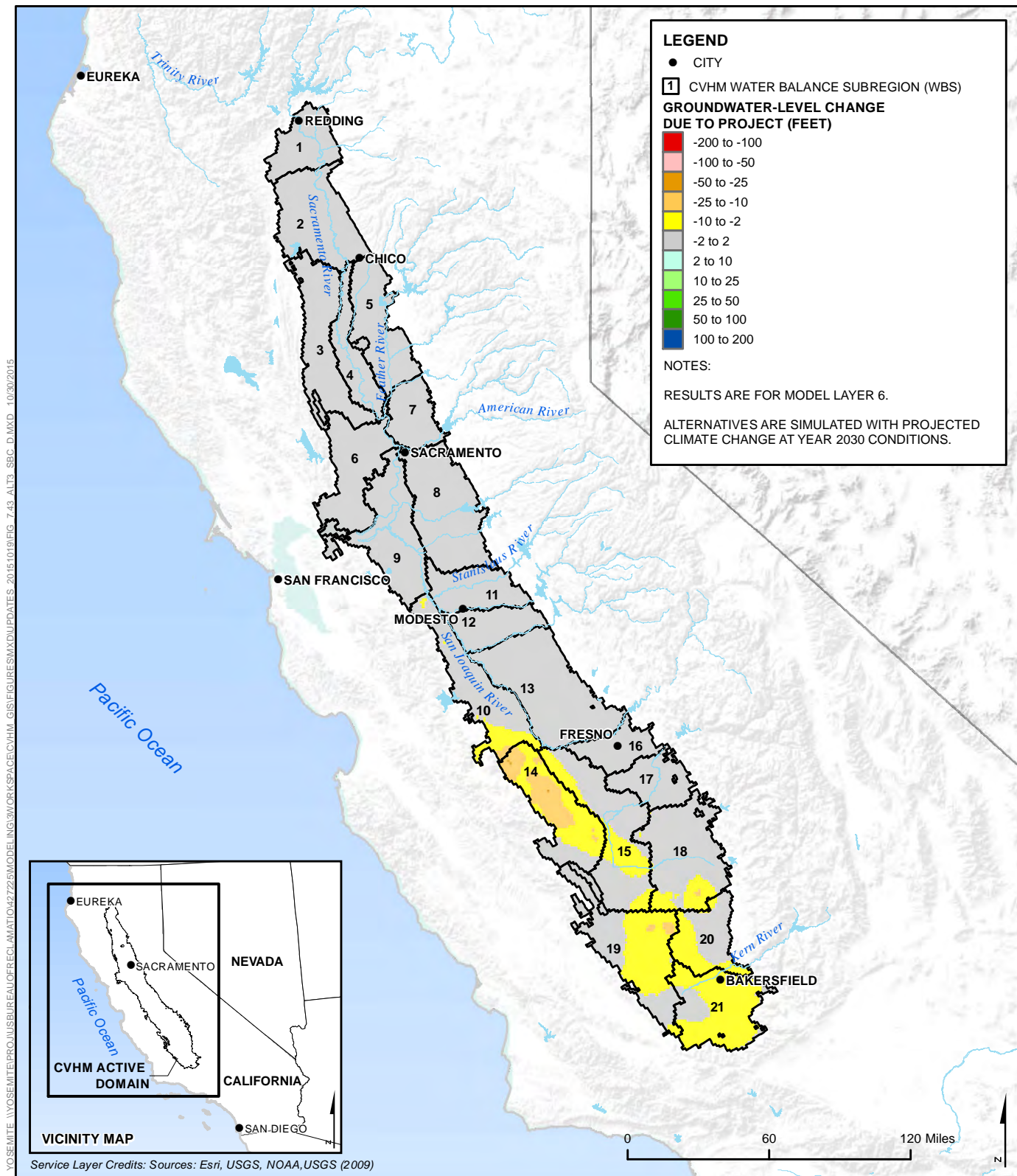




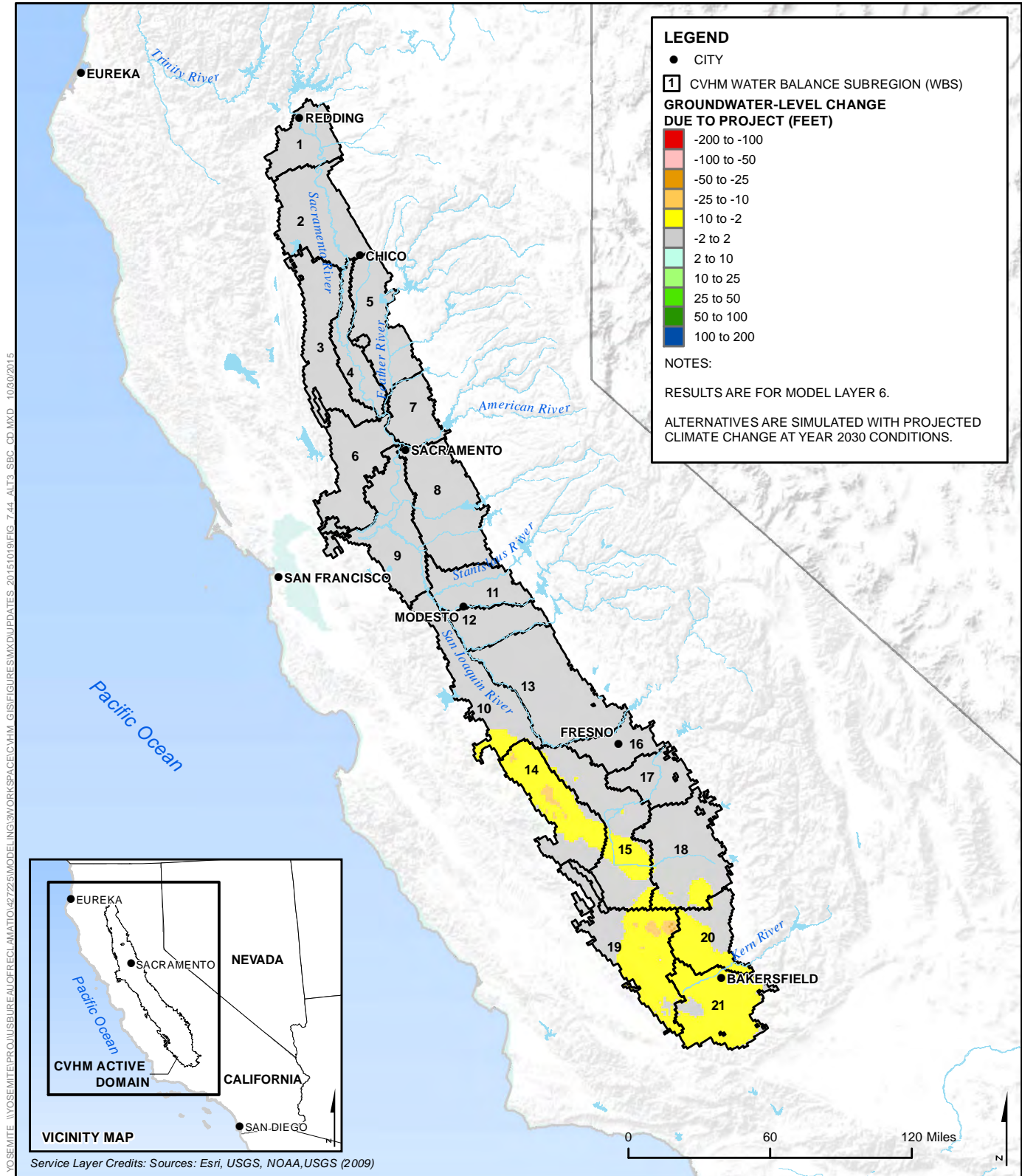
**Figure 7.41 Forecast Groundwater-Level Changes for Alternative 3 Compared to Second Basis of Comparison for Average July in a Future Above-Normal Year**



**Figure 7.42 Forecast Groundwater-Level Changes for Alternative 3 Compared to Second Basis of Comparison for Average July in a Future Below-Normal Year**

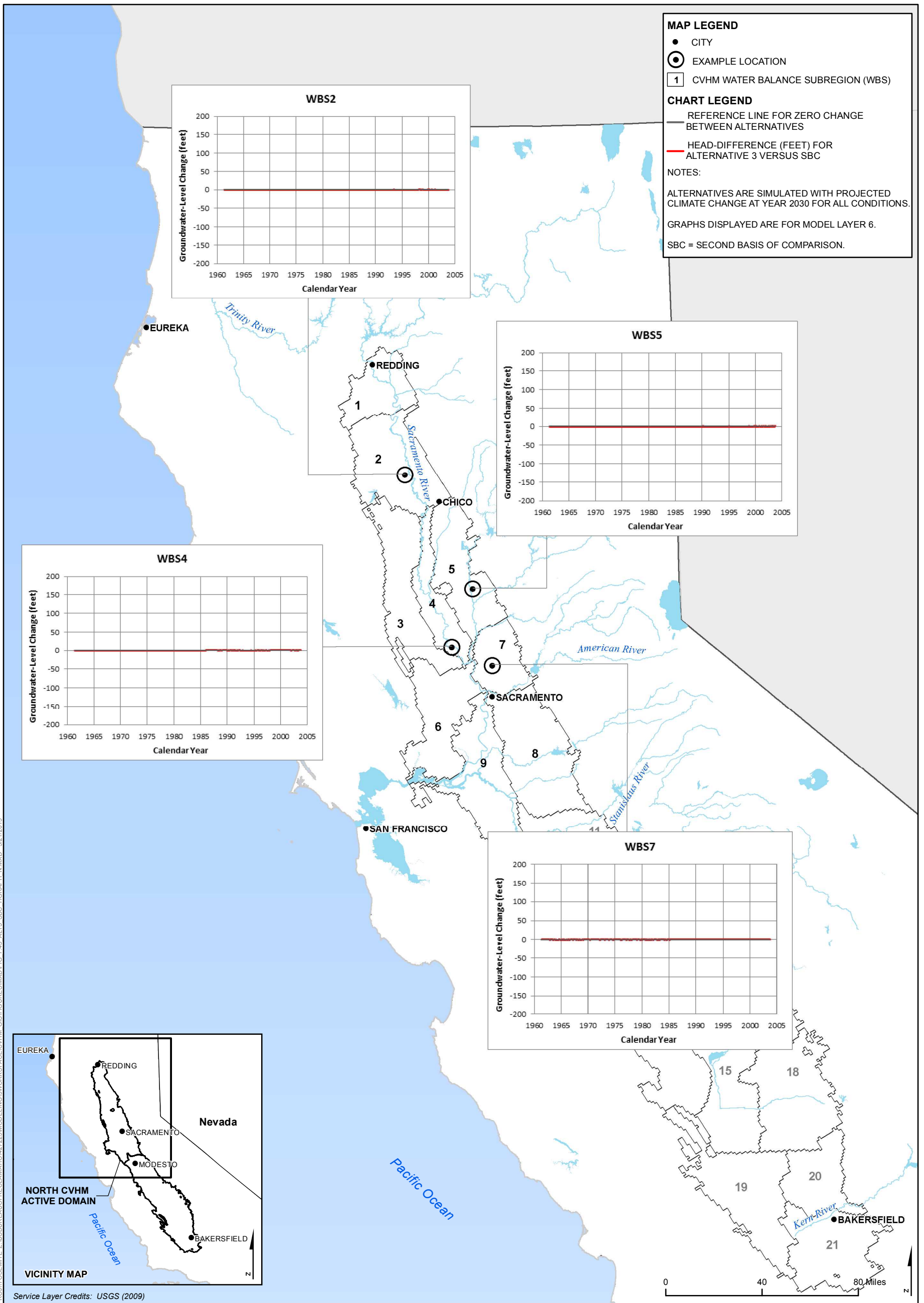


**Figure 7.43 Forecast Groundwater-Level Changes for Alternative 3 Compared to Second Basis of Comparison for Average July in a Future Dry Year**



**Figure 7.44 Forecast Groundwater-Level Changes for Alternative 3 Compared to Second Basis of Comparison for Average July in a Future Critically-Dry Year**

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**Figure 7.45 Forecast Groundwater-Level Change Hydrographs for Alternative 3 Compared to Second Basis of Comparison at Example Locations in the Sacramento Valley**

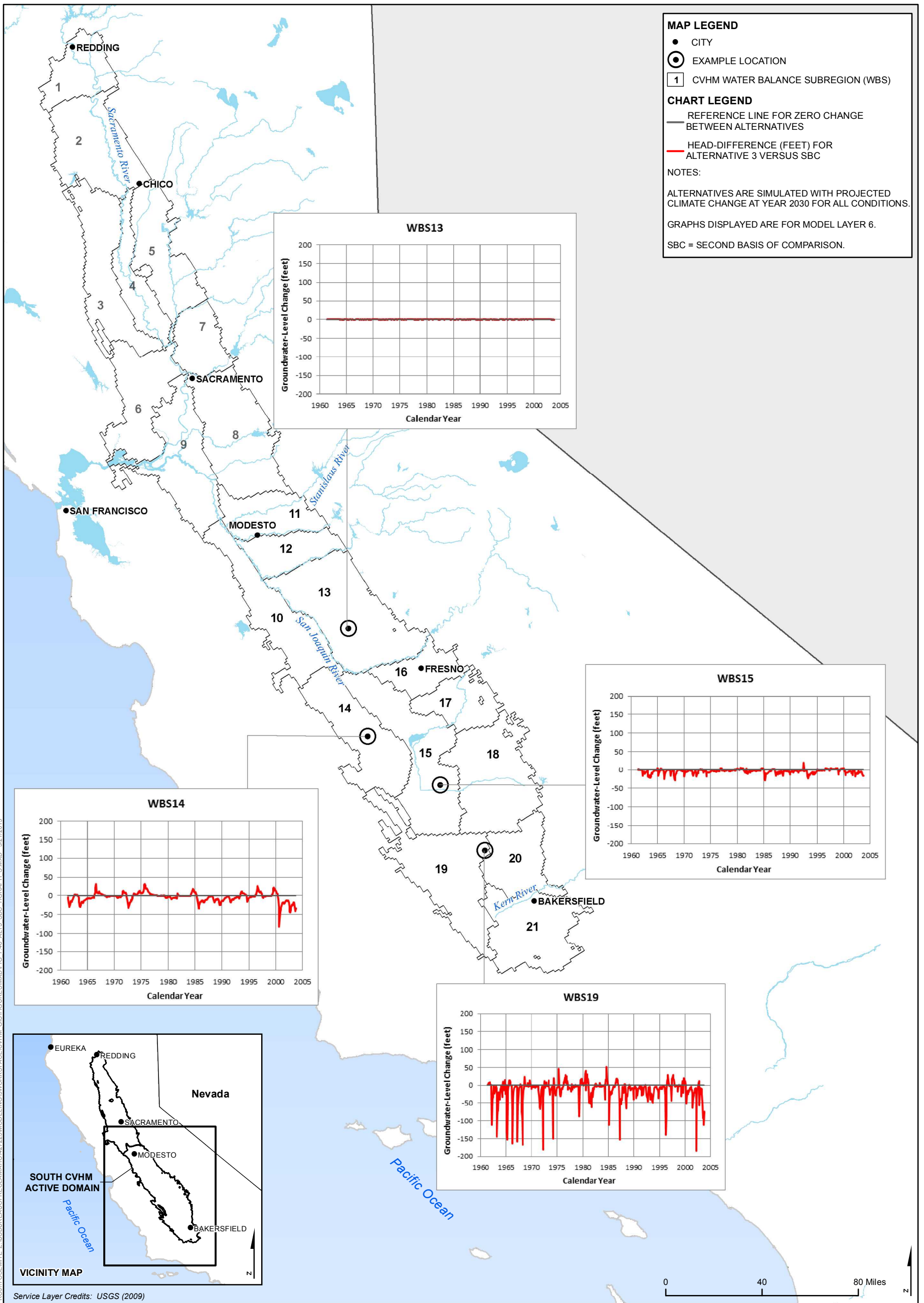
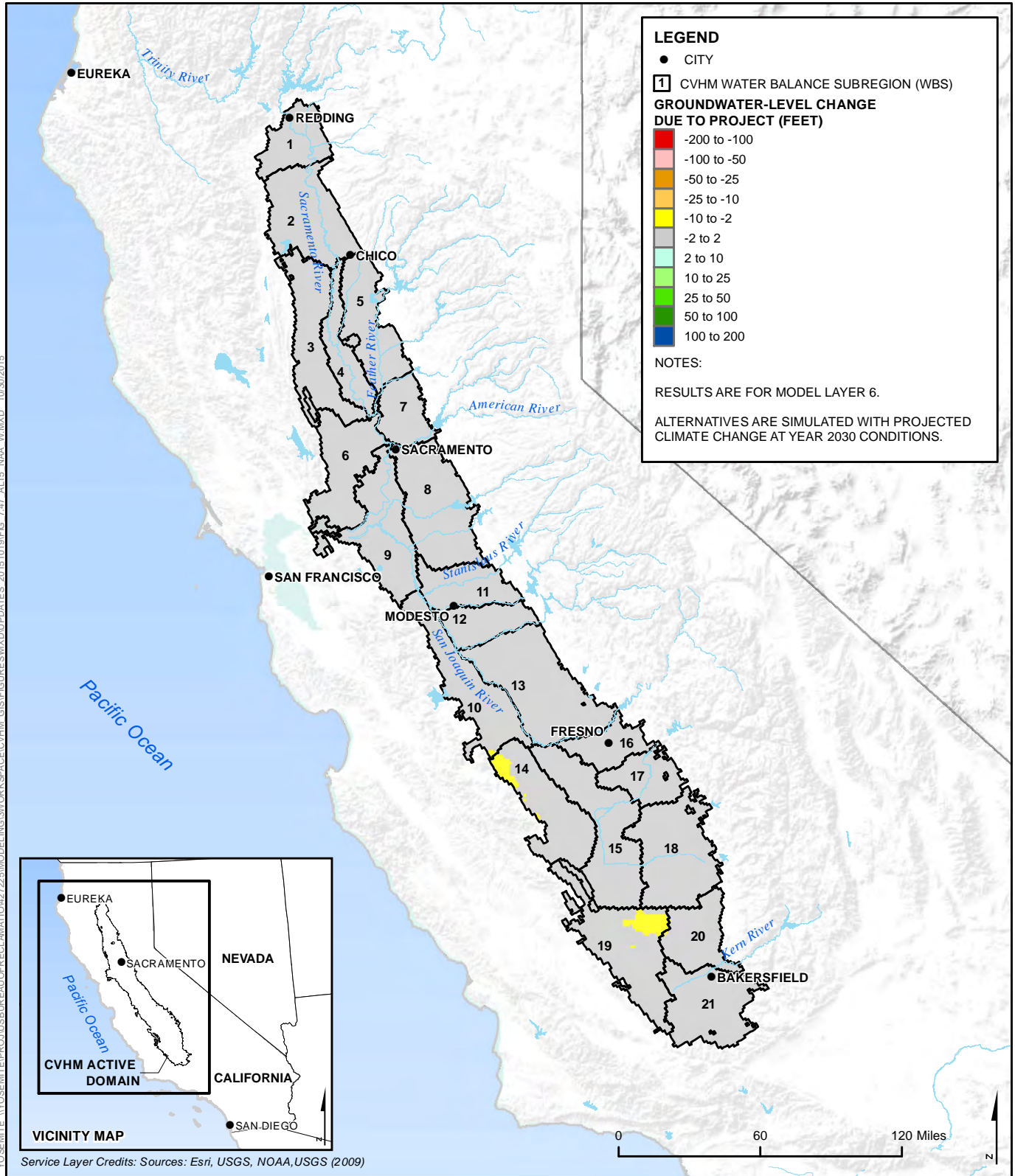
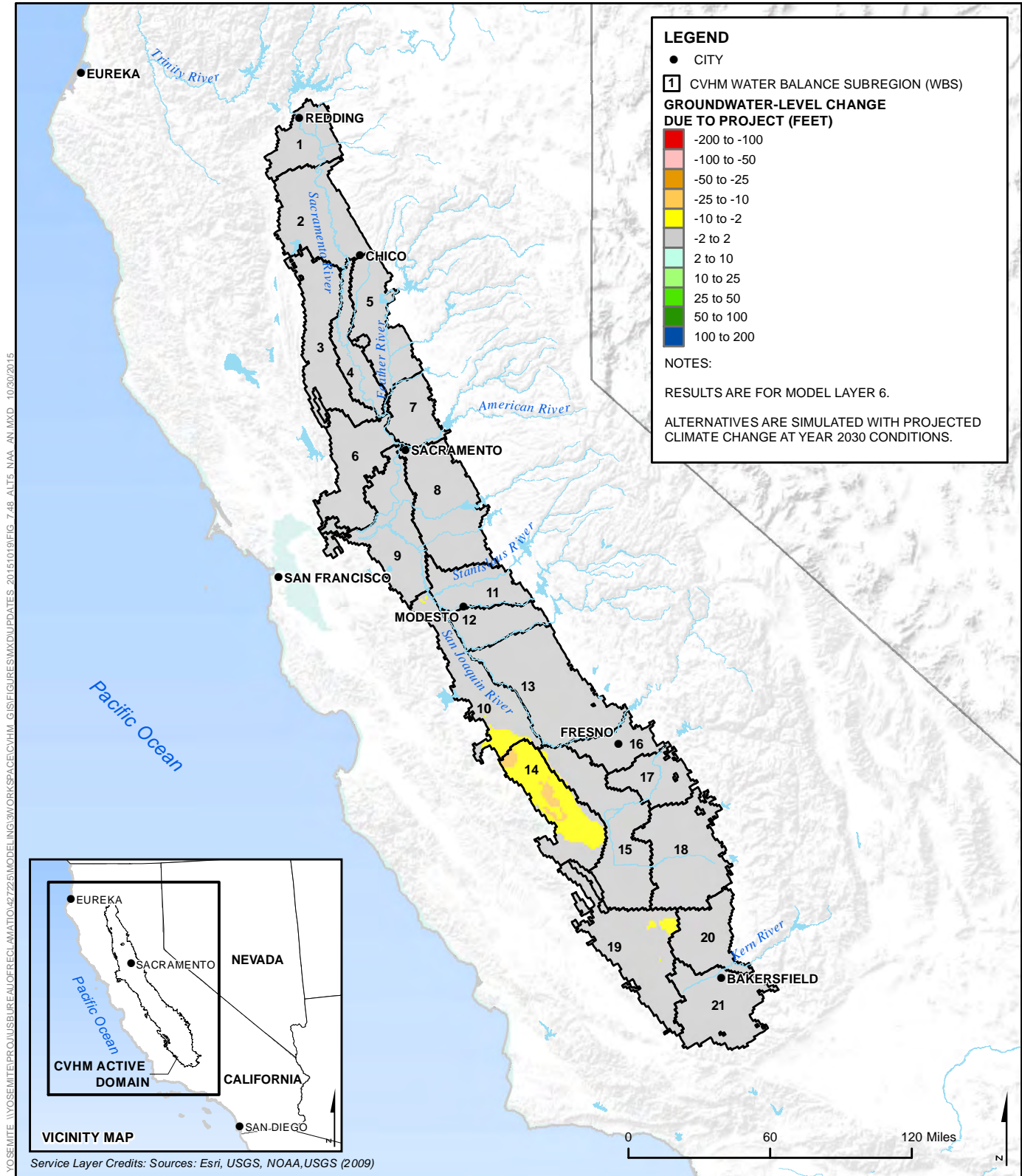


Figure 7.46 Forecast Groundwater-Level Change Hydrographs for Alternative 3 Compared to Second Basis of Comparison at Example Locations in the San Joaquin Valley

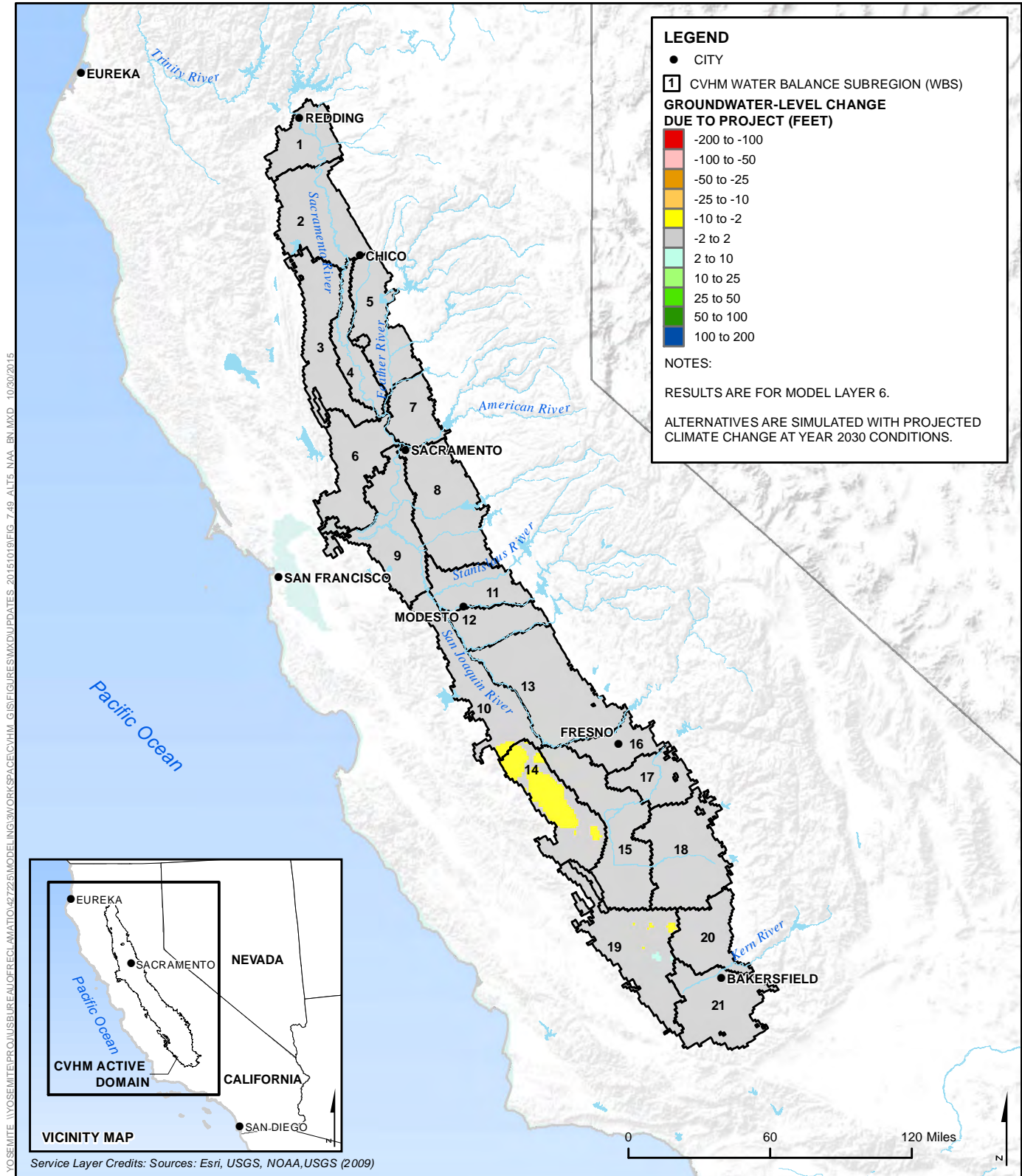


**Figure 7.47 Forecast Groundwater-Level Changes for Alternative 5 Compared to No Action Alternative For Average July in a Future Wet Year**

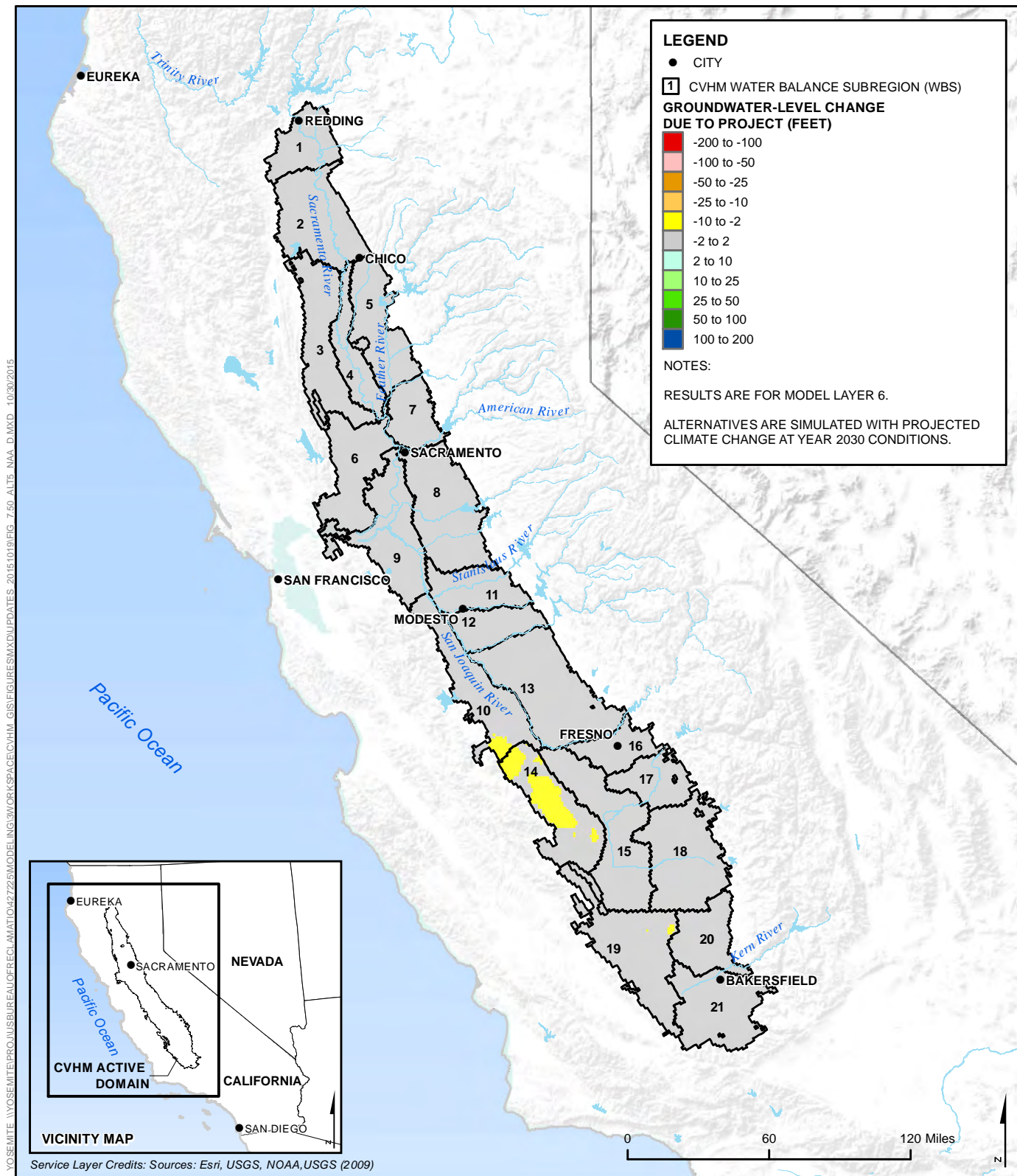




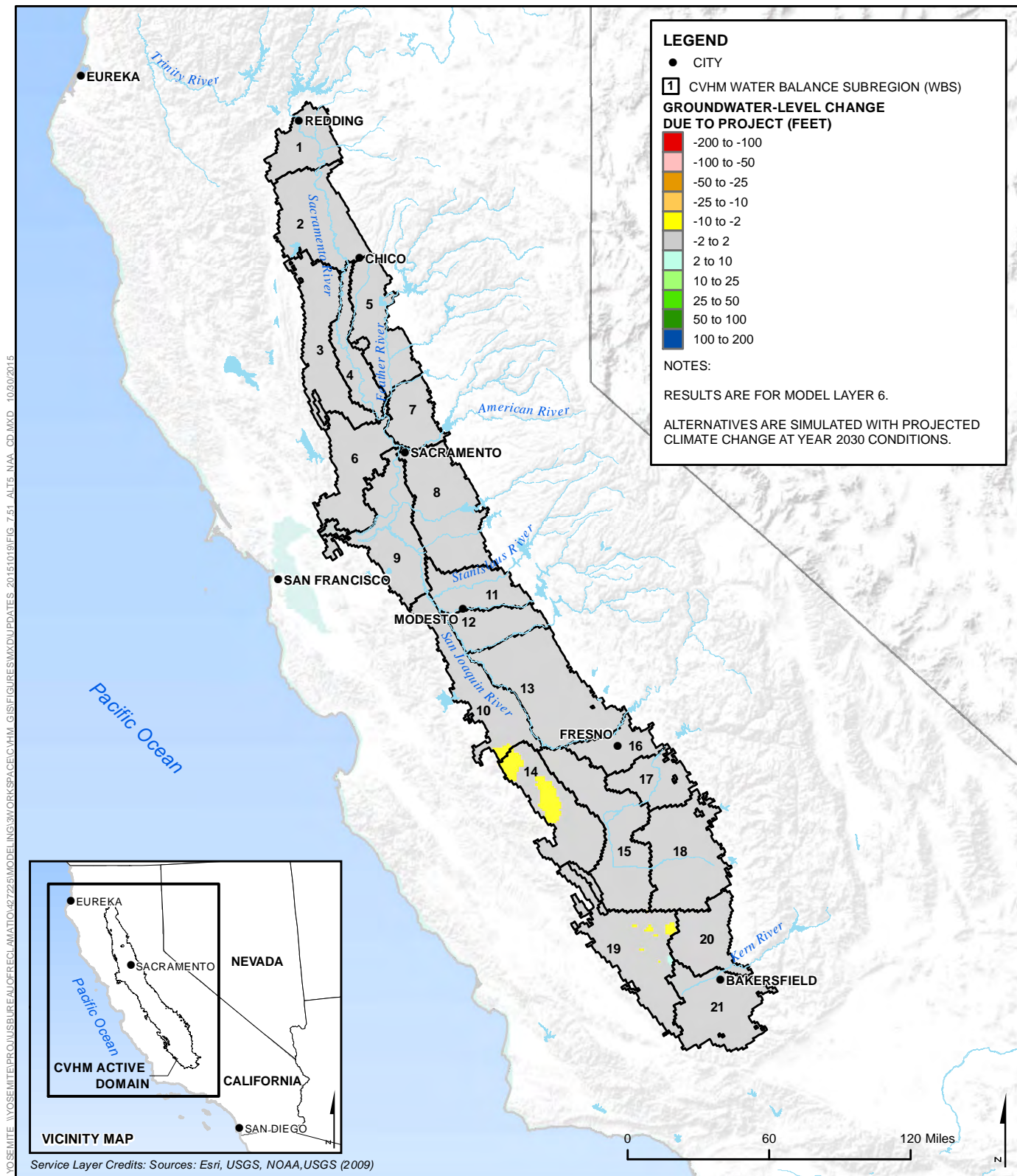
**Figure 7.48 Forecast Groundwater-Level Changes for Alternative 5 Compared to No Action Alternative For Average July in a Future Above-Normal Year**



**Figure 7.49 Forecast Groundwater-Level Changes for Alternative 5 Compared to No Action Alternative For Average July in a Future Below-Normal Year**

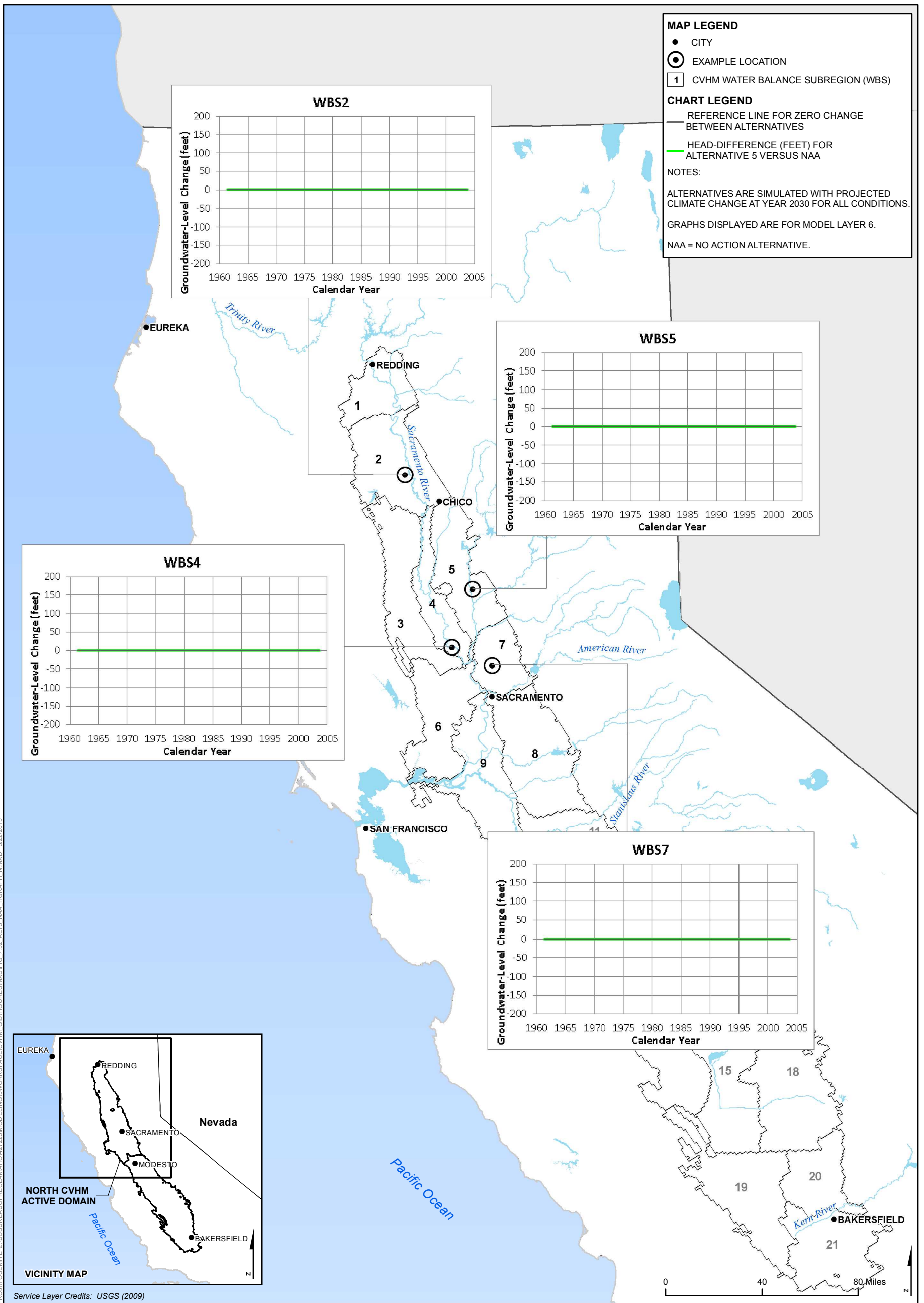


**Figure 7.50 Forecast Groundwater-Level Changes for Alternative 5 Compared to No Action Alternative for Average July in a Future Dry Year**



**Figure 7.51 Forecast Groundwater-Level Changes for Alternative 5 Compared to No Action Alternative for Average July in a Future Critically-Dry Year**

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**Figure 7.52 Forecast Groundwater-Level Change Hydrographs for Alternative 5 Compared to No Action Alternative at Example Locations in the Sacramento Valley**

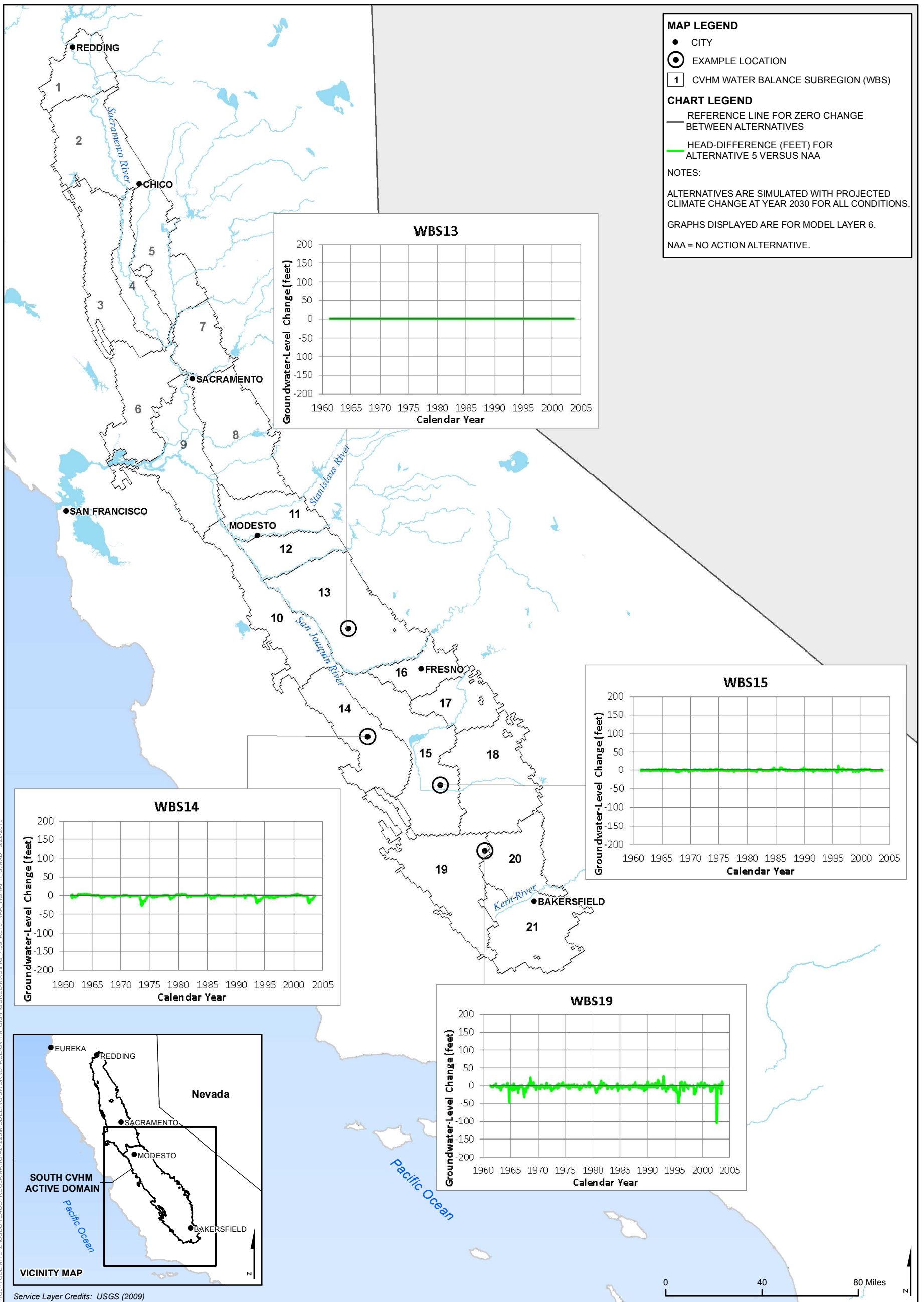
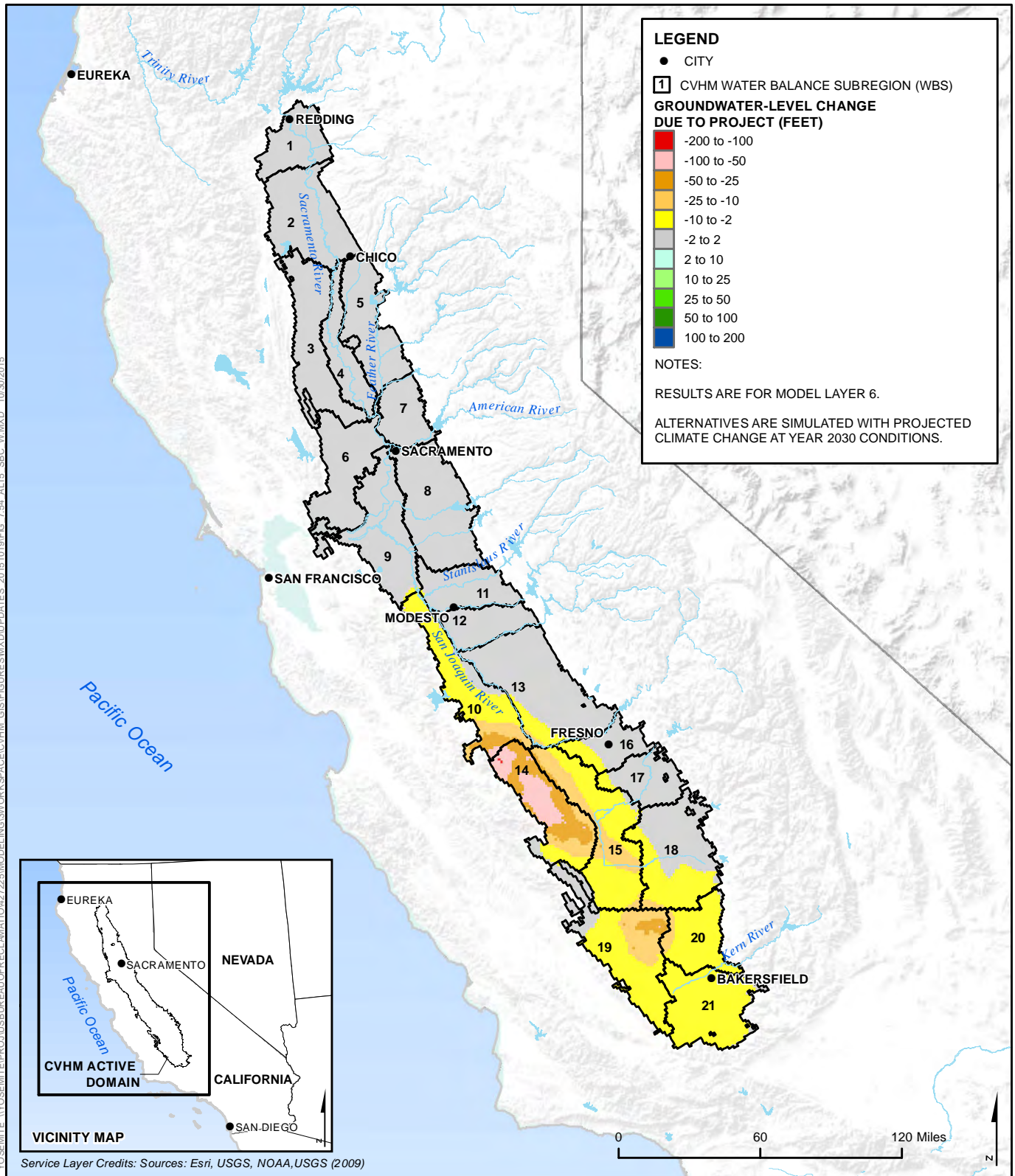
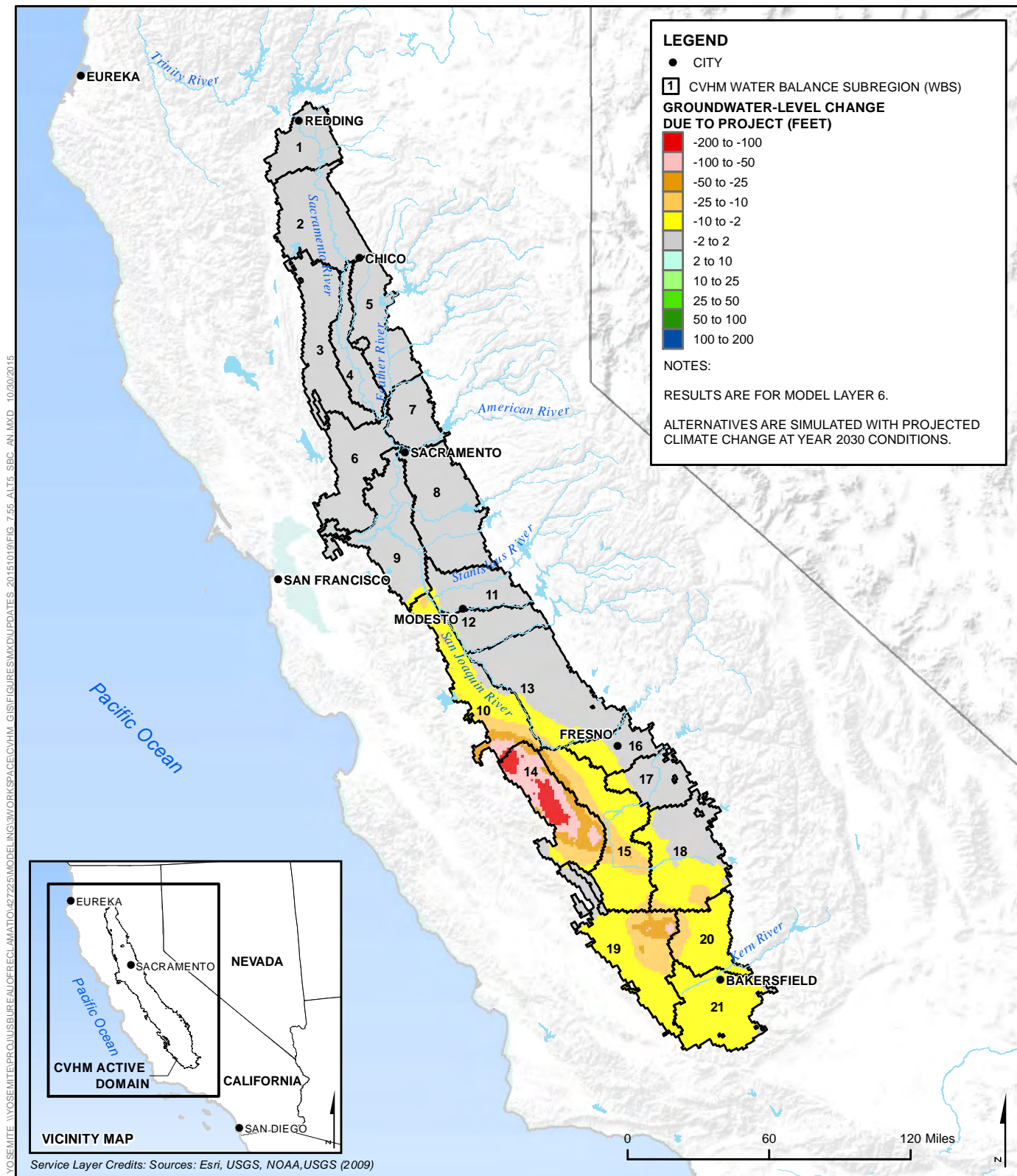


Figure 7.53 Forecast Groundwater-Level Change Hydrographs for Alternative 5 Compared to No Action Alternative at Example Locations in the San Joaquin Valley

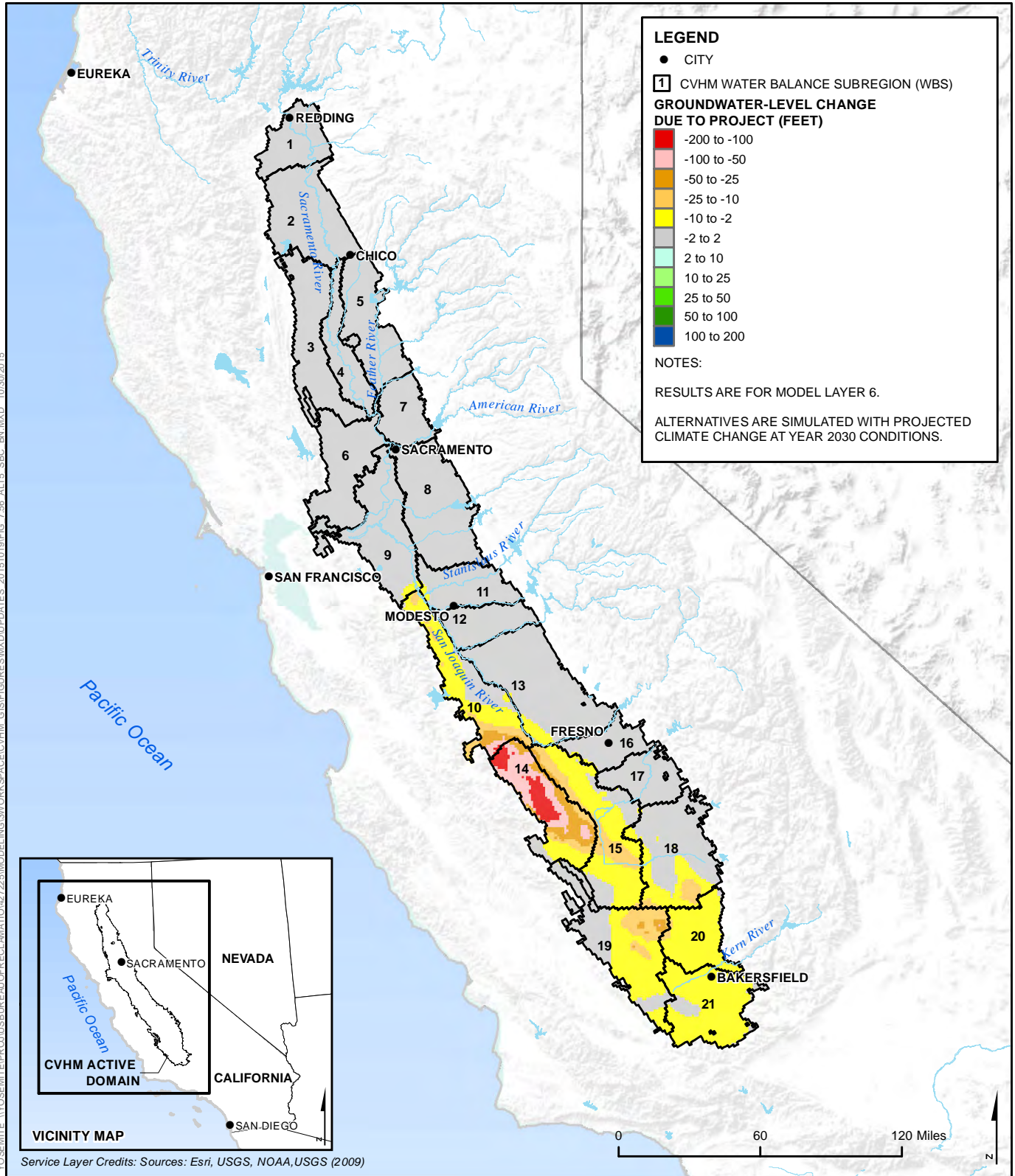


**Figure 7.54 Forecast Groundwater-Level Changes for Alternative 5 Compared to Second Basis of Comparison for Average July in a Future Wet Year**

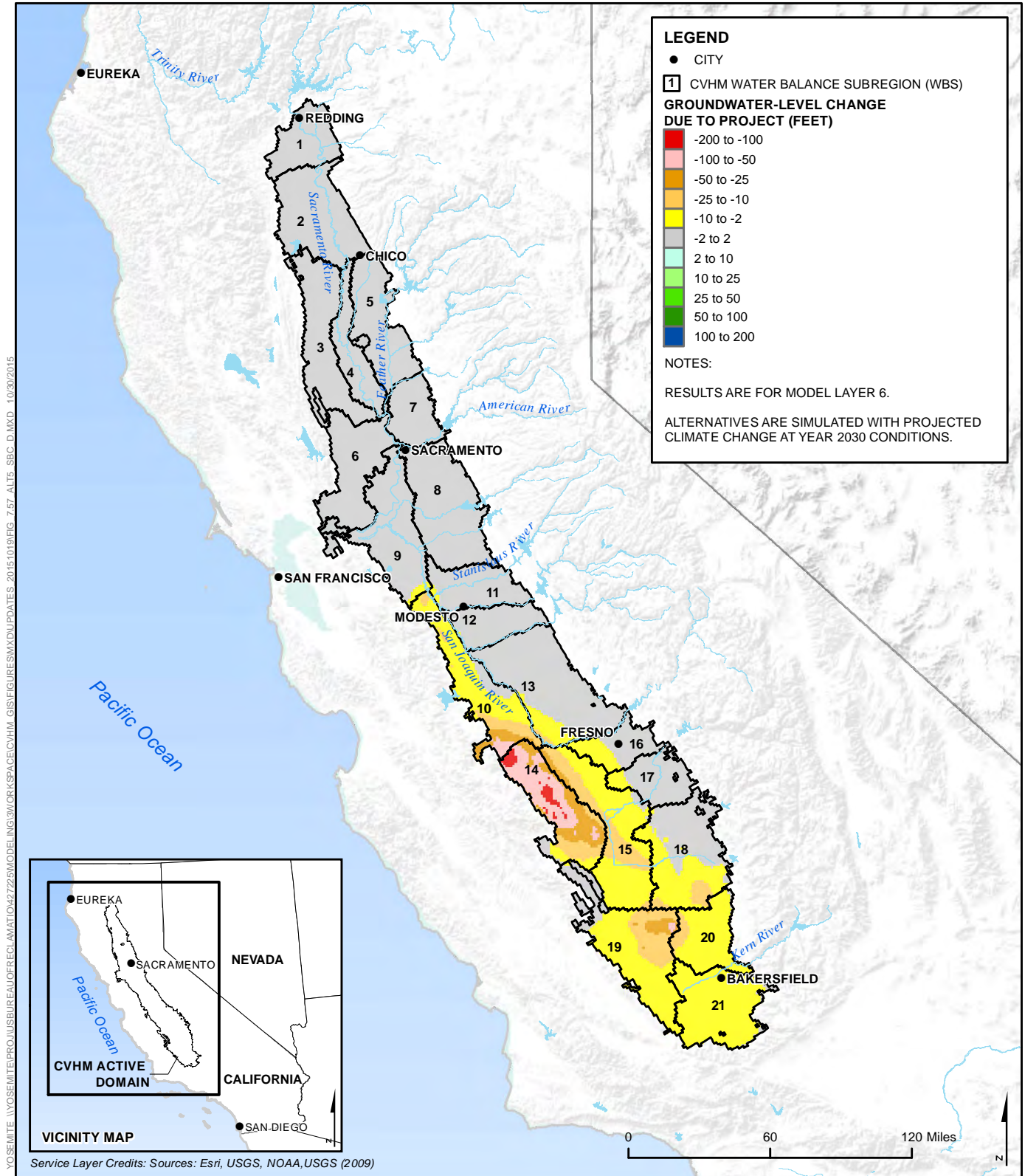




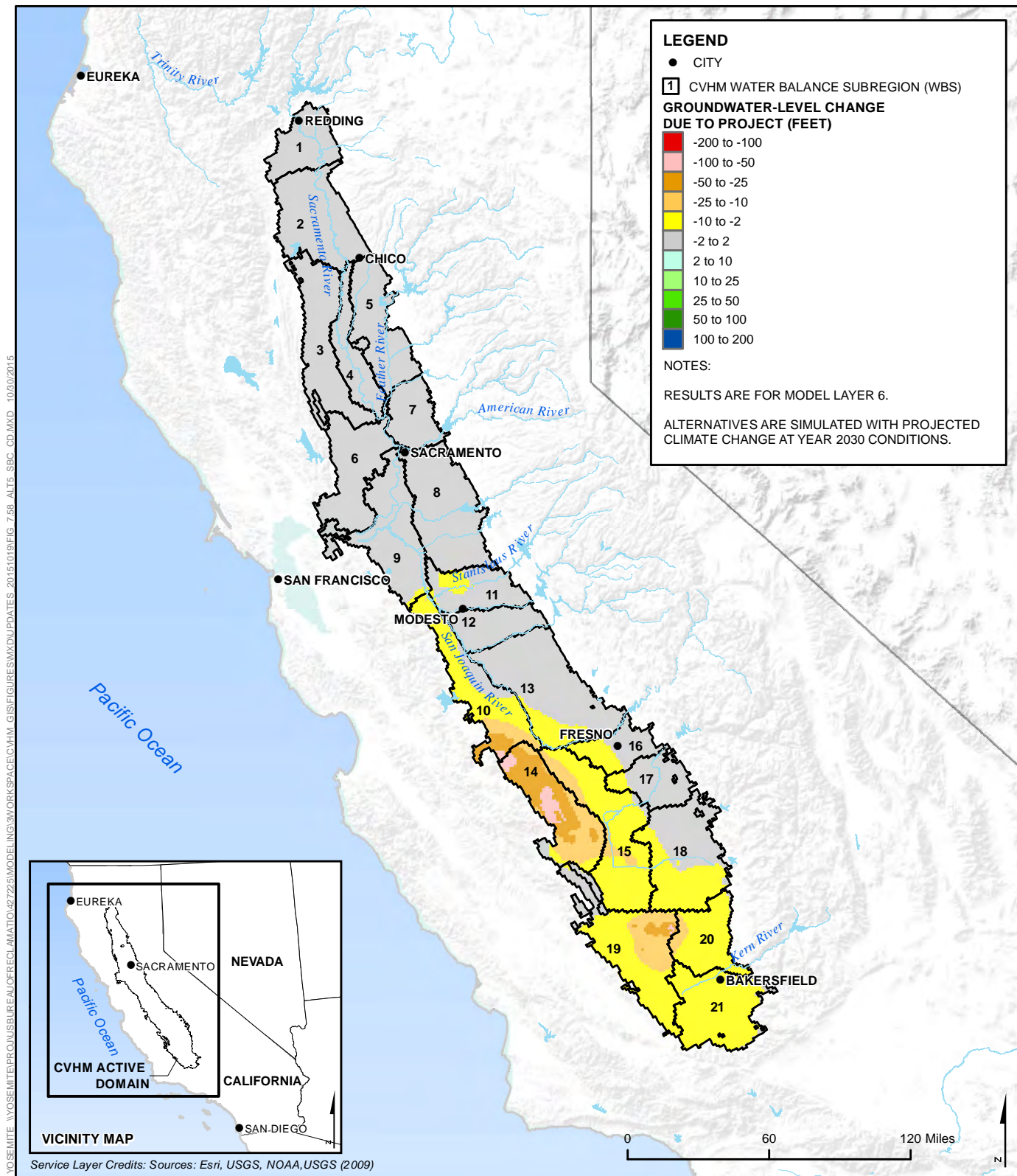
**Figure 7.55 Forecast Groundwater-Level Changes for Alternative 5 Compared to Second Basis of Comparison For Average July in a Future Below-Normal Year**



**Figure 7.56 Forecast Groundwater-Level Changes for Alternative 5 Compared to Second Basis of Comparison for Average July in a Future Below-Normal Year**

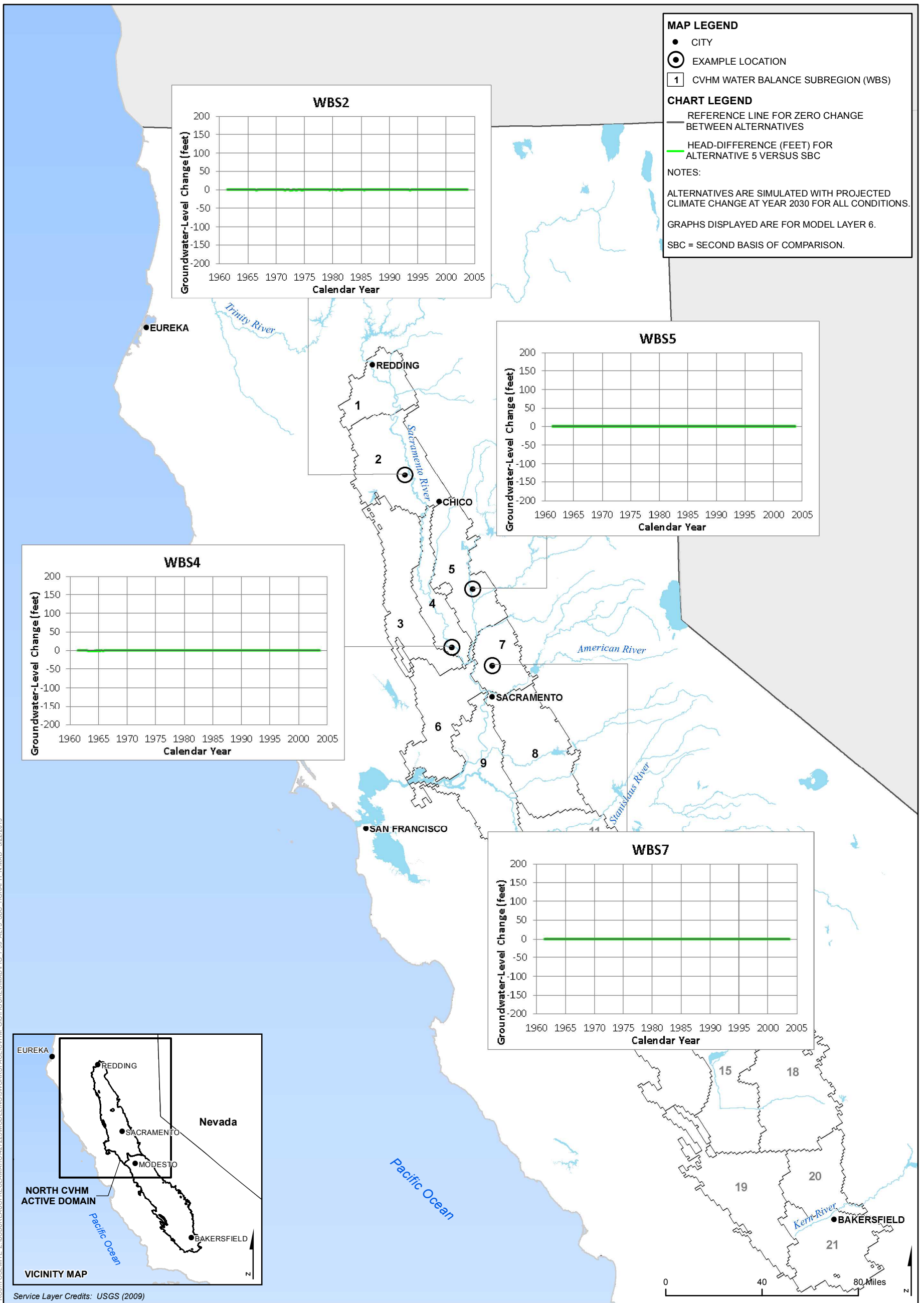


**Figure 7.57 Forecast Groundwater-Level Changes for Alternative 5 Compared to Second Basis of Comparison for Average July in a Future Dry Year**



**Figure 7.58 Forecast Groundwater-Level Changes for Alternative 5 Compared to Second Basis of Comparison for Average July in a Future Critically-Dry Year**

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**Figure 7.59 Forecast Groundwater-Level Change Hydrographs for Alternative 5 Compared to Second Basis of Comparison at Example Locations in the Sacramento Valley**

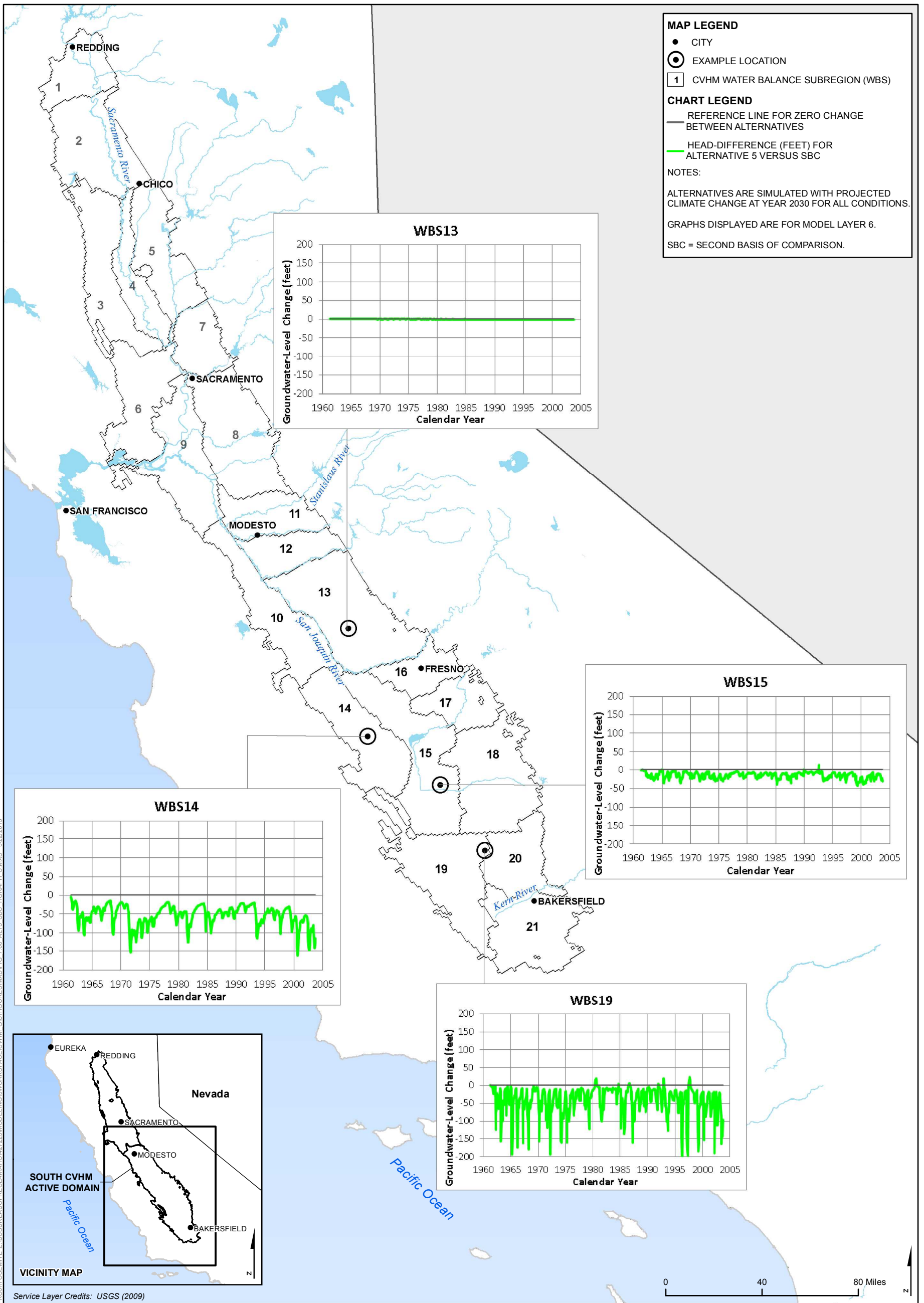


Figure 7.60 Forecast Groundwater-Level Change Hydrographs for Alternative 5 Compared to Second Basis of Comparison at Example Locations in the San Joaquin Valley

## Chapter 8

# 1 Energy

## 2 8.1 Introduction

3 This chapter describes the hydroelectric generation facilities and power demands  
4 for the Central Valley Project (CVP) and State Water Project (SWP) related to  
5 changes that could occur as a result of implementing the alternatives evaluated in  
6 this Environmental Impact Statement (EIS). Implementation of the alternatives  
7 could affect CVP and SWP power generation and energy demands through  
8 potential changes in operation of the CVP and SWP facilities.

9 Changes in CVP and SWP operations are described in more detail in Chapter 5,  
10 Surface Water Resources and Water Supplies.

## 11 8.2 Regulatory Environment and Compliance 12 Requirements

13 Potential actions that could be implemented under the alternatives evaluated in  
14 this EIS could affect CVP and/or SWP hydroelectric generation and electricity  
15 use. The changes in power production and energy use would need to be  
16 compliant with appropriate Federal and state agency policies and regulations, as  
17 summarized in Chapter 4, Approach to Environmental Analysis.

## 18 8.3 Affected Environment

19 This section describes CVP and SWP hydroelectric generation and electricity use  
20 of the generated electricity within the study area.

21 The study area includes CVP and SWP hydroelectric generation facilities at the  
22 CVP and SWP reservoirs; transmission of the generated electricity; and the CVP  
23 and SWP facilities and other users throughout California that rely upon electricity  
24 generated by the CVP and SWP hydroelectric facilities. These CVP and SWP  
25 energy generation facilities are located in the Trinity River and Central Valley  
26 regions. CVP and SWP energy use primarily occurs in the Central Valley,  
27 San Francisco Bay Area, Central Coast, and Southern California regions, as  
28 defined below.

### 29 8.3.1 Central Valley Project and State Water Project Electric 30 Generation Facilities

31 Hydroelectric facilities are located at most of the CVP and SWP dams, as shown  
32 on Figure 8.1. As water is released from the CVP and SWP reservoirs, the  
33 generation facilities produce power that is used by the CVP and SWP pumping  
34 plants, respectively. The SWP also generates hydroelectricity along the



1 California Aqueduct at energy recovery plants (California Department of Water  
2 Resources [DWR] 2013a, 2013b). Between 1983 and 2013, the DWR owned a  
3 portion of the Nevada Power Company’s coal-fired Reid Gardner Unit 4  
4 Powerplant. However, this agreement was not renewed upon expiration in 2013.

5 Power generated by the CVP is transmitted by Western Area Power  
6 Administration (Western) to CVP facilities. Power that is excess to CVP needs is  
7 marketed by Western to electric utilities, government and public installations, and  
8 commercial “preference” customers who have 20-year contracts (Bureau of  
9 Reclamation [Reclamation] 2012a). Power generated by the SWP is transmitted  
10 by Pacific Gas & Electric Company, Southern California Edison, and California  
11 Independent System Operator through other facilities (DWR 2013a, 2013b). The  
12 SWP also markets energy in excess of the SWP demands to a utility and members  
13 of the Western Systems Power Pool.

14 Hydropower is an important renewable energy and supplies between 14 and  
15 28 percent of electricity used in California depending upon the water year type  
16 (The California Energy Commission [CEC] 2014a; Hydropower Working Group  
17 [HWG] 2014). In 1992, at the end of the 1987-to-1992 drought, hydropower  
18 provided less than 11 percent of the electricity used in California. However,  
19 during a wetter year (1995), hydropower provided approximately 28 percent of  
20 electricity used in California. Between 1982 and 2012, approximately  
21 33,927 gigawatt-hours were generated in California by hydropower, including  
22 approximately 4,810 and 2,613 gigawatt-hours generated by the CVP and SWP,  
23 respectively.

#### 24 **8.3.1.1 CVP Hydroelectric Generation Facilities**

25 The CVP power facilities include 11 hydroelectric powerplants and have a total  
26 maximum generating capacity of 2,076 megawatts, as presented in Table 8.1.  
27 Hydrology can vary significantly from year to year, which then affects the  
28 hydropower production. Typically, in an average water year, approximately  
29 4,500 gigawatt-hours of energy is produced (Reclamation 2012a). Major factors  
30 that influence powerplant operations include required downstream water releases,  
31 electric system needs, and project use demand. The power generated from CVP  
32 powerplants is dedicated to first meeting the requirements of the CVP facilities.  
33 The remaining energy is marketed by Western to preferred customers in northern  
34 California.

1 **Table 8.1 Central Valley Project Hydroelectric Powerplants**

Facility	Installed Capacity (Megawatts)
Trinity Powerplant	140
Lewiston Powerplant	0.35
Judge Francis Powerplant	154
Shasta Powerplant	710
Spring Creek Powerplant	180
Keswick Powerplant	117
Folsom Powerplant	207
Nimbus Powerplant	17
New Melones Powerplant	383
O'Neill Pump-Generating Plant	14.4
San Luis Powerplant (CVP portion of the William R. Gianelli/San Luis Pump-Generating Plant)	202

2 Sources: Reclamation 2013a, 2013b, 2013c, 2013d, 2013e, 2013f, 2013g, 2013h, 2013i,  
3 2013j, 2013k, 2013l

#### 4 **8.3.1.1.1 Trinity Division Powerplants**

5 The Trinity Powerplant is located along the Trinity River (Reclamation 2013b).  
6 Primary releases of Trinity Dam are made through the powerplant. Trinity  
7 County has first preference to the power from this plant.

8 The Lewiston Powerplant is located at the Lewiston Dam along the Trinity River  
9 (Reclamation 2013c). It is operated in conjunction with the spillway gates to  
10 maintain the minimum flow in the Trinity River downstream. The turbines are  
11 usually set at maximum output with the spillway gates adjusted to regulate river  
12 flow. The turbine capacity is less than the Trinity River minimum flow criteria,  
13 as described in Chapter 5, Surface Water Resources and Water Supplies. The  
14 Lewiston Powerplant provides power to the adjacent fish hatchery.

15 The Judge Francis Carr Powerplant is a peaking powerplant located on the Clear  
16 Creek Tunnel (Reclamation 2013d). It generates power from water exported from  
17 the Trinity River Basin. Similar to Trinity Powerplant, Trinity County has first  
18 preference to the power benefit from this facility.

#### 19 **8.3.1.1.2 Sacramento River Powerplants**

20 The Shasta Powerplant is a peaking powerplant located downstream of Shasta  
21 Dam along the Sacramento River (Reclamation 2013a, 2013e). Until early 1990s,  
22 concerns with downstream temperatures resulted in the bypasses of outflows  
23 around the powerplant and lost hydropower generation. Installation of the Shasta  
24 Temperature Control Device enabled operators to decide the depth of the  
25 reservoir from which the water feeding into the penstocks originates. The system  
26 has shown significant success in controlling the water temperature of powerplant

1 releases through Shasta Dam. The Shasta Powerplant also provides water supply  
2 for the Livingston Stone National Fish Hatchery.

3 The Spring Creek Powerplant is a peaking plant located along Spring Creek, at  
4 the foot of Spring Creek Debris Dam (Reclamation 2013f). Water discharged via  
5 the Judge Francis Carr Powerplant flows into the Whiskeytown Reservoir and  
6 then provides the source of water for the Spring Creek Powerplant generation.  
7 Trinity County has first preference to the power benefits from Spring Creek  
8 Powerplant. Water from Spring Creek Powerplant is discharged into Keswick  
9 Reservoir. Releases from Spring Creek Powerplant also are operated to maintain  
10 water quality in the Spring Creek arm of Keswick Reservoir.

11 The Keswick Powerplant is located at Keswick Dam along the Sacramento River  
12 downstream of Shasta Dam and regulates the flows into the Sacramento River  
13 from both Shasta Lake and Spring Creek releases and can be considered as a run-  
14 of-the-river powerplant (Reclamation 2013g).

#### 15 **8.3.1.1.3 American River Powerplants**

16 The Folsom Powerplant is a peaking powerplant located at Folsom Dam along the  
17 American River (Reclamation 2013h). The Folsom Powerplant is operated in an  
18 integrated manner with flood control operations at Folsom Lake. One of the  
19 integrated operations is related to coordinating early flood control releases with  
20 power generation. It also provides power for the pumping plant that supplies the  
21 local domestic water supply. Folsom Powerplant supports voltage support for the  
22 Sacramento Region during summer heavy load times.

23 The Nimbus Powerplant is located at Nimbus Dam along the American River,  
24 downstream of Folsom Dam (Reclamation 2013i). The Nimbus Powerplant  
25 regulates releases from Folsom Dam into the American River and can be  
26 considered as a run-of-the river powerplant.

#### 27 **8.3.1.1.4 Stanislaus River Powerplants**

28 The New Melones Powerplant is a peaking powerplant located along the  
29 Stanislaus River (Reclamation 2013j). Primary reservoir releases are made  
30 through the powerplant. This plant provides significant voltage support to the  
31 Pacific Gas and Electric Company system during summer heavy load periods.

#### 32 **8.3.1.1.5 San Luis Reservoir Powerplants**

33 The O'Neill Pump-Generating Plant is located on a channel that conveys water  
34 between the Delta-Mendota Canal and the O'Neill Forebay (Reclamation 2013k).  
35 This pump-generating plant only generates power when water is released from the  
36 O'Neill Reservoir to the Delta-Mendota Canal. When water is conveyed from the  
37 Delta-Mendota Canal to O'Neill Forebay, the units serve as pumps, not  
38 hydroelectric generators. The generated power is used to support CVP pumping  
39 and irrigation actions of the CVP.

40 The William R. Gianelli (San Luis) Pump-Generating Plant is located along the  
41 along the western boundary of the O'Neill Forebay at the San Luis Dam

1 (Reclamation 2013l). This pump-generating plant is owned by the Federal  
 2 government but is operated as a joint Federal-State facility that is shared by the  
 3 CVP and SWP. Energy is generated when water is needed to be conveyed from  
 4 San Luis Reservoir back into O’Neill Forebay for continued conveyance to the  
 5 Delta-Mendota Canal. The plant is operated in pumping mode when water is  
 6 moved from O’Neill Forebay to San Luis Reservoir for storage until heavier water  
 7 demands develop. The generated power is used to offset CVP and SWP pumping  
 8 loads. The powerplant can generate up to 424 megawatts, with the CVP share of  
 9 the total capacity being 202 megawatts. This facility is operated and maintained  
 10 by the State of California under an operation and maintenance agreement with  
 11 Reclamation.

12 **8.3.1.2 SWP Electric Generation Facilities**

13 The SWP power facilities are operated primarily to provide power for the SWP  
 14 facilities (DWR 2013b). The SWP power facilities and capacities are summarized  
 15 in Table 8.2. The SWP has power contracts with electric utilities and the  
 16 California Independent System Operator that act as exchange agreements with  
 17 utility companies for transmission and power sales/purchases. In all years, the  
 18 SWP must purchase additional power to meet pumping requirements.

19 **Table 8.2 State Water Project Hydroelectric Powerplants**

Facility	Installed Capacity (Megawatts)
Oroville Facilities	–
Hyatt Pumping-Generating Plant	645
Thermalito Diversion Dam Powerplant	3
Thermalito Pumping-Generating Plant	114
William R. Gianelli (San Luis) Pumping-Generating Plant (SWP share)	222
Alamo Powerplant	17
Mojave Siphon Powerplant	30
Devil Canyon Powerplant	276
Warne Powerplant	74

20 Source: DWR 2012

21 **8.3.1.2.1 Feather River Powerplants**

22 The Hyatt Pumping-Generating Plant is located on the channel between Lake  
 23 Oroville and the Thermalito Diversion Pool (DWR 2007). Water in the  
 24 Thermalito Diversion Pool can be pumped back to Lake Oroville to be released  
 25 through the Hyatt Pumping-Generating Plant and generate more electricity;  
 26 released through the Thermalito Diversion Dam Powerplant for delivery to the  
 27 low flow channel upstream of Thermalito Forebay; or conveyed to Thermalito  
 28 Forebay for subsequent release through the Thermalito Pumping-Generating  
 29 Plant. The combined Hyatt Pumping-Generating Plant and Thermalito Pumping-  
 30 Generating Plant generate approximately 2,200 gigawatt-hours of energy in a

1 median water year, while the 3 megawatts generated by Thermalito Diversion  
2 Dam Powerplant adds another 24 gigawatt-hours per year (DWR 2013).

### 3 **8.3.1.2.2 San Luis Reservoir Powerplant**

4 As described above, the William R. Gianelli (San Luis) Pump-Generating Plant is  
5 owned by the Federal government and is operated as a joint Federal-state facility  
6 that is shared by the CVP and SWP. The SWP water flows from the California  
7 Aqueduct into O'Neill Forebay downstream of the CVP's O'Neill Pump-  
8 Generating Plant. The pump-generating plant is located along the western  
9 boundary of the O'Neill Forebay at the San Luis Dam (DWR 2013a, 2013b,  
10 Reclamation 2013l). Electricity is generated when water is transferred from  
11 San Luis Reservoir back to O'Neill Forebay for continued conveyance in the  
12 California Aqueduct. The plant acts as a pumping plant when water is transferred  
13 from O'Neill Forebay to San Luis Reservoir. The generated power is used to  
14 offset CVP and SWP pumping loads. The powerplant can generate up to  
15 424 megawatts, with the SWP share of the total capacity being 222 megawatts.  
16 This facility is operated and maintained by the State of California under an  
17 operation and maintenance agreement with Reclamation.

### 18 **8.3.1.2.3 East Branch and West Branch Powerplants**

19 Downstream of the Antelope Valley, the California Aqueduct divides into the  
20 East Branch and West Branch. The Alamo Powerplant, Mojave Powerplant, and  
21 Devil Canyon Powerplant are located along the East Branch which conveys water  
22 into San Bernardino County (DWR 2013a, 2013b). The Warne Powerplant is  
23 located along the West Branch which conveys water into Los Angeles County.  
24 The generation rates vary at these powerplants depending upon the amount of  
25 water conveyed.

### 26 **8.3.1.2.4 Other Energy Resources for the State Water Project**

27 Other energy supplies have been obtained by DWR from other utilities and energy  
28 marketers under agreements that allow DWR to buy, sell, or exchange energy on  
29 a short-term hourly basis or a long-term multi-year basis (DWR 2013a, 2013b).

30 For example, DWR jointly developed the 1,254-megawatt Castaic Powerplant on  
31 the West Branch with the Los Angeles Department of Water and Power (DWR  
32 2012, 2013). The power is available to DWR at the Sylmar Substation.

33 DWR has a long-term purchase agreement with the Kings River Conservation  
34 District for the approximately 400 million kilowatt-hours of energy from the  
35 165-megawatt hydroelectric Pine Flat Powerplant (DWR 2012, 2013). DWR also  
36 purchases energy from five hydroelectric plants with 30 megawatts of installed  
37 capacity that are owned and operated by Metropolitan Water District of Southern  
38 California (DWR 2012, 2013).

39 DWR also purchases energy under short-term purchase agreements from utilities  
40 and energy marketers of the Western Systems Power Pool (DWR 2012, 2013). In  
41 addition, the 1988 Coordination Agreement between DWR and Metropolitan

1 Water District of Southern Californian enables DWR to purchase and exchange  
2 energy (DWR 2012, 2013).

### 3 **8.3.2 Other Hydroelectric Generation Facilities**

4 Hydroelectric facilities in addition to CVP and SWP hydroelectric facilities in the  
5 study area are owned by investor-owned utility companies, such as Pacific Gas &  
6 Electric Company and Southern California Edison; municipal agencies, such as  
7 Sacramento Municipal Utility District; and by local and regional water agencies.  
8 Some of the larger facilities outside the CVP and SWP systems and within or  
9 adjacent to the study area include (DWR 2013d; 2013e; YCWA 2012):

- 10 • Pacific Gas and Electric Company
  - 11 – Helms Pumped Storage (1,200 megawatts) in Fresno County.
  - 12 – Pit System (320 megawatts) and McCloud-Pit System (370 megawatts,  
13 total) in Shasta County.
  - 14 – Upper North Fork Feather River System (360 megawatts) in Plumas  
15 County.
- 16 • Sacramento Municipal Utility District Upper American River Project System  
17 (688 megawatts) in El Dorado County.
- 18 • City and County of San Francisco Hetch Hetchy Power System  
19 (390 megawatts) in Tuolumne County.
- 20 • Southern California Edison
  - 21 – Big Creek System and Eastwood Pump Storage (approximately  
22 1,000 megawatts) in Fresno and Madera counties.
  - 23 – Mammoth Pool Project (187 megawatts) in Fresno and Madera counties.
- 24 • Turlock Irrigation District and Modesto Irrigation District New Don Pedro  
25 Project (203 megawatts) in Tuolumne County.
- 26 • Yuba County Water Agency Yuba River Development Project  
27 (390 megawatts) in Yuba County.

### 28 **8.3.3 CVP and SWP System Energy Demands**

29 Power generation at CVP and SWP hydropower facilities fluctuates in response to  
30 reservoir releases and conveyance flows. Reservoir releases are significantly  
31 affected by hydrologic conditions, minimum stream flow requirements, flow  
32 fluctuation restrictions, water quality requirements, and non-CVP and non-SWP  
33 water rights which must be met prior to releases for CVP water service  
34 contractors and SWP entitlement holders.

#### 35 **8.3.3.1 CVP Power Generation and Energy Use**

36 The CVP power generation facilities were developed to meet CVP energy use  
37 loads.

1 The majority of the energy used by the CVP is needed for pumping plants located  
 2 in the Delta, at San Luis Reservoir, and along the Delta-Mendota Canal and San  
 3 Luis Canal portion of the California Aqueduct. Table 8.3 presents historical  
 4 average annual CVP hydropower generation and use. Monthly power generation  
 5 pattern follows seasonal reservoir releases, with peaks during the irrigation  
 6 season, as shown on Figure 8.2. The hydropower generation between January and  
 7 June decreases after 2007 because the potential to convey CVP water across the  
 8 Delta during this period was reduced after 2007 to reduce reverse flows in Old  
 9 and Middle River, in accordance with legal decisions and subsequently through  
 10 implementation of the biological opinions.

11 **Table 8.3 Hydropower Generation and Energy Use by the CVP**

Calendar Year	Water Year Type <sup>a</sup>	Net CVP Hydropower Generation (Gigawatt-hours)	Energy Used CVP Facilities (Gigawatt-hours)
2000	AN	5,667	–
2001	D	4,107	957
2002	D	4,322	1,090
2003	AN	5,483	1,170
2004	BN	5,186	1,172
2005	AN	4,599	1,150
2006	W	7,284	1,037
2007	D	4,276	1,064
2008	C	3,659	923
2009	D	3,560	803
2010	BN	3,624	1,001
2011	W	5,469	1,276
2012	BN	4,849	990

12 Sources: Reclamation 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008a-l, 2009a-l,  
 13 2010a-l, 2011a-l, 2012b-m.

14 Note:

15 a. Water Year Type based on Sacramento Valley 40-30-30 Index, as described in  
 16 Chapter 5, Surface Water Resources and Water Supplies.

17 Recently, the California Public Utilities Commission (CPUC) evaluated the  
 18 “energy intensity” of several types of water supplies (CPUC 2010). The energy  
 19 intensity is defined as the average amount of energy required to convey and/or  
 20 treat water on a unit basis, such as per 1 acre-foot. Substantial quantities of  
 21 energy are required by the CVP pumping plants to convey large amounts of water  
 22 over long distances with significant changes in elevation. The study indicated  
 23 that the energy intensity of CVP water delivered to users downstream of San Luis  
 24 Reservoir ranged from 0.292 megawatt-hours/acre-foot for users along the Delta-  
 25 Mendota Canal; to 0.428 megawatt-hours/acre-foot for users along the San Luis

1 Canal/California Aqueduct; to 0.870 megawatt-hours/acre-foot in San Benito and  
2 Santa Clara counties.

### 3 **8.3.3.2 SWP Power Generation and Energy Use**

4 The SWP power generation facilities also were developed to meet SWP energy  
5 use loads. The majority of the energy used by the SWP is needed for pumping  
6 plants located in the Delta, at the San Luis Reservoir, and along the California  
7 Aqueduct. Table 8.4 presents historical average annual SWP hydropower  
8 generation and use. Monthly power generation pattern follows seasonal reservoir  
9 releases, with peaks during the irrigation season, as shown on Figure 8.3.  
10 Table 8.4 presents SWP power use and generation values for the period 2001  
11 through 2012 that indicate the SWP generates approximately 63 percent of the  
12 energy needed for deliveries (DWR 2002, 2004a, 2004b, 2005, 2006, 2007, 2008,  
13 2012a, 2012b, 2013). The energy generation and purchases and energy use  
14 decreases after 2007 because the potential to convey SWP water across the Delta  
15 was reduced in accordance with legal decisions and subsequently through  
16 implementation of the biological opinions.

17 **Table 8.4 Hydropower Generation and Energy Use by the State Water Project**

Calendar Year	Water Year Type <sup>a</sup>	SWP Hydropower Generation (Gigawatt-hour)	Energy Acquired through Long-term Agreements and Purchases (Gigawatt-hour)	Energy Used by SWP Facilities (Gigawatt-hour)
2000	AN	6,372	5,741	9,190
2001	D	4,295	4,660	6,656
2002	D	4,953	4,610	8,394
2003	AN	5,511	4,668	9,175
2004	BN	6,056	4,429	9,868
2005	AN	5,151	5,367	8,308
2006	W	7,056	5,811	9,158
2007	D	5,577	6,642	9,773
2008	C	3,541	4,603	5,745
2009	D	4,295	4,660	6,656
2010	BN	4,953	4,610	8,394
2011	W	5,511	4,668	9,175
2012	BN	6,056	4,429	9,868

18 Sources: DWR 2002, 2004a, 2004b, 2005, 2006, 2007, 2008, 2012a, 2012b, 2013

19 Note:

20 a. Water Year Type based on Sacramento Valley 40-30-30 Index, as described in  
21 Chapter 5, Surface Water Resources and Water Supplies.



1 The energy intensity values calculated by the California Public Utilities  
2 Commission for the SWP ranged from 1.128 megawatt-hours/acre-foot for water  
3 users along the South Bay Aqueduct; to 1.157 megawatt-hours/acre-foot for water  
4 users in Kern County; to 4,644 megawatt-hours/acre-foot for water users at the  
5 terminal end of the East Branch Extension of the California Aqueduct (CPUC  
6 2010).

### 7 **8.3.4 Energy Demands for Groundwater Pumping**

8 Groundwater provided approximately 37 percent of the state’s agricultural,  
9 municipal, and industrial water supply of the average water needs between 1998  
10 and 2010, or approximately 16 million acre-feet/year of groundwater (DWR  
11 2013). The use of groundwater varies regionally throughout the State. For  
12 example in some areas, groundwater provides less than 10 percent to more than  
13 90 percent, as described in Chapter 7, Groundwater Resources and Groundwater  
14 Quality.

15 The amount of energy used statewide to pump groundwater is not well quantified  
16 (CPUC 2010). The California Public Utilities Commission estimated  
17 groundwater energy use by hydrologic region and by type of use to evaluate the  
18 water and energy relationships. Groundwater pumping estimates were calculated  
19 in each DWR Planning Areas for agricultural and municipal water demands.  
20 Groundwater energy use was estimated based upon assumptions of well depths  
21 and pump efficiencies. Some wells use natural gas for individual engines instead  
22 of electricity; however, the amount of natural gas pumping versus electric  
23 pumping is generally unknown. In 2010, average groundwater use in the state  
24 was approximately 14.7 million acre-feet, or 36 percent of total agricultural,  
25 municipal, and industrial water supplies (DWR 2013). The California Public  
26 Utilities Commission estimated that in 2010, statewide groundwater pumping  
27 accounted for more electricity use between May and August than the total  
28 electricity use by the CVP and SWP during that time period (CPUC 2010). Over  
29 the entire year, it was estimated that groundwater pumping used approximately  
30 10 percent more electricity than the SWP and approximately 5 percent less than  
31 the CVP and SWP combined.

## 32 **8.4 Impact Analysis**

33 This section describes the potential mechanisms for change in energy generation  
34 and analytical methods; results of the impact analyses; potential mitigation  
35 measures; and cumulative effects.

### 36 **8.4.1 Potential Mechanisms for Change and Analytical Tools**

37 The environmental consequences assessment considers changes in energy  
38 resources conditions related to changes in CVP and SWP operations under the  
39 alternatives as compared to the No Action Alternative and Second Basis of  
40 Comparison.

1     **8.4.1.1     Changes in Energy Resources Related to CVP and SWP Water**  
 2                   **Users**

3     Energy generation is limited on a monthly bases by the average power capacity of  
 4     each generation facility based upon reservoir elevations and water release  
 5     patterns. The majority of the CVP and SWP energy use is for the conveyance  
 6     facilities located in the Delta and south of the Delta. Energy use would change  
 7     with changes in CVP and SWP deliveries.

8     Reservoir elevations and flow patterns through pumping facilities output from the  
 9     CalSim II model (see Chapter 5, Surface Water Resources and Water Supplies)  
 10    are used with LTGen and SWP Power tools, as described in Appendix 8A, Power  
 11    Model Documentation. These tools estimate average annual peaking power  
 12    capacity, energy use, and energy generation at CVP and SWP facilities,  
 13    respectively. The tools estimate average annual energy generation and use and  
 14    net generation. When net generation values are negative, the CVP or SWP would  
 15    purchase power from other generation facilities. When net generation values are  
 16    positive, power would be available for use by non-CVP and SWP electricity  
 17    users.

18    When CVP and SWP water deliveries change, water users would be anticipated  
 19    to change their use of groundwater, recycled water, and/or desalinated water, as  
 20    described in Chapter 5, Surface Water Resources and Water Supplies, Chapter 12,  
 21    Agricultural Resources, and Chapter 19, Socioeconomics. Specific responses by  
 22    water users to changes in CVP and SWP water deliveries are not known; and  
 23    therefore, energy use for the alternate water supplies cannot be quantified in this  
 24    analysis. It is not known whether the net change in energy use for the CVP and  
 25    SWP would or would not be similar to the net change in energy use for alternate  
 26    water supplies (e.g., groundwater pumping, water treatment, water conveyance).

27    **8.4.1.2     Effect Related to Cross Delta Water Transfers**

28    Historically water transfer programs have been developed on an annual basis.  
 29    The demand for water transfers is dependent upon the availability of water  
 30    supplies to meet water demands. Water transfer transactions have increased over  
 31    time as CVP and SWP water supply availability has decreased, especially during  
 32    drier water years. Water transfers using CVP and SWP Delta pumping plants and  
 33    south of Delta canals generally occur when there is unused capacity in these  
 34    facilities, especially in drier years.

35    Parties seeking water transfers generally acquire water from sellers who have  
 36    available surface water who can make the water available through releasing  
 37    previously stored water, pump groundwater instead of using surface water  
 38    (groundwater substitution); idle crops; or substitute crops that uses less water in  
 39    order to reduce normal consumptive use of surface water.

40    Changes in net energy generation could occur statewide during cross Delta water  
 41    transfers due to following reasons:

- 42    • Changed reservoir release patterns at CVP and SWP reservoirs
- 43    • Changed conveyance patterns at the CVP and SWP pumping plants

- 1 • Increased groundwater pumping in the seller’s service area if groundwater  
2 substitution is used to make the transferred water available
- 3 • Reductions in groundwater pumping in the purchaser’s service area if less  
4 groundwater would be used due to the water transfer

5 Reclamation recently prepared a long-term regional water transfer environmental  
6 document which evaluated potential changes in surface water conditions related to  
7 water transfer actions (Reclamation 2014c). Results from this analysis were used  
8 to inform the impact assessment of potential effects of water transfers under the  
9 alternatives as compared to the No Action Alternative and the Second Basis of  
10 Comparison.

#### 11 **8.4.2 Conditions in Year 2030 without Implementation of** 12 **Alternatives 1 through 5**

13 The impact analysis in this EIS is based upon the comparison of the alternatives to  
14 the No Action Alternative and the Second Basis of Comparison in the Year 2030.  
15 Changes that would occur over the next 15 years without implementation of the  
16 alternatives are not analyzed in this EIS. However, the changes that are assumed  
17 to occur by 2030 under the No Action Alternative and the Second Basis of  
18 Comparison are summarized in this section.

19 Many of the changed conditions would occur in the same manner under both the  
20 No Action Alternative and the Second Basis of Comparison. Other future  
21 conditions would be different under the No Action Alternative as compared to the  
22 Second Basis of Comparison due to the implementation of the 2008 U.S. Fish and  
23 Wildlife Service (USFWS) Biological Opinion (BO) and 2009 National Marine  
24 Fisheries Service (NMFS) BO under the No Action Alternative.

25 This section of Chapter 8 provides qualitative projections of the No Action  
26 Alternative as compared to existing conditions described under the Affected  
27 Environment; and qualitative projections of the Second Basis of Comparison as  
28 compared to “recent historical conditions.” Recent historical conditions are not  
29 the same as existing conditions which include implementation of the 2008  
30 USFWS BO and 2009 NMFS BO; and consider changes that would have occurred  
31 without implementation of the 2008 USFWS BO and the 2009 NMFS BO.

##### 32 **8.4.2.1 Common Changes in Conditions under the No Action Alternative** 33 **and Second Basis of Comparison**

34 Conditions in 2030 would be different than existing conditions due to:

- 35 • Climate change and sea-level rise
- 36 • General plan development throughout California, including increased water  
37 demands in portions of Sacramento Valley
- 38 • Implementation of reasonable and foreseeable water resources management  
39 projects to provide water supplies

40 These changes would result in a decline of the long-term average CVP and SWP  
41 water supply deliveries by 2030 as compared to recent historical long-term

1 average deliveries, as described in Chapter 5, Surface Water Resources and Water  
2 Supplies.

#### 3 **8.4.2.1.1 Changes in Conditions due to Climate Change and Sea Level Rise**

4 It is anticipated that climate change would result in more short-duration high-  
5 rainfall events and less snowpack in the winter and early spring months. The  
6 reservoirs would be full more frequently by the end of April or May by 2030 than  
7 in recent historical conditions. However, as the water is released in the spring,  
8 there would be less snowpack to refill the reservoirs. This condition would  
9 reduce reservoir storage and potential hydropower generation in the summer.  
10 These conditions would occur for all reservoirs in the California foothills and  
11 mountains, including non-CVP and SWP reservoirs.

#### 12 **8.4.2.1.2 General Plan Development in California**

13 Counties and cities throughout California have adopted general plans which  
14 identify land use classifications including those for municipal and industrial uses  
15 and those for agricultural uses. Population projections from those general plan  
16 evaluations are provided to the State Department of Finance and are used to  
17 project future water needs and the potential for conversion of existing  
18 undeveloped lands and agricultural lands. Many of the existing general plans for  
19 counties with municipal areas recently have been modified to include land use and  
20 population projections through 2030. The No Action Alternative and the Second  
21 Basis of Comparison assume that land uses will develop through 2030 in  
22 accordance with existing general plans.

23 Statewide the increased population would result in increased energy demands.  
24 Under the No Action Alternative and Second Basis of Comparison, it is assumed  
25 that energy demands would be met on a long-term basis and in dry and critical dry  
26 years using a combination of conservation, increased efficiency in energy  
27 generation and transmission, and renewable energy sources.

#### 28 **8.4.2.1.3 Reasonable and Foreseeable Water Resources Management** 29 **Projects**

30 The No Action Alternative and the Second Basis of Comparison assumes  
31 completion of water resources management and environmental restoration  
32 projects that would have occurred without implementation of the 2008 USFWS  
33 BO and 2009 NMFS BO by 2030, as described in Chapter 3, Description of  
34 Alternatives. Many of these future actions involve additional water treatment and  
35 conveyance facilities that would change statewide energy demands.

#### 36 **8.4.2.2 Changes in Conditions under the No Action Alternative**

37 Due to the climate change and sea level rise and increased water demands in the  
38 Sacramento Valley, CVP and SWP energy generation would be less in the  
39 summer months when energy demand is high for water conveyance and air  
40 conditioning equipment throughout the state. It is also anticipated that water  
41 deliveries would be less in 2030 than under recent historical conditions; and,

1 therefore, energy use for CVP and SWP water conveyance facilities would be  
2 less.

3 **8.4.2.3 Changes in Conditions under the Second Basis of Comparison**

4 Due to the climate change and sea level rise and increased water demands in the  
5 Sacramento Valley, CVP and SWP energy generation would be less in the  
6 summer months when energy demand is high for water conveyance and air  
7 conditioning equipment throughout the State. It is also anticipated that water  
8 deliveries would be less in 2030 than under recent historical conditions; and,  
9 therefore, energy use for CVP and SWP water conveyance facilities would be  
10 less.

11 As described in Chapter 5, Surface Water Resources and Water Supplies, the  
12 availability of CVP and SWP water supplies would be greater under the Second  
13 Basis of Comparison as compared to the No Action Alternative because CVP and  
14 SWP water operations would not include requirements of the 2008 USFWS BO  
15 and 2009 NMFS BO. Therefore, CVP and SWP energy use would be greater, and  
16 possibly groundwater pumping use would be less, under the Second Basis of  
17 Comparison as compared to the No Action Alternative.

18 **8.4.3 Evaluation of Alternatives**

19 As described in Chapter 4, Approach to Environmental Analysis, Alternatives 1  
20 through 5 have been compared to the No Action Alternative; and the No Action  
21 Alternative and Alternatives 1 through 5 have been compared to the Second Basis  
22 of Comparison.

23 During review of the numerical modeling analyses used in this EIS, an error was  
24 determined in the CalSim II model assumptions related to the Stanislaus River  
25 operations for the Second Basis of Comparison, Alternative 1, and Alternative 4  
26 model runs. Appendix 5C includes a comparison of the CalSim II model run  
27 results presented in this chapter and CalSim II model run results with the error  
28 corrected. Appendix 5C also includes a discussion of changes in the comparison  
29 of groundwater conditions for the following alternative analyses.

- 30 • No Action Alternative compared to the Second Basis of Comparison
- 31 • Alternative 1 compared to the No Action Alternative
- 32 • Alternative 3 compared to the Second Basis of Comparison
- 33 • Alternative 5 compared to the Second Basis of Comparison

34 **8.4.3.1 No Action Alternative**

35 The No Action Alternative is compared to the Second Basis of Comparison.

36 **8.4.3.1.1 Potential Changes in Energy Resources Related to CVP and SWP**  
37 **Water Users**

38 Changes in CVP and SWP operations under the No Action Alternative as  
39 compared to the Second Basis of Comparison would result in a reduction of CVP  
40 and SWP water deliveries to areas located south of the Delta; and therefore,

1 annual energy use would result in changes in CVP and SWP energy resources, as  
 2 summarized in Table 8.5. The CVP net generation over the long-term conditions  
 3 (averaged over the 81-year model simulation period, as described in Chapter 5)  
 4 and in dry and critical dry years would be similar (within 5 percent) under the  
 5 No Action Alternative and the Second Basis of Comparison. The SWP net  
 6 generation would be reduced by 29 percent over the long-term condition and by  
 7 37 percent in dry and critical dry years. Changes in monthly energy use are  
 8 presented in Appendix 8A, Power Model Documentation.

9 **Table 8.5 Energy Generation, Energy Use, and Net Generation under the No Action**  
 10 **Alternative as Compared to the Second Basis of Comparison**

<b>Project</b>	<b>Water Year</b>	<b>Energy (Gigawatt-hours)</b>	<b>No Action Alternative (NAA)</b>	<b>Second Basis of Comparison (SBC)</b>	<b>Changes between NAA and SBC</b>
CVP Facilities	Long-term Average	Energy Generation	4,558	4,604	-46
		Energy Use	1,113	1,289	-177
		Net Generation	3,445	3,315	131
	Dry and Critical Water Years	Energy Generation	2,696	2,773	-77
		Energy Use	699	773	-75
		Net Generation	1,997	2,000	-2
SWP Facilities	Long-term Average	Energy Generation	4,202	4,721	-520
		Energy Use	7,798	9,802	-2,004
		Net Generation	-3,597	-5,081	1,484
	Dry and Critical Water Years	Energy Generation	1,914	2,494	-579
		Energy Use	3,929	5,686	-1,757
		Net Generation	-2,015	-3,192	1,177

11 Under the No Action Alternative as compared to the Second Basis of  
 12 Comparison, CVP and SWP water deliveries would be less and it is anticipated

1 that CVP and SWP water users would use more alternate water supplies. These  
2 alternate water supplies would require energy. Specific changes in energy use  
3 would depend upon specific responses by water users, and are not known at this  
4 time. Therefore, it is uncertain whether the increased regional and local water  
5 supply energy requirements would be similar to the reduced energy use by the  
6 CVP and SWP operations in 2030 under the No Action Alternative as compared  
7 to the Second Basis of Comparison. For the purposes of this analysis, a worse-  
8 case scenario is assumed, and that total energy use by CVP and SWP water users  
9 could be higher under the No Action Alternative than under the Second Basis of  
10 Comparison.

#### 11 **8.4.3.1.2 Effects Related to Cross Delta Water Transfers**

12 Potential effects to energy resources could be similar to those identified in a  
13 recent environmental analysis conducted by Reclamation for long-term water  
14 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c).  
15 Potential effects to energy resources were identified as changes in power  
16 generation patterns at the reservoirs due to changes in reservoir release patterns  
17 and surface water elevation patterns. These potential changes were not  
18 considered to be substantial because the total amount of electricity generated  
19 would be similar and the power loss would be minimal due to changes in release  
20 patterns. For the purposes of this EIS, it is anticipated that similar conditions  
21 would occur during implementation of cross Delta water transfers under the  
22 No Action Alternative and the Second Basis of Comparison.

23 Groundwater pumping in areas that purchase the transferred water could be  
24 reduced if additional surface water is provided. However, if the transferred water  
25 is used to meet water demands that would not have been met (e.g., crops that had  
26 been idled), groundwater pumping would be similar with or without water  
27 transfers.

28 Under the No Action Alternative, the timing of cross Delta water transfers would  
29 be limited to July through September and include annual volumetric limits, in  
30 accordance with the 2008 USFWS BO and 2009 NMFS BO. Under the Second  
31 Basis of Comparison, water could be transferred throughout the year without an  
32 annual volumetric limit. Overall, the potential for cross Delta water transfers  
33 would be less under the No Action Alternative than under the Second Basis of  
34 Comparison; however, energy resources conditions would be similar.

#### 35 **8.4.3.2 Alternative 1**

36 Alternative 1 is identical to the Second Basis of Comparison. Alternative 1 is  
37 compared to the No Action Alternative and the Second Basis of Comparison.  
38 However, because energy resource conditions under Alternative 1 are identical to  
39 energy resource conditions under the Second Basis of Comparison; Alternative 1  
40 is only compared to the No Action Alternative.

1 **8.4.3.2.1 Alternative 1 Compared to the No Action Alternative**

2 *Potential Changes in Energy Resources Related to CVP and SWP Water Users*

3 Changes in CVP and SWP operations under Alternative 1 as compared to the No  
 4 Action Alternative would result in an increase of CVP and SWP water deliveries  
 5 to areas located south of the Delta; and therefore, annual energy use would result  
 6 in changes in CVP and SWP energy resources, as summarized in Table 8.6. The  
 7 CVP net generation over the long-term conditions and in dry and critical dry years  
 8 would be similar under Alternative 1 as compared to the No Action Alternative.  
 9 The SWP net generation would be increased by 41 percent over the long-term  
 10 condition and by 58 percent in dry and critical dry years. Changes in monthly  
 11 energy use are presented in Appendix 8A, Power Model Documentation.

12 **Table 8.6 Energy Generation, Energy Use, and Net Generation under Alternative 1**  
 13 **as Compared to the No Action Alternative**

Project	Water Year	Energy (Gigawatt-hours)	Alternative 1	No Action Alternative (NAA)	Changes between Alternative 1 and NAA
CVP Facilities	Long-term Average	Energy Generation	4,604	4,558	46
		Energy Use	1,289	1,113	177
		Net Generation	3,315	3,445	-131
	Dry and Critical Water Years	Energy Generation	2,773	2,696	77
		Energy Use	773	699	75
		Net Generation	2,000	1,997	2
SWP Facilities	Long-term Average	Energy Generation	4,721	4,202	520
		Energy Use	9,802	7,798	2,004
		Net Generation	-5,081	-3,597	-1,484
	Dry and Critical Water Years	Energy Generation	2,494	1,914	579
		Energy Use	5,686	3,929	1,757
		Net Generation	-3,192	-2,015	-1,177



1 Under Alternative 1 as compared to the No Action Alternative, CVP and SWP  
2 water deliveries would be increased and it is anticipated that CVP and SWP water  
3 users would use less alternate water supplies. Specific changes in energy use  
4 would depend upon specific responses by water users, and are not known at this  
5 time. Therefore, it is uncertain whether the decreased regional and local water  
6 supply energy requirements would be similar to the increased energy use by the  
7 CVP and SWP operations in 2030 under Alternative 1 as compared to the No  
8 Action Alternative. For the purposes of this analysis, a worse-case scenario is  
9 assumed, and that total energy use by CVP and SWP water users could be lower  
10 under Alternative 1 as compared to the No Action Alternative.

#### 11 *Effects Related to Cross Delta Water Transfers*

12 Potential effects to energy resources could be similar to those identified in a  
13 recent environmental analysis conducted by Reclamation for long-term water  
14 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c), as  
15 described above under the No Action Alternative compared to the Second Basis  
16 of Comparison. For the purposes of this EIS, it is anticipated that similar energy  
17 conditions would occur during implementation of cross Delta water transfers  
18 under Alternative 1 and the No Action Alternative.

19 Under Alternative 1, water could be transferred throughout the year without an  
20 annual volumetric limit. Under the No Action Alternative, the timing of cross  
21 Delta water transfers would be limited to July through September and include  
22 annual volumetric limits, in accordance with the 2008 USFWS BO and 2009  
23 NMFS BO. Overall, the potential for cross Delta water transfers would be  
24 increased under Alternative 1 as compared to the No Action Alternative; however,  
25 energy resources conditions would be similar.

#### 26 **8.4.3.2 Alternative 1 Compared to the Second Basis of Comparison**

27 Alternative 1 is identical to the Second Basis of Comparison.

#### 28 **8.4.3.3 Alternative 2**

29 The CVP and SWP operations under Alternative 2 are identical to the CVP and  
30 SWP operations under the No Action Alternative; therefore, the energy resources  
31 conditions under Alternative 2 is only compared to the Second Basis of  
32 Comparison.

#### 33 **8.4.3.3.1 Alternative 2 Compared to the Second Basis of Comparison**

34 Changes to energy resources under Alternatives 2 as compared to the Second  
35 Basis of Comparison would be the same as the impacts described in  
36 Section 8.4.3.1, No Action Alternative.

#### 37 **8.4.3.4 Alternative 3**

38 CVP and SWP operations under Alternative 3 are similar to the Second Basis of  
39 Comparison with modified Old and Middle River flow criteria and New Melones  
40 Reservoir operations. Alternative 3 would include changed water demands for  
41 American River water supplies as compared to the No Action Alternative or

1 Second Basis of Comparison. Alternative 3 would provide water supplies of up to  
 2 17 TAF/year under a Warren Act Contract for El Dorado Irrigation District and  
 3 15 TAF/year under a Warren Act Contract for El Dorado County Water Agency.  
 4 These demands are not included in the analysis presented in this section of the  
 5 EIS. A sensitivity analysis comparing the results of the analysis with and without  
 6 these demands is presented in Appendix 5B of this EIS.

#### 7 **8.4.3.4.1 Alternative 3 Compared to the No Action Alternative**

##### 8 *Potential Changes in Energy Resources to CVP and SWP Water Users*

9 Changes in CVP and SWP operations under Alternative 3 as compared to the No  
 10 Action Alternative would result in changes in CVP and SWP energy resources, as  
 11 summarized in Table 8.7. The CVP net generation over the long-term conditions  
 12 and in dry and critical dry years would be similar under Alternative 3 as compared  
 13 to the No Action Alternative. The SWP net generation would be increased by  
 14 27 percent over the long-term condition and by 16 percent in dry and critical dry  
 15 years. Changes in monthly energy use are presented in Appendix 8A, Power  
 16 Model Documentation.

17 **Table 8.7 Energy Generation, Energy Use, and Net Generation under Alternative 3**  
 18 **as Compared to the No Action Alternative**

Project	Water Year	Energy (Gigawatt-hours)	Alternative 3	No Action Alternative (NAA)	Changes between Alternative 3 and NAA
CVP Facilities	Long-term Average	Energy Generation	4,582	4,558	24
		Energy Use	1,238	1,113	125
		Net Generation	3,344	3,445	-102
	Dry and Critical Water Years	Energy Generation	2,798	2,696	102
		Energy Use	715	699	16
		Net Generation	2,084	1,997	86
SWP Facilities	Long-term Average	Energy Generation	4,537	4,202	335
		Energy Use	9,115	7,798	1,317
		Net Generation	-4,578	-3,597	-981

Project	Water Year	Energy (Gigawatt-hours)	Alternative 3	No Action Alternative (NAA)	Changes between Alternative 3 and NAA
	Dry and Critical Water Years	Energy Generation	2,128	1,914	214
		Energy Use	4,455	3,929	526
		Net Generation	-2,327	-2,015	-312

1 Under Alternative 3 as compared to the No Action Alternative, CVP and SWP  
 2 water deliveries would be increased and it is anticipated that CVP and SWP water  
 3 users would use less alternate water supplies. Specific changes in energy use  
 4 would depend upon specific responses by water users, and are not known at this  
 5 time. Therefore, it is uncertain whether the decreased regional and local water  
 6 supply energy requirements would be similar to the increased energy use by the  
 7 CVP and SWP operations in 2030 under Alternative 3 as compared to the No  
 8 Action Alternative. For the purposes of this analysis, a worse-case scenario is  
 9 assumed, and that total energy use by CVP and SWP water users could be lower  
 10 under Alternative 3 as compared to the No Action Alternative.

11 *Effects Related to Cross Delta Water Transfers*

12 Potential effects to energy resources could be similar to those identified in a  
 13 recent environmental analysis conducted by Reclamation for long-term water  
 14 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c), as  
 15 described above under the No Action Alternative compared to the Second Basis  
 16 of Comparison. For the purposes of this EIS, it is anticipated that similar energy  
 17 conditions would occur during implementation of cross Delta water transfers  
 18 under Alternative 3 and the No Action Alternative.

19 Under Alternative 3, water could be transferred throughout the year without an  
 20 annual volumetric limit. Under the No Action Alternative, the timing of cross  
 21 Delta water transfers would be limited to July through September and include  
 22 annual volumetric limits, in accordance with the 2008 USFWS BO and 2009  
 23 NMFS BO. Overall, the potential for cross Delta water transfers would be  
 24 increased under Alternative 3 as compared to the No Action Alternative; however,  
 25 energy resources conditions would be similar.

26 **8.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison**

27 *Potential Changes in Energy Resources to CVP and SWP Water Users*

28 Changes in CVP and SWP operations under Alternative 3 as compared to the  
 29 Second Basis of Comparison would result in changes in CVP and SWP energy  
 30 resources, as summarized in Table 8.8. The CVP net generation over the long-

1 term conditions and in dry and critical dry years would be similar under  
 2 Alternative 3 as compared to the Second Basis of Comparison. The SWP net  
 3 generation would be reduced by 10 percent over the long-term condition and by  
 4 58 percent in dry and critical dry years. Changes in monthly energy use are  
 5 presented in Appendix 8A, Power Model Documentation.

6 **Table 8.8 Energy Generation, Energy Use, and Net Generation under Alternative 3**  
 7 **as Compared to the Second Basis of Comparison**

Project	Water Year	Energy (Gigawatt-hours)	Alternative 3	Second Basis of Comparison (SBC)	Changes between Alternative 3 and SBC
CVP Facilities	Long-term Average	Energy Generation	4,582	4,604	-22
		Energy Use	1,238	1,289	-51
		Net Generation	3,344	3,315	29
	Dry and Critical Water Years	Energy Generation	2,798	2,773	25
		Energy Use	715	773	-59
		Net Generation	2,084	2,000	84
SWP Facilities	Long-term Average	Energy Generation	4,537	4,721	-184
		Energy Use	9,115	9,802	-687
		Net Generation	-4,578	-5,081	503
	Dry and Critical Water Years	Energy Generation	2,128	2,494	-366
		Energy Use	4,455	5,686	-1,230
		Net Generation	-2,327	-3,192	865

8 Under Alternative 3 as compared to the Second Basis of Comparison, CVP and  
 9 SWP water deliveries would be decreased and it is anticipated that CVP and SWP  
 10 water users would use more alternate water supplies. Specific changes in energy  
 11 use would depend upon specific responses by water users, and are not known at  
 12 this time. Therefore, it is uncertain whether the increased regional and local water  
 13 supply energy requirements would be similar to the decreased energy use by the  
 14 CVP and SWP operations in 2030 under Alternative 3 as compared to the Second  
 15 Basis of Comparison. For the purposes of this analysis, a worse-case scenario is

1 assumed, and that total energy use by CVP and SWP water users could be higher  
2 under Alternative 3 as compared to the Second Basis of Comparison.

3 *Effects Related to Cross Delta Water Transfers*

4 Potential effects to energy resources could be similar to those identified in a  
5 recent environmental analysis conducted by Reclamation for long-term water  
6 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c), as  
7 described above under the No Action Alternative compared to the Second Basis  
8 of Comparison. For the purposes of this EIS, it is anticipated that similar energy  
9 conditions would occur during implementation of cross Delta water transfers  
10 under Alternative 3 as compared to the Second Basis of Comparison.

11 Under Alternative 3 and the Second Basis of Comparison, water could be  
12 transferred throughout the year without an annual volumetric limit. Overall, the  
13 potential for cross Delta water transfers would be similar under Alternative 3 as  
14 compared to the Second Basis of Comparison; and energy resources conditions  
15 would be similar.

16 **8.4.3.5 Alternative 4**

17 Energy resources under Alternative 4 would be identical to the conditions under  
18 the Second Basis of Comparison. Alternative 4 is only compared to the No  
19 Action Alternative.

20 **8.4.3.5.1 Alternative 4 Compared to the No Action Alternative**

21 Changes in energy resources under Alternative 4 as compared to the No Action  
22 Alternative would be the same as the impacts described in Section 8.4.3.2.1,  
23 Alternative 1 Compared to the No Action Alternative.

24 **8.4.3.6 Alternative 5**

25 The CVP and SWP operations under Alternative 5 are similar to the No Action  
26 Alternative with modified Old and Middle River flow criteria and New Melones  
27 Reservoir operations. Alternative 5 would include changed water demands for  
28 American River water supplies as compared to the No Action Alternative or  
29 Second Basis of Comparison. Alternative 5 would provide water supplies of up to  
30 17 TAF/year under a Warren Act Contract for El Dorado Irrigation District and  
31 15 TAF/year under a Warren Act Contract for El Dorado County Water Agency.  
32 These demands are not included in the analysis presented in this section of the  
33 EIS. A sensitivity analysis comparing the results of the analysis with and without  
34 these demands is presented in Appendix 5B of this EIS.

35 **8.4.3.6.1 Alternative 5 Compared to the No Action Alternative**

36 *Potential Changes in Energy Resources to CVP and SWP Water Users*

37 Changes in CVP and SWP operations under Alternative 5 as compared to the No  
38 Action Alternative would result in changes in CVP and SWP energy resources, as  
39 summarized in Table 8.9. The CVP and SWP net generation over the long-term  
40 conditions and in dry and critical dry years would be similar under Alternative 5

1 as compared to the No Action Alternative. Changes in monthly energy use are  
 2 presented in Appendix 8A, Power Model Documentation.

3 **Table 8.9 Energy Generation, Energy Use, and Net Generation under Alternative 5**  
 4 **as Compared to the No Action Alternative**

Project	Water Year	Energy (Gigawatt-hours)	Alternative 3	Second Basis of Comparison (SBC)	Changes between Alternative 3 and SBC
CVP Facilities	Long-term Average	Energy Generation	4,552	4,558	-6
		Energy Use	1,110	1,113	-3
		Net Generation	3,442	3,445	-4
	Dry and Critical Water Years	Energy Generation	2,684	2,696	-12
		Energy Use	699	699	0
		Net Generation	1,986	1,997	-11
SWP Facilities	Long-term Average	Energy Generation	4,191	4,202	-11
		Energy Use	7,732	7,798	-66
		Net Generation	-3,541	-3,597	56
	Dry and Critical Water Years	Energy Generation	1,904	1,914	-10
		Energy Use	3,841	3,929	-88
		Net Generation	-1,937	-2,015	78

5 Under Alternative 5 as compared to the No Action Alternative, CVP and SWP  
 6 water deliveries would be similar, and it is anticipated that CVP and SWP water  
 7 users would use similar alternate water supplies. Therefore, for the purposes of  
 8 this analysis, it is assumed that total energy use by CVP and SWP water users  
 9 could be similar under Alternative 5 as compared to the No Action Alternative.

10 *Effects Related to Cross Delta Water Transfers*

11 Potential effects to energy resources could be similar to those identified in a  
 12 recent environmental analysis conducted by Reclamation for long-term water  
 13 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c), as  
 14 described above under the No Action Alternative compared to the Second Basis

1 of Comparison. For the purposes of this EIS, it is anticipated that similar energy  
 2 conditions would occur during implementation of cross Delta water transfers  
 3 under Alternative 5 and the No Action Alternative.

4 Under Alternative 5 and the No Action Alternative, the timing of cross Delta  
 5 water transfers would be limited to July through September and include annual  
 6 volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO.  
 7 Overall, the potential for cross Delta water transfers would be similar under  
 8 Alternative 5 as compared to the No Action Alternative; and energy resources  
 9 conditions would be similar.

10 **8.4.3.6.2 Alternative 5 Compared to the Second Basis of Comparison**

11 *Potential Changes in Energy Resources to CVP and SWP Water Users*

12 Changes in CVP and SWP operations under Alternative 5 as compared to the  
 13 Second Basis of Comparison would result in changes in CVP and SWP energy  
 14 resources, as summarized in Table 8.10. The CVP net generation over the long-  
 15 term conditions and in dry and critical dry years would be similar under  
 16 Alternative 3 as compared to the Second Basis of Comparison. The SWP net  
 17 generation would be reduced by 30 percent over the long-term condition and by  
 18 39 percent in dry and critical dry years. Changes in monthly energy use are  
 19 presented in Appendix 8A, Power Model Documentation.

20 **Table 8.10 Energy Generation, Energy Use, and Net Generation under Alternative 5**  
 21 **as Compared to the Second Basis of Comparison**

Project	Water Year	Energy (Gigawatt-hours)	Alternative 5	Second Basis of Comparison (SBC)	Changes between Alternative 5 and SBC
CVP Facilities	Long-term Average	Energy Generation	4,552	4,604	-52
		Energy Use	1,110	1,289	-179
		Net Generation	3,442	3,315	127
	Dry and Critical Water Years	Energy Generation	2,684	2,773	-89
		Energy Use	699	773	-75
		Net Generation	1,986	2,000	-14
SWP Facilities	Long-term Average	Energy Generation	4,191	4,721	-530
		Energy Use	7,732	9,802	-2,070
		Net Generation	-3,541	-5,081	1,540

Project	Water Year	Energy (Gigawatt-hours)	Alternative 5	Second Basis of Comparison (SBC)	Changes between Alternative 5 and SBC
	Dry and Critical Water Years	Energy Generation	1,904	2,494	-590
		Energy Use	3,841	5,686	-1,845

1 Under Alternative 5 as compared to the Second Basis of Comparison, CVP and  
2 SWP water deliveries would be decreased and it is anticipated that CVP and SWP  
3 water users would use more alternate water supplies. Specific changes in energy  
4 use would depend upon specific responses by water users, and are not known at  
5 this time. Therefore, it is uncertain whether the increased regional and local water  
6 supply energy requirements would be similar to the decreased energy use by the  
7 CVP and SWP operations in 2030 under Alternative 5 as compared to the Second  
8 Basis of Comparison. For the purposes of this analysis, a worse-case scenario is  
9 assumed, and that total energy use by CVP and SWP water users could be higher  
10 under Alternative 5 as compared to the Second Basis of Comparison.

#### 11 *Effects Related to Cross Delta Water Transfers*

12 Potential effects to energy resources could be similar to those identified in a  
13 recent environmental analysis conducted by Reclamation for long-term water  
14 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c), as  
15 described above under the No Action Alternative compared to the Second Basis  
16 of Comparison. For the purposes of this EIS, it is anticipated that similar energy  
17 conditions would occur during implementation of cross Delta water transfers  
18 under Alternative 5 as compared to the Second Basis of Comparison.

19 Under Alternative 5, the timing of cross Delta water transfers would be limited to  
20 July through September and include annual volumetric limits, in accordance with  
21 the 2008 USFWS BO and 2009 NMFS BO. Under Second Basis of Comparison,  
22 water could be transferred throughout the year without an annual volumetric limit.  
23 Overall, the potential for cross Delta water transfers would be reduced under  
24 Alternative 5 as compared to the Second Basis of Comparison; however, energy  
25 resources conditions would be similar.

#### 26 **8.4.3.7 Summary of Impact Analysis**

27 The results of the environmental consequences of implementation of Alternatives  
28 1 through 5 as compared to the No Action Alternative and the Second Basis of  
29 Comparison are presented in Tables 8.11 and 8.12.



1 **Table 8.11 Comparison of Alternatives 1 through 5 to No Action Alternative**

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	<p>CVP annual net generation would be similar.</p> <p>SWP annual net generation would be increased by 41 percent over the long-term condition; and by 58 percent in dry and critical dry years.</p> <p>Total energy use by CVP and SWP water users, including energy for alternate water supplies, is assumed to decrease.</p>	None needed.
Alternative 2	No effects on energy resources.	None needed.
Alternative 3	<p>CVP annual net generation would be similar.</p> <p>SWP annual net generation would be increased by 27 percent over the long-term condition and by 16 percent in dry and critical dry years.</p> <p>Total energy use by CVP and SWP water users, including energy for alternate water supplies, is assumed to decrease.</p>	None needed.
Alternative 4	Same effects as described for Alternative 1 compared to the No Action Alternative.	None needed.
Alternative 5	<p>CVP and SWP annual net generation would be similar.</p> <p>Total energy use by CVP and SWP water users, including energy for alternate water supplies, is assumed to be similar.</p>	None needed.

Note: Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools, incremental differences of 5 percent or less between alternatives and the No Action Alternative are considered to be “similar.”

1 **Table 8.12 Comparison of No Action Alternative and Alternatives 1 through 5 to**  
 2 **Second Basis of Comparison**

Alternative	Potential Change	Consideration for Mitigation Measures
No Action Alternative	CVP annual net generation would be similar. SWP annual net generation would be reduced by 29 percent over the long-term condition and by 37 percent in dry and critical dry years. Total energy use by CVP and SWP water users, including energy for alternate water supplies, is assumed to increase.	Not considered for this comparison.
Alternative 1	No effects on energy resources.	Not considered for this comparison.
Alternative 2	Same effects as described for No Action Alternative as compared to the Second Basis of Comparison.	Not considered for this comparison.
Alternative 3	CVP annual net generation would be similar. SWP annual net generation would be reduced by 10 percent over the long-term condition and by 58 percent in dry and critical dry years. Total energy use by CVP and SWP water users, including energy for alternate water supplies, is assumed to increase.	Not considered for this comparison.
Alternative 4	No effects on energy resources.	Not considered for this comparison.
Alternative 5	CVP annual net generation would be similar. SWP annual net generation would be reduced by 30 percent over the long-term condition and by 39 percent in dry and critical dry years. Total energy use by CVP and SWP water users, including energy for alternate water supplies, is assumed to increase.	Not considered for this comparison.

Note: Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools, incremental differences of 5 percent or less between alternatives and the No Action Alternative are considered to be "similar."

3 **8.4.3.8 Potential Mitigation Measures**

4 Mitigation measures are presented in this section to avoid, minimize, rectify,  
 5 reduce, eliminate, or compensate for adverse environmental effects of  
 6 Alternatives 1 through 5 as compared to the No Action Alternative. Mitigation  
 7 measures were not included to address adverse impacts under the alternatives as

1 compared to the Second Basis of Comparison because this analysis was included  
 2 in this EIS for information purposes only.

3 Changes under Alternatives 1 through 5 as compared to the No Action Alternative  
 4 would result in similar or increased net energy generation, and reduced potential  
 5 energy use by CVP and SWP water users for alternate water supplies. Therefore,  
 6 there would be no adverse impacts to energy resources as compared to the No  
 7 Action Alternative; and no mitigation measures are needed.

8 **8.4.3.9 Cumulative Effects Analysis**

9 As described in Chapter 3, the cumulative effects analysis considers projects,  
 10 programs, and policies that are not speculative; and are based upon known or  
 11 reasonably foreseeable long-range plans, regulations, operating agreements, or  
 12 other information that establishes them as reasonably foreseeable.

13 The cumulative effects analysis Alternatives 1 through 5 for Energy Resources  
 14 are summarized in Table 8.13.

15 **Table 8.13 Summary of Cumulative Effects on Energy Resources of Alternatives 1**  
 16 **through 5 as Compared to the No Action Alternative**

Scenarios	Actions	Cumulative Effects of Actions
Past & Present, and Future Actions included in the No Action Alternative and in All Alternatives in Year 2030	Consistent with Affected Environment conditions plus: Actions in the 2008 USFWS BO and 2009 NMFS BO that Would Have Occurred without Implementation of the Biological Opinions, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives), including climate change and sea level rise Actions not included in the 2008 USFWS BO and 2009 NMFS BO that Would Have Occurred without Implementation of the Biological Opinions, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives):  - Implementation of Federal and state policies and programs, including Clean Water Act (e.g., Total Maximum Daily Loads); Safe Drinking Water Act; Clean Air Act; and flood management programs - General plans for 2030. - Trinity River Restoration Program. - Central Valley Project Improvement Act programs	These effects would be the same in all alternatives. Climate change and sea level rise, development under the general plans, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce carryover storage in reservoirs and changes in stream flow patterns in a manner that could reduce hydroelectric generation in the summer and fall months. Reduced CVP and SWP water deliveries south of the Delta would also reduce CVP and SWP electricity use. Future water supply projects are anticipated to both improve water supply reliability due to reduced surface water supplies and to accommodate planned growth in the general plans. It is anticipated that some of these projects could increase energy use, such as implementation of desalination projects.

Scenarios	Actions	Cumulative Effects of Actions
	<ul style="list-style-type: none"> <li>- Folsom Dam Water Control Manual Update</li> <li>- FERC Relicensing for the Middle Fork of the American River Project</li> <li>- San Joaquin River Restoration Program</li> <li>- Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects with completed environmental documents)</li> </ul>	<p>However, other projects, such as water recycling, would not substantially increase energy use because most of the energy use was previously required for wastewater treatment. It is anticipated that energy required for water treatment of alternative water supplies would be similar as treatment for CVP and SWP water supplies. Increased use of groundwater pumps would increase energy use; however, this energy use would be similar or less than the energy used for CVP and SWP water conveyance.</p> <p>Most of these programs were initiated prior to implementation of the 2008 USFWS BO and 2009 NMFS BO which reduced CVP and SWP water supply reliability.</p>
<p>Future Actions considered as Cumulative Effects Actions in All Alternatives in Year 2030</p>	<p>Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives):</p> <ul style="list-style-type: none"> <li>- Bay-Delta Water Quality Control Plan Update</li> <li>- FERC Relicensing Projects</li> <li>- Bay Delta Conservation Plan (including the California WaterFix alternative)</li> <li>- Shasta Lake Water Resources, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations</li> <li>- El Dorado Water and Power Authority Supplemental Water Rights Project</li> <li>- Sacramento River Water Reliability Project</li> <li>- Semitropic Water Storage District Delta Wetlands</li> <li>- North Bay Aqueduct Alternative Intake</li> <li>- Irrigated Lands Regulatory Program</li> </ul>	<p>These effects would be the same in all alternatives.</p> <p>Most of the future reasonably foreseeable actions are anticipated to improve water supplies in California to reduce impacts due to climate change, sea level rise, increased water allocated to improve habitat conditions, and future growth. If CVP and SWP water supply reliability increases, energy use for conveyance of CVP and SWP water supplies also would increase.</p> <p>Some of the future reasonably foreseeable actions are anticipated to potentially reduce CVP and SWP water supply reliability (e.g., Water Quality Control Plan Update and FERC Relicensing Projects).</p> <p>Future water supply projects are anticipated to both improve water supply reliability due to reduced</p>

<b>Scenarios</b>	<b>Actions</b>	<b>Cumulative Effects of Actions</b>
	<ul style="list-style-type: none"> <li>- San Luis Reservoir Low Point Improvement Project</li> <li>- Westlands Water District v. United States Settlement</li> <li>- Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects that did not have completed environmental documents during preparation of the EIS)</li> </ul>	<p>surface water supplies and to accommodate planned growth in the general plans. It is anticipated that some of these projects could increase energy use, such as implementation of desalination projects. However, other projects, such as water recycling, would not substantially increase energy use because most of the energy use was previously required for wastewater treatment. It is anticipated that energy required for water treatment of alternative water supplies would be similar as treatment for CVP and SWP water supplies. Increased use of groundwater pumps would increase energy use; however, this energy use would be similar or less than the energy used for CVP and SWP water conveyance.</p>
<p>No Action Alternative with Associated Cumulative Effects Actions in Year 2030</p>	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP</p>	<p>Implementation of No Action Alternative future reasonably foreseeable actions would result in changes stream flows and related changes in hydroelectric generation patterns, and reduced CVP and SWP water supplies as compared to conditions prior to the BOs.</p> <p>If CVP and SWP water supply reliability decreases, energy use for conveyance of CVP and SWP water supplies also would decrease and energy use for alternative water supplies could increase.</p>
<p>Alternatives 1 and 4 with Associated Cumulative Effects Actions Year 2030</p>	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)</p>	<p>Implementation of Alternatives 1 and 4 future reasonably foreseeable actions would result in changes in stream flows and related hydroelectric generation patterns, and increased CVP and SWP</p>

Scenarios	Actions	Cumulative Effects of Actions
		<p>water supplies as compared to the No Action Alternative with the added actions.</p> <p>Increased CVP and SWP water supply reliability would increase energy use for conveyance of CVP and SWP water supplies; and it is anticipated that energy use for alternative water supplies would decrease as compared to the No Action Alternative with the added actions.</p>
Alternative 2 with Associated Cumulative Effects Actions Year 2030	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions</p> <p>No implementation of structural improvements or other actions that require further study to develop a more detailed action description.</p>	Implementation of Alternative 2 future reasonably foreseeable actions with future reasonably foreseeable actions for energy resources would be the same as for the No Action Alternative with the added actions.
Alternative 3 with Associated Cumulative Effects Actions Year 2030	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)</p> <p>Slight increase in positive Old and Middle River flows in the winter and spring months</p>	<p>Implementation of Alternative 3 future reasonably foreseeable actions would result in changes in stream flows and related hydroelectric generation patterns, and increased CVP and SWP water supplies as compared to the No Action Alternative with the added actions.</p> <p>Increased CVP and SWP water supply reliability would increase energy use for conveyance of CVP and SWP water supplies; and it is anticipated that energy use for alternative water supplies would decrease as compared to the No Action Alternative with the added actions.</p>
Alternative 5 with Associated Cumulative Effects Actions Year 20530	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO</p> <p>Positive Old and Middle River flows and increased Delta outflow in spring months</p>	Implementation of Alternative 5 would result in changes in stream flows and related hydroelectric generation patterns, and reduced CVP and SWP water supplies as compared to the No Action

Scenarios	Actions	Cumulative Effects of Actions
		<p>Alternative with the added actions.</p> <p>Reduced CVP and SWP water supply reliability would decrease energy use for conveyance of CVP and SWP water supplies; and it is anticipated that energy use for alternative water supplies would increase as compared to the No Action Alternative with the added actions.</p>

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**Chapter 8**

1 **Energy Figures**

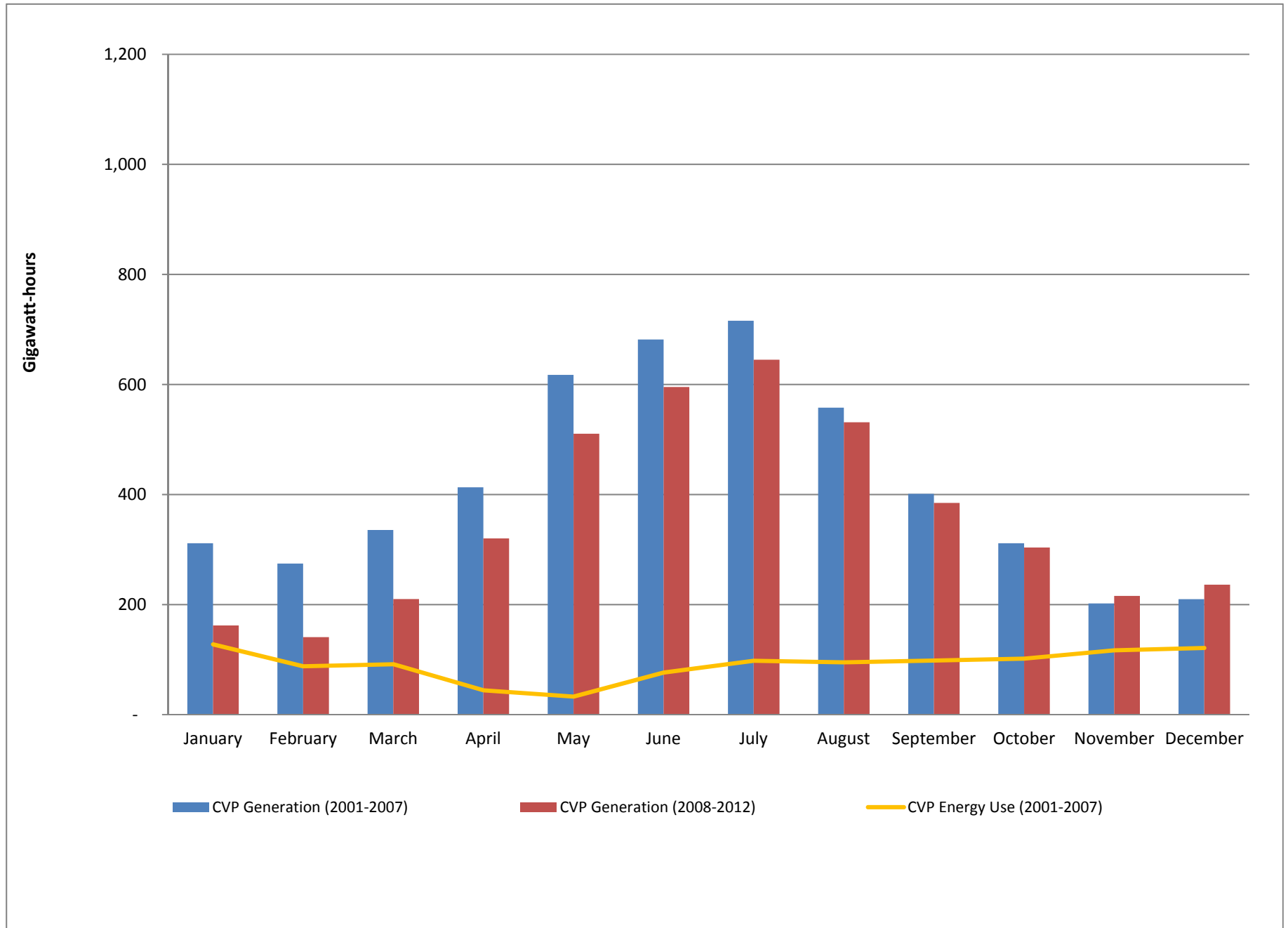
2 The following figures are included in Chapter 8, Energy.

- 3 • 8.1 Central Valley Project and State Water Project Hydroelectric Generation  
4 Facilities
- 5 • 8.2 Central Valley Project Energy Generation and Energy Use
- 6 • 8.3 State Water Project Energy Generation and Energy Use



**Figure 8.1 Central Valley Project and State Water Project Hydroelectric Generation Facilities**

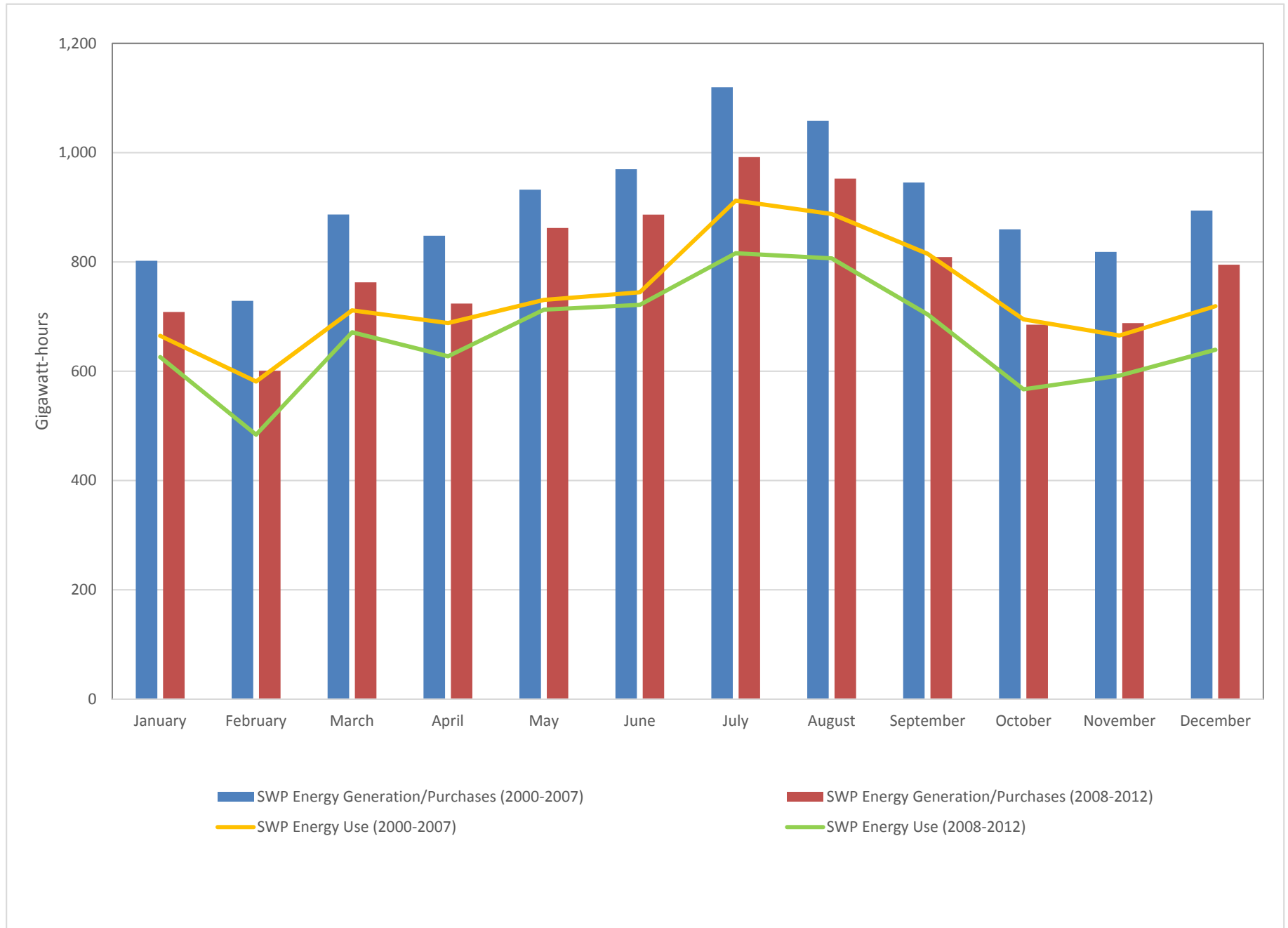
Sources: Reclamation 2013a, 2013b, 2013c, 2013d, 2013e, 2013f, 2013g, 2013h, 2013i, 2013j, 2013k, 2013l; DWR 2012



**Figure 8.2 Central Valley Project Energy Generation and Energy Use**

Sources: Reclamation 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008 a-l, 2009a-l, 2010a-l, 2011a-l, 2012a-l





**Figure 8.3 State Water Project Energy Generation and Energy Use**

Sources: DWR 2002, 2004a, 2004b, 2005, 2006, 2007, 2008, 2012a, 2012b, 2013

## Chapter 9

# 1 Fish and Aquatic Resources

## 2 9.1 Introduction

3 This chapter describes the fish and aquatic resources that occur in the portions of  
4 the project area that could be affected as a result of implementing the alternatives  
5 evaluated in this Environmental Impact Statement (EIS). Implementation of the  
6 alternatives could affect aquatic resources through changes in ecological attributes  
7 as a result of potential changes in long-term operation of the Central Valley  
8 Project (CVP) and State Water Project (SWP) and ecosystem restoration.

## 9 9.2 Regulatory Environment and Compliance 10 Requirements

11 Potential actions implemented under the alternatives evaluated in this EIS could  
12 affect fish and aquatic resources. Actions located on public agency lands, or  
13 implemented, funded, or approved by Federal and state agencies, would need to  
14 be compliant with appropriate Federal and state agency policies and regulations,  
15 as summarized in Chapter 4, Approach to Environmental Analyses.

## 16 9.3 Affected Environment

17 This section describes fish and aquatic resources that could be affected by the  
18 implementation of the alternatives considered in this EIS. Changes in aquatic  
19 resources due to changes in CVP and SWP operations may occur in the Trinity  
20 River, Central Valley, San Francisco Bay Area, Central Coast, and Southern  
21 California regions.

22 The following description of the affected environment focuses on CVP and SWP  
23 reservoirs, rivers downstream of CVP and SWP reservoirs, the Sacramento-San  
24 Joaquin Rivers Delta Estuary (Delta), and conditions downstream of the Delta that  
25 are affected by operation of the CVP and SWP.

26 This section is organized by geographic area, generally in an upstream to  
27 downstream direction. This format does not necessarily coincide with the use by  
28 fish and aquatic species, which can move among geographic areas either  
29 seasonally or during different phases of their life history.

30 The descriptions of species and biological and hydrodynamic processes in this  
31 chapter frequently use the terms “Delta” and “San Francisco Estuary.” The Delta  
32 refers to the Sacramento-San Joaquin Delta, as legally defined in the Delta  
33 Protection Act. The San Francisco Estuary refers to the portion of the  
34 Sacramento-San Joaquin Rivers watershed downstream of Chipps Island that is

1 influenced by tidal action and where fresh water and salt water mix, which  
 2 includes the following waterbodies: Suisun, San Pablo, and San Francisco bays.

3 **9.3.1 Fish and Aquatic Species Evaluated**

4 Many fish and aquatic species use the project area during all or some portion of  
 5 their lives; however, certain fish and aquatic species were selected to be the focus  
 6 of the analysis of alternatives considered in this EIS based on their sensitivity and  
 7 their potential to be affected by changes in the operation of the CVP and SWP  
 8 implemented under the alternatives considered in this EIS, as summarized in  
 9 Table 9.1. While many of the species identified in Table 9.1 also occur in  
 10 tributaries to the major rivers, the focus of this EIS is on the waterbodies  
 11 influenced by operations of the CVP and SWP. Operation of the CVP and SWP  
 12 would not directly affect ocean conditions; however, operations have the potential  
 13 to affect Southern Resident Killer Whales indirectly by influencing the number of  
 14 Chinook Salmon (produced in the Sacramento-San Joaquin River and associated  
 15 tributaries) that enter the Pacific Ocean and become available as a food supply for  
 16 the whales.

17 These focal species are fish and marine mammal species listed as threatened or  
 18 endangered or at risk of being listed as endangered or threatened, legally  
 19 protected, or are otherwise considered sensitive by the U.S. Fish and Wildlife  
 20 Service (USFWS), National Marine Fisheries Service (NMFS), or California  
 21 Department of Fish and Wildlife (CDFW) (previously known as Department of  
 22 Fish and Game [DFG]) and fish that have tribal, commercial or recreational  
 23 importance. In addition, salmon, steelhead, sturgeon, Striped Bass, and American  
 24 Shad are managed in accordance with Section 3406 of the Central Valley Project  
 25 Improvement Act. Details on the status, life history, habitat requirements, and  
 26 population trends for each of the aquatic focal species are provided in  
 27 Appendix 9B.

28 **Table 9.1 Focal Fish Species by Region of Occurrence**

Species or Population <sup>a</sup>	Federal Status	State Status <sup>b</sup>	Tribal, Commercial, or Recreational Importance	Occurrence within Area of Analysis
<b>Trinity River Region</b>				
Coho Salmon <i>Southern Oregon/Northern California Coast ESU</i>	Threatened	Threatened	Yes	Trinity River, Klamath River
Eulachon <i>Southern DPS</i>	Threatened	None	Yes	Klamath River
Green Sturgeon <i>Southern DPS</i>	Threatened	Species of Special Concern	Yes	Trinity River, Klamath River
Spring-run Chinook Salmon <i>Upper Klamath-Trinity River ESU</i>	None	Species of Special Concern	Yes	Trinity River, Klamath River
Steelhead (winter- and summer-run) <i>Klamath Mountains Province DPS</i>	None	Species of Special Concern <sup>c</sup>	Yes	Trinity River, Klamath River
American Shad	None	None	Yes	Trinity River
Pacific Lamprey	None	None	Yes	Trinity River, Klamath River

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Species or Population <sup>a</sup>	Federal Status	State Status <sup>b</sup>	Tribal, Commercial, or Recreational Importance	Occurrence within Area of Analysis
White Sturgeon	None	None	Yes	Trinity River, Klamath River
Black Bass (Largemouth, Smallmouth, Spotted)	None	None	Yes	Trinity River
<b>Central Valley Region</b>				
Winter-run Chinook Salmon <i>Sacramento River ESU</i>	Endangered	Endangered	Yes	Sacramento River <sup>d</sup> , Delta, and Suisun Marsh
Spring-run Chinook Salmon <i>Central Valley ESU</i>	Threatened	Threatened	Yes	Clear Creek, Sacramento River, Feather River, American River, Delta, and Suisun Marsh
Steelhead <i>Central Valley DPS</i>	Threatened	None	Yes	Clear Creek, Feather River, Sacramento River; American River, Stanislaus River, San Joaquin River, Delta and Suisun Marsh
Green Sturgeon <i>Southern DPS</i>	Threatened	Species of Special Concern	Yes	Feather River, Sacramento River, Delta and Suisun Marsh
Delta Smelt	Threatened	Endangered	No	Delta and Suisun Marsh
Longfin Smelt <i>Bay Delta DPS</i>	Candidate	Threatened	No	Delta and Suisun Marsh
Fall-/late Fall-run Chinook Salmon <i>Central Valley ESU</i>	None	Species of Special Concern	Yes	Clear Creek, Feather River, Sacramento River, American River, Stanislaus River, San Joaquin River, Delta and Suisun Marsh
Sacramento Splittail	None	Species of Special Concern	No	Feather River, American River, Sacramento River, Delta and Suisun Marsh, San Joaquin River
Hardhead	None	Species of Special Concern	No	Clear Creek, Feather River, Sacramento River, American River, Delta, Stanislaus River, San Joaquin River
Sacramento-San Joaquin Roach	None	Species of Special Concern	No	Clear Creek, Feather River, American River, Sacramento River, Delta, Stanislaus River, San Joaquin River

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Species or <i>Population</i> <sup>a</sup>	Federal Status	State Status <sup>b</sup>	Tribal, Commercial, or Recreational Importance	Occurrence within Area of Analysis
River Lamprey	None	None	Yes	Feather River, American River, Sacramento River, Delta and Suisun Marsh, Stanislaus River, San Joaquin River
Pacific Lamprey	None	None	Yes	Clear Creek, Feather River, Sacramento River, American River, Delta, Stanislaus River, San Joaquin River
White Sturgeon	None	None	Yes	Feather River, Sacramento River, American River, San Joaquin River, Delta and Suisun Marsh
American Shad	None	None	Yes	Feather River, American River, Sacramento River, Delta and Suisun Marsh, Stanislaus River, San Joaquin River
Black Bass (Largemouth, Smallmouth, Spotted)	None	None	Yes	Feather River, American River, Sacramento River, Delta and Suisun Marsh, Stanislaus River, San Joaquin River
Striped Bass	None	None	Yes	Feather River, American River, Sacramento River, Delta and Suisun Marsh, Stanislaus River, San Joaquin River
<b>San Francisco Bay and Pacific Ocean Waters</b>				
Steelhead Central California Coast DPS	Threatened	None	Yes	San Francisco Bay region
Killer Whale <i>Southern Resident DPS</i>	Endangered	None	Yes	Pacific Coast

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Notes:

- a. The term *population* refers to the listed Evolutionarily Significant Unit (ESU) or Distinct Population Segment (DPS) for that species.
- b. Includes species listed by the State of California as threatened, endangered, or considered a Species of Special Concern.
- c. The California Species of Special Concern designation refers only to the summer-run of the Klamath Mountains Province DPS steelhead population
- d. Also includes lower reaches of tributaries (e.g., American River) used for nonnatal rearing areas by juvenile salmon.

10 The life history attributes (e.g., timing of juvenile outmigration) for most of the  
11 species listed above, along with the ecological attributes important to the species  
12 and potentially influenced by the alternatives, are discussed in this chapter

1 according to the geographic areas (regions/subregions) where the species occurs;  
 2 Pacific Lamprey, Green Sturgeon, White Sturgeon, American Shad, and Striped  
 3 Bass are discussed in detail only in those regions where they spend the majority of  
 4 their life cycle such that geographic information is available. There are also  
 5 several species (i.e., River Lamprey, Sacramento-San Joaquin Roach, and  
 6 Hardhead) for which little geographic information is available; therefore, they are  
 7 not discussed in detail in this chapter, but are described in the species accounts  
 8 presented in Appendix 9B. Additionally, these species are only generally  
 9 addressed in the analysis of impacts presented in the Environmental  
 10 Consequences section of this chapter.

11 The level of detail presented in the Affected Environment section is tailored to  
 12 correspond the level of resolution of the analysis, which relies on modeling tools  
 13 that broadly characterize the changes in CVP and SWP operations on reservoir  
 14 storage and flows. This level of detail is intended to support an understanding of  
 15 the resources potentially affected and the context within which the project is  
 16 evaluated. The inclusion of unnecessary detail is avoided.

### 17 **9.3.2 Critical Habitat**

18 Critical habitat refers to areas designated by USFWS or NMFS for the  
 19 conservation of their jurisdictional species listed as threatened or endangered  
 20 under the Endangered Species Act (ESA). When a species is proposed for listing  
 21 under the ESA, USFWS or NMFS considers whether there are certain areas  
 22 essential to the conservation of the species. Critical habitat is defined in  
 23 Section 3, Provision 5 of the ESA as follows.

24 *(5)(A) The term “critical habitat” for a threatened or endangered species*  
 25 *means—*

26 *(i) the specific areas within the geographical area occupied by a species*  
 27 *at the time it is listed in accordance with the Act, on which are found those*  
 28 *physical or biological features (I) essential to the conservation of the*  
 29 *species, and (II) which may require special management considerations or*  
 30 *protection; and*

31 *(ii) specific areas outside the geographical area occupied by a species at*  
 32 *the time it is listed in accordance with the provisions of section 4 of this*  
 33 *Act, upon a determination by the Secretary that such areas are essential*  
 34 *for the conservation of the species.*

35 Any Federal action (permit, license, or funding) in critical habitat requires that the  
 36 Federal agency consult with USFWS or NMFS where the action has potential to  
 37 adversely modify the habitat for the listed species.

38 ESA regulations state that the physical and biological features essential to the  
 39 conservation of the species include space for individual and population growth  
 40 and for normal behavior; food, water, air, light, minerals, or other nutritional or  
 41 physiological requirements; cover or shelter; sites for breeding, reproduction, and  
 42 rearing of offspring; and habitats that are protected from disturbance or are  
 43 representative of the historical geographical and ecological distribution of a

1 species. These principal biological and physical features are known as Primary  
2 Constituent Elements (PCEs)<sup>1</sup>. Specific PCEs identified for salmonids, Green  
3 Sturgeon, Delta Smelt, and Eulachon are described below.

#### 4 **9.3.2.1 Anadromous Salmonids**

5 In designating critical habitat for anadromous salmonids (70 Federal Register  
6 [FR] 52536), NMFS identified the following PCEs as essential to the conservation  
7 of the listed populations:

- 8 • Freshwater spawning sites with water quantity and quality conditions and  
9 substrate that support spawning, incubation, and larval development.
- 10 • Freshwater rearing sites with:
  - 11 – Water quantity and floodplain connectivity to form and maintain physical  
12 habitat conditions and support juvenile growth and mobility
  - 13 – Water quality and forage supporting juvenile development
  - 14 – Natural cover such as shade, submerged and overhanging large wood, log  
15 jams and beaver dams, aquatic vegetation, large rocks and boulders, side  
16 channels, and undercut banks
- 17 • Freshwater migration corridors free of obstruction and excessive predation  
18 with water quantity and quality conditions and natural cover such as  
19 submerged and overhanging large wood, aquatic vegetation, large rocks and  
20 boulders, side channels, and undercut banks supporting juvenile and adult  
21 mobility and survival.
- 22 • Estuarine areas free of obstruction and excessive predation with:
  - 23 – Water quality, water quantity, and salinity conditions supporting juvenile  
24 and adult physiological transitions between fresh water and salt water
  - 25 – Natural cover such as submerged and overhanging large wood, aquatic  
26 vegetation, large rocks and boulders, and side channels
  - 27 – Juvenile and adult forage, including aquatic invertebrates and fishes,  
28 supporting growth and maturation

29 Critical habitat in nontidal waters includes the stream channels in the designated  
30 stream reaches, the lateral extent of which generally defined by the ordinary  
31 high-water line.

##### 32 **9.3.2.1.1 Central Valley Spring-run Chinook Salmon ESU**

33 This ESU consists of spring-run Chinook Salmon in the Sacramento River Basin,  
34 including spring-run Chinook Salmon from the Feather River Hatchery.  
35 Designated critical habitat for Central Valley spring-run Chinook Salmon  
36 includes stream reaches of the American, Feather, Yuba, and Bear rivers;

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<sup>1</sup> The U.S. Fish and Wildlife Service and National Marine Fisheries Service have proposed discontinuing the use of the term "Primary Constituent Elements" to simplify and clarify the critical habitat process and to provide consistency with the language contained in the Endangered Species Act, which uses the term "physical or biological features."

1 tributaries of the Sacramento River, including Big Chico, Butte, Deer, Mill,  
 2 Battle, Antelope, and Clear creeks; and the main stem of the Sacramento River  
 3 from Keswick Dam through the Delta. Designated critical habitat in the Delta  
 4 includes portions of the Delta Cross Channel (DCC); Yolo Bypass; and portions  
 5 of the network of channels in the northern Delta. Critical habitat for spring-run  
 6 Chinook Salmon was not designated for the Stanislaus or San Joaquin River.

7 The spring-run Chinook Salmon critical habitat potentially affected by operation  
 8 of the CVP and SWP includes the network of channels in the northern Delta,  
 9 Sacramento River up to Keswick Dam, Clear Creek up to Whiskeytown Dam, the  
 10 Feather River up to the Fish Barrier Dam, and the American River up to Watt  
 11 Avenue in the Sacramento Valley subregion. The section of the American River  
 12 denoted as critical habitat serves only as juvenile nonnatal rearing habitat;  
 13 spring-run Chinook Salmon do not spawn in the American River. Operation of  
 14 the CVP and SWP would have no effect on designated critical habitat for spring-  
 15 run Chinook Salmon in the Yuba River and Big Chico, Butte, Deer, Mill, Battle,  
 16 and Antelope creeks or other tributaries of the Sacramento River. Operation of  
 17 the CVP and SWP could affect designated critical habitat in the Delta subregion.  
 18 There is no designated critical habitat for spring-run Chinook Salmon in the San  
 19 Joaquin Valley subregion.

#### 20 **9.3.2.1.2 Sacramento River Winter-run Chinook Salmon ESU**

21 The Sacramento River winter-run Chinook Salmon ESU consists of only one  
 22 population confined to the upper Sacramento River. This ESU includes all fish  
 23 spawning naturally in the Sacramento River and its tributaries, as well as fish that  
 24 are propagated at the Livingston Stone National Fish Hatchery (NFH), operated  
 25 by USFWS (NMFS 2005a). Critical habitat was delineated as the Sacramento  
 26 River from Keswick Dam to Chipps Island at the westward margin of the Delta;  
 27 all waters from Chipps Island westward to the Carquinez Bridge, including  
 28 Honker Bay, Grizzly Bay, Suisun Bay, and the Carquinez Strait; all waters of San  
 29 Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco  
 30 Bay (north of the San Francisco-Oakland Bay Bridge) to the Golden Gate Bridge  
 31 (NMFS 1993).

#### 32 **9.3.2.1.3 Central Valley Steelhead DPS**

33 The California Central Valley Steelhead DPS includes all naturally spawned  
 34 populations of steelhead in the Sacramento and San Joaquin rivers and their  
 35 tributaries, excluding steelhead from San Francisco and San Pablo bays and their  
 36 tributaries. Two artificial propagation programs, the Coleman NFH and Feather  
 37 River Hatchery steelhead hatchery programs, are considered to be part of the  
 38 DPS. Critical habitat for Central Valley Steelhead includes stream reaches of the  
 39 American, Feather, Yuba, and Bear rivers and their tributaries, and tributaries of  
 40 the Sacramento River including Deer, Mill, Battle, Antelope, and Clear creeks in  
 41 the Sacramento River Basin; the Mokelumne, Calaveras, Stanislaus, Tuolumne,  
 42 and Merced rivers in the San Joaquin River Basin; and portions of the Sacramento  
 43 and San Joaquin rivers. Designated critical habitat in the Delta includes portions  
 44 of the DCC, Yolo Bypass, Ulatis Creek, and portions of the network of channels



1 in the Sacramento River portion of the Delta; and portions of the San Joaquin,  
2 Cosumnes, and Mokelumne rivers and portions of the network of channels in the  
3 San Joaquin portion of the Delta.

4 The Central Valley Steelhead critical habitat potentially affected by operation of  
5 the CVP and SWP includes the Sacramento River up to Keswick Dam, Clear  
6 Creek up to Whiskeytown Dam, the Feather River up to the Fish Barrier Dam,  
7 and the American River up to Nimbus Dam in the Sacramento Valley subregion.  
8 Operation of the CVP and SWP would have no effect on designated critical  
9 habitat for steelhead in the Yuba River and Big Chico, Butte, Deer, Mill, Battle,  
10 and Antelope creeks or other tributaries of the Sacramento River.

#### 11 **9.3.2.1.4 Central California Coast Steelhead DPS**

12 The Central California Coast Steelhead DPS includes all naturally spawned  
13 populations of steelhead in streams from the Russian River to Aptos Creek, Santa  
14 Cruz County (inclusive). It also includes the drainages of San Francisco and San  
15 Pablo bays. Critical habitat for Central California Coast Steelhead includes  
16 stream reaches in the Russian River, Bodega, Marin Coastal, San Mateo, Bay  
17 Bridge, Santa Clara, San Pablo, and Big Basin Hydrologic Units. Operation of  
18 the CVP and SWP would not affect designated critical habitat for this DPS of  
19 Central California Coast Steelhead, and NMFS (2009a) concluded that operation  
20 would not likely adversely affect individual fish; therefore, this species is not  
21 addressed in this EIS.

#### 22 **9.3.2.1.5 Southern Oregon/Northern California Coastal Coho Salmon ESU**

23 The Southern Oregon/Northern California Coast Coho Salmon ESU consists of  
24 populations from Cape Blanco, Oregon, to Punta Gorda, California, including  
25 Coho Salmon in the Trinity River. In the Trinity River Region, all Trinity River  
26 reaches downstream of Lewiston Dam, the south fork of the Trinity River, and the  
27 entire lower Klamath River are designated as critical habitat with the exception of  
28 tribal lands (NMFS 1999).

#### 29 **9.3.2.2 North American Green Sturgeon Southern DPS**

30 The North American Green Sturgeon Southern DPS consists of coastal and  
31 Central Valley populations south of the Eel River, with the only known spawning  
32 population in the Sacramento River. In designating critical habitat for the North  
33 American Green Sturgeon Southern DPS, NMFS (74 FR 52345) identified PCEs  
34 as essential to the conservation of this species in freshwater riverine systems,  
35 estuarine areas, and nearshore marine waters. The PCEs for each area largely  
36 overlap and include the following items:

- 37 • **Food Resources.** Abundant prey items for larval, juvenile, subadult, and  
38 adult life stages.
- 39 • **Substrate Type or Size (i.e., structural features of substrates).** Substrates  
40 suitable for egg deposition and development (e.g., bedrock sills and shelves,  
41 cobble and gravel, or hard clean sand, with interstices or irregular surfaces to  
42 “collect” eggs and provide protection from predators, and free of excessive silt

- 1 and debris that could smother eggs during incubation), larval development  
 2 (e.g., substrates with interstices or voids providing refuge from predators and  
 3 from high-flow conditions), and subadults and adults (e.g., substrates for  
 4 holding and spawning).
- 5 • **Water Flow.** A flow regime (i.e., the magnitude, frequency, duration,  
 6 seasonality, and rate-of-change of fresh water discharge over time) necessary  
 7 for normal behavior, growth, and survival of all life stages.
  - 8 • **Water Quality.** Water quality, including temperature, salinity, oxygen  
 9 content, and other chemical characteristics, necessary for normal behavior,  
 10 growth, and viability of all life stages.
  - 11 • **Migratory Corridor.** A migratory pathway necessary for the safe and timely  
 12 passage of Southern DPS fish within riverine habitats and between riverine  
 13 and estuarine habitats (e.g., an unobstructed river or dammed river that still  
 14 allows for safe and timely passage).
  - 15 • **Water Depth.** Deep (greater than 5 meters [m]) holding pools for both  
 16 upstream and downstream holding of adult or subadult fish, with adequate  
 17 water quality and flow to maintain the physiological needs of the holding  
 18 adult or subadult fish.
  - 19 • **Sediment Quality.** Sediment quality (i.e., chemical characteristics) necessary  
 20 for normal behavior, growth, and viability of all life stages.

21 Critical habitat in freshwater riverine habitats includes the stream channels in the  
 22 designated stream reaches with the lateral extent defined by the ordinary high-  
 23 water line. The ordinary high-water line on nontidal rivers is defined as “the line  
 24 on the shore established by the fluctuations of water and indicated by physical  
 25 characteristics such as a clear, natural line impressed on the bank; shelving;  
 26 changes in the character of soil; destruction of terrestrial vegetation; the presence  
 27 of litter and debris, or other appropriate means that consider the characteristics of  
 28 the surrounding areas” [33 Code of Federal Regulations 329.11(a)(1)].

29 Within the study area, critical habitat includes the Sacramento River from the  
 30 I-Street Bridge upstream to Keswick Dam, including areas in the Yolo Bypass  
 31 and the Sutter Bypass and the lower American River from the confluence with the  
 32 Sacramento River upstream to the State Route 160 bridge over the American  
 33 River; the lower Feather River from the confluence with the Sacramento River  
 34 upstream to the Fish Barrier Dam; and the lower Yuba River from the confluence  
 35 with the Feather River upstream to Daguerre Dam. Critical habitat also includes  
 36 all waterways of the Delta up to the elevation of mean higher high water except  
 37 for certain excluded areas and all tidally influenced areas of San Francisco Bay,  
 38 San Pablo Bay, and Suisun Bay up to the elevation of mean higher high water  
 39 (NMFS 2009b).

1     **9.3.2.3     Delta Smelt**

2     In designating critical habitat for Delta Smelt (59 FR 65256), USFWS identified  
3     the following PCEs essential to the conservation of the species: (1) suitable  
4     substrate for spawning; (2) water of suitable quality and depth to support survival  
5     and reproduction (e.g., temperature, turbidity, lack of contaminants); (3) sufficient  
6     Delta flow to facilitate spawning migrations and transport of larval Delta Smelt to  
7     appropriate rearing habitats; and (4) salinity, which influences the extent and  
8     location of the low salinity zone where Delta Smelt rear. The location of the low  
9     salinity zone (or X2) is described in terms of the average distance of the two  
10    practical salinity units isohaline from the Golden Gate Bridge. Critical habitat for  
11    Delta Smelt includes all water and submerged lands below ordinary high water  
12    and the entire water column bounded by and contained in Suisun Bay (including  
13    the contiguous Grizzly and Honker bays); the length of Goodyear, Suisun, Cutoff,  
14    First Mallard (Spring Branch), and Montezuma sloughs; and the existing  
15    contiguous waters contained in the legal Delta (as defined in Section 12220 of the  
16    California Water Code) (USFWS 1994a).

17    **9.3.2.4     Eulachon Southern DPS**

18    In designating critical habitat for Eulachon, NMFS (76 FR 65323) identified the  
19    following physical or biological features essential to the conservation of the  
20    Eulachon Southern DPS fall reflecting key life history phases of Eulachon:  
21    (1) freshwater spawning and incubation sites with water flow, quality and  
22    temperature conditions and substrate supporting spawning and incubation, and  
23    with migratory access for adults and juveniles; (2) freshwater and estuarine  
24    migration corridors associated with spawning and incubation sites that are free of  
25    obstruction and with water flow, quality and temperature conditions supporting  
26    larval and adult mobility, and with abundant prey items supporting larval feeding  
27    after the yolk sac is depleted; and (3) nearshore and offshore marine foraging  
28    habitat with water quality and available prey, supporting juveniles and adult  
29    survival.

30    Within the study area, critical habitat for Eulachon includes the Klamath River  
31    from the mouth upstream to the confluence with Omogar Creek. The critical  
32    habitat designation specifically excludes all lands of the Yurok Tribe and  
33    Reshigini Rancheria, based upon a determination that the benefits of exclusion  
34    outweigh the benefits of designation (NMFS 2011b). Exclusion of these areas  
35    will not result in the extinction of the Southern DPS because the  
36    overall percentage of critical habitat on Indian lands is so small (approximately  
37    5 percent of the total are designated), and it is likely that Eulachon production on  
38    these lands represents a small percent of the total annual production for the DPS  
39    (NMFS 2011a, 2011b).

40    **9.3.3        Trinity River Region**

41    The Trinity River Region includes Trinity Lake, Lewiston Reservoir and the  
42    Trinity River from Lewiston Reservoir to the confluence with the Klamath River;  
43    and the portion of the lower Klamath River watershed in Humboldt and Del Norte  
44    counties from the confluence with the Trinity River to the Pacific Ocean. The

1 CVP Trinity Lake and Lewiston Reservoir are located upstream of the  
 2 confluences of several Trinity River tributaries (i.e., north fork, south fork, and  
 3 New River) and flows on these tributaries are not affected by CVP facilities. The  
 4 Trinity River flows approximately 112 miles from Lewiston Reservoir to its  
 5 confluence with the Klamath River, traversing through Trinity and Humboldt  
 6 counties and the Hoopa Indian Reservation within Trinity and Humboldt counties.  
 7 The Trinity River is the largest tributary to the Klamath River (DOI and  
 8 DFG 2012).

9 The lower Klamath River flows 43.5 miles from the confluence with the Trinity  
 10 River to the Pacific Ocean (USFWS et al. 1999). Downstream of the Trinity  
 11 River confluence, the Klamath River flows through Humboldt and Del Norte  
 12 counties and through the Hoopa Indian Reservation, Yurok Indian Reservation,  
 13 and Resighini Indian Reservation within Humboldt and Del Norte counties (DOI  
 14 and DFG 2012). There are no dams located in the Klamath River watershed  
 15 downstream of the confluence with the Trinity River. The Klamath River estuary  
 16 extends from approximately 5 miles upstream of the Pacific Ocean. This area is  
 17 generally under tidal effects, and salt water can occur up to 4 miles from the  
 18 coastline during high tides in summer and fall when Klamath River flows are low.

#### 19 **9.3.3.1 Trinity Lake and Lewiston Reservoir**

20 Trinity Lake is created by Trinity Dam and is considered relatively unproductive,  
 21 with low-standing crops of phytoplankton and zooplankton (USFWS et al. 2004).  
 22 The fish in Trinity Lake include cold-water and warm-water species. Trinity  
 23 Lake supports a trophy Smallmouth Bass fishery and provides substantial sport  
 24 fishing for Largemouth Bass, Rainbow and Brown Trout, and Kokanee Salmon  
 25 (landlocked Sockeye Salmon). Other fish species in Trinity Lake include  
 26 Speckled Dace, Klamath Smallscale Sucker, Coast Range Sculpin, and the  
 27 nonnative Green Sunfish and Brown Bullhead.

28 Lewiston Reservoir is a re-regulating reservoir for Trinity Lake. The water  
 29 surface elevation is relatively constant. The reservoir contains Rainbow, Brown,  
 30 and Brook Trout and Kokanee Salmon. Other fish species present include Pacific  
 31 Lamprey, Speckled Dace, Klamath Smallscale Sucker, Coast Range Sculpin, and  
 32 Smallmouth Bass (USFWS et al. 2004).

#### 33 **9.3.3.2 Trinity River from Lewiston Reservoir to Klamath River**

34 The Trinity River flows out of Trinity Lake and Lewiston Reservoir. Native  
 35 anadromous salmonids in the mainstem Trinity River and its tributaries  
 36 downstream of Lewiston Dam are spring- and fall-run Chinook Salmon, Coho  
 37 Salmon, and steelhead (NCRWQCB et al. 2009). Native non-salmonid  
 38 anadromous species that inhabit the Trinity River Basin include Green Sturgeon,  
 39 White Sturgeon, Pacific Lamprey, and Eulachon.

40 The hydrologic and geomorphic changes following construction of the Trinity and  
 41 Lewiston dams changed the character of the river channel substantially and  
 42 altered the quantity and quality of aquatic habitat. Riparian vegetation was  
 43 allowed to encroach on areas that had previously been scoured by flood flows,

1 resulting in the formation of a riparian berm that armored and anchored the river  
2 banks and prevented meandering of the river channel (USFWS et al. 1999). The  
3 berm reduced the potential for encroachment and maturation of woody vegetation  
4 along the stabilized channel.

5 The ongoing Trinity River Restoration Program includes specific minimum  
6 instream flows (as described in Chapter 5, Surface Water Resources and Water  
7 Supplies); mechanical channel rehabilitation; fine and coarse sediment  
8 management; watershed restoration; infrastructure improvement; and adaptive  
9 management components (NCRWQCB et al. 2009, USFWS et al. 1999). The  
10 mechanical channel rehabilitation includes removal of fossilized riparian berms  
11 that had been anchored by extensive woody vegetation root systems and had  
12 confined the river. Following removal of the berms, the areas have been  
13 re-vegetated to support native vegetation, re-establish alternate point bars, and  
14 re-establish complex fish habitat similar to conditions prior to construction of the  
15 dams. Sediment management activities include introduction of coarse sediment at  
16 locations to support spawning and other aquatic life stages; and relocation of sand  
17 outside of the floodway. In areas closer to Lewiston Dam with limited gravel  
18 supply, gravel/cobble point bars are being rebuilt to increase gravel storage and  
19 improve channel dynamics. Riparian vegetation planted on the restored  
20 floodplains and flows will be managed to encourage natural riparian growth on  
21 the floodplain and limit encroachment on the newly formed gravel bars.  
22 Improvement projects have been completed and others are under construction or  
23 in the planning phases. These restoration actions are occurring in the 40-mile  
24 restoration reach between Lewiston Dam and the confluence with north fork of  
25 the Trinity River (TRRP 2014).

#### 26 **9.3.3.2.1 Fish in the Trinity River**

27 The following focal fish species that occur in the Trinity River are considered in  
28 this EIS.

- 29 • Coho Salmon
- 30 • Chinook Salmon (spring- and fall-run)
- 31 • Steelhead (winter-and summer-run)
- 32 • Green Sturgeon
- 33 • White Sturgeon
- 34 • Pacific Lamprey
- 35 • American Shad

#### 36 *Coho Salmon*

37 Coho Salmon in the Trinity River are thought to be exclusively 3-year lifecycle  
38 fish, living a full year in the river as juveniles before migrating to the ocean.  
39 Most returning adult Coho Salmon enter rivers between August and January.  
40 Spawning in the Trinity River and tributaries occurs primarily in November and  
41 December. Most of the spawning by Coho Salmon in the mainstem Trinity River  
42 occurs from Lewiston Dam downstream to the North Fork Trinity confluence  
43 (NMFS 2014a). Coho Salmon eggs incubate from 35 to more than 100 days,

1 depending on water temperature, and emerge from the gravel 2 weeks to 7 weeks  
2 after hatching. Because juvenile Coho Salmon remain in their spawning stream  
3 for a full year after emerging from the gravel, they are exposed to a broad range  
4 of freshwater conditions. Coho Salmon smolts typically migrate to the ocean  
5 between March and June, with most leaving in April and May (the term “smolt”  
6 refers to young salmon prior to entering the ocean that have undergone the  
7 physiological changes necessary for life in salt water).

8 Coho Salmon were not likely the dominant species of salmon in the Trinity River  
9 before dam construction. However, the species was widespread in the Trinity  
10 River Basin, ranging as far upstream as Stuarts Fork above present-day Trinity  
11 Dam. Passage for Coho Salmon and other anadromous salmonids is now blocked  
12 at Lewiston Dam, which prevents access to roughly 109 miles of upstream habitat  
13 for Coho Salmon (DOI 2000). The Trinity River Salmon and Steelhead Hatchery  
14 (Trinity River Hatchery) produces Coho Salmon with an annual production goal  
15 of 500,000 yearlings to mitigate the upstream habitat loss (CHSRG 2012).

16 Several interrelated factors affect Coho Salmon abundance and distribution in the  
17 Trinity River. These factors include degradation of spawning and rearing habitat,  
18 sparse spawning gravel recruitment, lack of deep pools, stressful late summer  
19 water temperatures, water diversions, channelization and confinement, irregular  
20 timing of flows, fragmentation of populations, genetic and ecological interactions  
21 with hatchery salmonids, migration barriers, water quality problems, and  
22 unscreened diversions (NMFS 2014a). Current CVP operations primarily affect  
23 water temperature, water flow, and habitat suitability in the Trinity River  
24 (Reclamation 2008a). Currently accessible habitat downstream of Lewiston Dam  
25 represents about 50 percent of historically available habitat (USFWS 1999).

26 Habitat in the Trinity River has changed since flow regulation that began with the  
27 completion of Trinity and Lewiston dams, with the encroachment of riparian  
28 vegetation restricting channel movement and limiting fry rearing habitat (Trush  
29 et al. 2000). The Trinity River Restoration Program is implemented to provide  
30 higher peak flows to restore attributes of a fully functioning alluvial river, such as  
31 alternating bar features and additional off-channel habitat, and to provide better  
32 rearing habitat for Coho Salmon (Reclamation 2008a, TRRP 2013). Several  
33 restoration actions have been completed to reconnect the river with the floodplain,  
34 including selective removal of terraces and riparian berms and physical alteration  
35 of the adjacent floodplain to increase inundation frequency. Releases from  
36 Trinity Lake occur on a variable flow schedule with higher spring releases to  
37 promote the restored geomorphic processes and habitat.

38 An estimated 21,906 adult Coho Salmon migrated into the Trinity River Basin  
39 upstream of Willow Creek (about 88 miles downstream of Lewiston Dam) in  
40 2013, of which 6,631 entered Trinity River Hatchery (located near Lewiston  
41 Dam) and 15,275 were estimated to have spawned in the river (CDFW 2014).  
42 The run-size estimates have ranged from 852 fish in 1994 to 59,079 fish in 1987.  
43 The 2011 run was ranked 10th of the 37 years on record and is 27.6 percent of the  
44 17,161 average (CDFW 2014). Both intra- and inter-specific redd  
45 superimposition on the spawning grounds can affect salmon reproductive success

1 and the spawning areas downstream of Lewiston Dam are likely near carrying  
2 capacity (NMFS 2014a).

3 *Spring-run Chinook Salmon*

4 Adult spring-run Chinook Salmon migrate upstream in the Trinity River from  
5 April through September, with most fish arriving at the mouth of the North Fork  
6 Trinity by the end of July. These fish remain in deep pools until the onset of the  
7 spawning season, which typically begins the third week of September, peaks in  
8 October, and continues through November. The distribution of spawning extends  
9 upstream to Lewiston Dam, and is concentrated in the reaches immediately  
10 downstream of the dam to the mouth of the North Fork Trinity River. Williams  
11 et al. (2011) concluded that although abundance is low compared with historical  
12 abundance, the current spring-run Chinook Salmon population (which includes  
13 hatchery fish) appears to have been fairly stable for the past 30 years. In 2013, an  
14 estimated 8,961 spring-run Chinook Salmon entered the Trinity River upstream of  
15 Junction City, including the 2,578 fish that entered the Trinity River Hatchery and  
16 6,129 natural area spawners (CDFW 2014). This run-size estimate is  
17 approximately 51 percent of the 34-year average spring-run Chinook Salmon run-  
18 size of 17,402, which has ranged from 2,381 fish in 1991 to 62,692 fish in 1988  
19 (CDFW 2014).

20 Emergence of spring-run Chinook Salmon fry in the Trinity River begins in  
21 December and continues into mid-April. Juvenile spring-run Chinook Salmon  
22 typically outmigrate after a year of growth in the Trinity River. Outmigration  
23 from the lower Trinity River, as indicated by monitoring near Willow Creek,  
24 peaks in May and June.

25 *Fall-run Chinook Salmon*

26 The adult fall-run Chinook Salmon migration in the Trinity River begins in  
27 August and continues into December, with spawning beginning in mid-October.  
28 Spawning activity peaks in November, and continues through December.  
29 Spawning of fall-run Chinook Salmon occurs throughout the mainstem Trinity  
30 River from Lewiston Dam to the Hoopa Valley (Myers et al. 1998). The first  
31 spawning activity usually occurs just downstream from Lewiston Dam and  
32 extends farther downstream as the spawning season progresses.

33 Like spring-run Chinook Salmon, emergence of fall-run Chinook Salmon fry  
34 begins in December and continues into mid-April. Juvenile fall-run Chinook  
35 Salmon typically outmigrate after a few months of growth in the Trinity River.  
36 Outmigration from the upper river, as indicated by monitoring near Junction City,  
37 begins in March and peaks in early May, ending by late May or early June.  
38 Outmigration of fall-run Chinook Salmon fry in the lower Trinity River occurs  
39 over approximately the same time period described above for the spring run.

40 An estimated 36,989 fall-run Chinook Salmon migrated into the Trinity River  
41 upstream of Willow Creek in 2013, of which 3,852 entered Trinity River  
42 Hatchery and 32,257 spawned naturally (CDFW 2014). This estimate is  
43 approximately 84.5 percent of the 43,762 mean run-size for the years since 1977,  
44 which has ranged from 9,207 fish in 1991 to 147,888 fish in 1986 (CDFW 2014).

1 *Steelhead*

2 Steelhead in the Trinity River exhibit two primary life history strategies: a  
3 summer-run that is stream maturing and a winter-run that is ocean maturing. The  
4 winter-run is considered by some to be composed of a fall-run and a winter-run  
5 based upon the timing of the adult migration. Summer-run steelhead have been  
6 observed in the north and south forks of the Trinity River and in the tributaries of  
7 New River and Canyon Creek (BLM 1995).

8 Adult summer-run steelhead enter the Trinity River from April through  
9 September and over-summer in deep pools within the mainstem. Some enter the  
10 smaller tributary streams of the Trinity River during the first November rains  
11 (Hill 2010), with most fish spawning in both the mainstem and tributaries from  
12 February through April (USFWS et al. 2004). Summer-run steelhead spawner  
13 escapements for the Trinity River upstream of Lewiston Dam prior to its  
14 construction were estimated to average 8,000 adults annually. Post-dam survey  
15 (reported in 2004) ranged from 20 to 1,037 adult summer steelhead in the  
16 tributaries and Trinity River (USFWS et al. 2004).

17 Juvenile summer-run steelhead may rear in fresh water for up to three years  
18 before outmigrating. Rearing in the Trinity River is highly variable, but most  
19 summer-run steelhead either outmigrate as young-of-the-year (YOY) or at age 1+  
20 (Scheiff et al. 2001, Pinnix and Quinn 2009, Pinnix et al. 2013). For juveniles  
21 that rear at least a year in fresh water, survival appears to be higher for those that  
22 outmigrate to the ocean at age 2+ (DFG 1998a). Juveniles outmigrating from the  
23 tributaries as 0+ or age 1+ may rear in the mainstem or in nonnatal tributaries  
24 (particularly during periods of poor water quality) for one or more years before  
25 smolting. Juvenile outmigration can occur from spring through fall, with three  
26 peak migration periods including March, May/June, and October/November  
27 (USFWS et al. 2004).

28 Fall-run and winter-run steelhead also are widely distributed throughout the  
29 Trinity River. Adult fall-run steelhead enter the Klamath River system in  
30 September and October (Hill 2010) and likely spawn in tributaries such as the  
31 Trinity River from January through April. Adult winter-run steelhead begin their  
32 upstream migration in the Klamath River from November through March  
33 (USFWS 1997). Winter-run steelhead primarily spawn in Klamath River  
34 tributaries (including the Trinity River) from January through April (USFWS  
35 1997), with peak spawn timing in February and March (NRC 2004).

36 An estimated run-size of 16,594 adult fall-run steelhead migrated into the Trinity  
37 River upstream of Willow Creek in 2013, including the 2,375 fish (80 natural-  
38 origin and 2,295 hatchery-origin) that entered the Trinity River Hatchery and  
39 13,560 natural area spawners (9,039 of natural origin and 4,521 of hatchery  
40 origin) (CDFW 2014). Since 1980, run-size estimates have ranged from 2,972 in  
41 1998 to 53,885 in 2007. The estimated abundance of steelhead in 2013 was  
42 8.4 percent above the average since 1980 (CDFW 2014).



1 *Green Sturgeon*

2 Limited Green Sturgeon data has been collected in the Trinity River, so most  
3 information on life history characteristics for Green Sturgeon in the Trinity River  
4 is based on data from the Klamath River. Green Sturgeon in the Klamath River  
5 sampled during their spawning migration ranged in age from 16 to 40 years (Van  
6 Eenennaam et al. 2006). Green Sturgeon are generally believed to have a life  
7 span of at least 50 years and spawn every four years on average after around  
8 age 16 (Klimley et al. 2007). Green Sturgeon enter the Trinity and Klamath rivers  
9 to spawn from February through July, and most spawning occurs from the middle  
10 of April to the middle of June (NRC 2004). After spawning, around 25 percent of  
11 Green Sturgeon migrate directly back to the ocean (Benson et al. 2007), and the  
12 remainder hold in mainstem pools through November. During the onset of fall  
13 rainstorms and increased river flow, adult sturgeon move downstream and leave  
14 the river system (Benson et al. 2007). Juvenile Green Sturgeon may rear for one  
15 to three years in the Klamath River system before they migrate to the estuary and  
16 Pacific Ocean (NRC 2004, FERC 2007a, CALFED 2007), usually during summer  
17 and fall (Emmett et al. 1991, Hardy and Addley 2001).

18 In the Trinity River Basin, Green Sturgeon are known to spawn in the mainstem  
19 from the confluence with the Klamath to as far upstream as Gray's Falls near  
20 Burnt Ranch. Juveniles are captured in rotary screw traps at Willow Creek on the  
21 Trinity River (Scheiff et al. 2001, Pinnix and Quinn 2009).

22 *White Sturgeon*

23 White Sturgeon are uncommon in the Klamath and Trinity rivers and spawning  
24 may not occur (NRC 2004). Historically there may have been small spawning  
25 runs in these rivers; almost all of the sturgeon occurring above the Klamath  
26 estuary are Green Sturgeon (Moyle 2002).

27 *Pacific Lamprey*

28 Pacific Lamprey are the only anadromous lamprey species in the Trinity River  
29 Basin. This species is important to local tribes and supports a subsistence fishery  
30 on the lower Trinity River. Although no systematic distribution surveys are  
31 available for the Trinity River Basin, they are expected to have a distribution  
32 similar to anadromous salmonids that use the mainstem Trinity River and  
33 accessible reaches of larger tributaries. No current status assessments are  
34 available for Pacific Lamprey in the Trinity River, but information from tribal  
35 fishermen who catch lampreys in the lower Klamath River suggests a decline that  
36 mirrors that observed across the species' range (Petersen Lewis 2009).

37 Adult Pacific Lampreys have been documented entering the Klamath River from  
38 the ocean during all months of the year, with peak upstream migration to holding  
39 areas from December through June (Larson and Belchik 1998, Petersen Lewis  
40 2009). Migration up the Trinity River is expected to begin slightly later. After  
41 entering fresh water as sexually immature adults and undergoing an initial  
42 migration, Pacific Lampreys hold through summer and most of winter before  
43 spawning the following spring when they reach sexual maturity (Robinson and  
44 Bayer 2005, Clemens et al. 2012). After the holding period, individuals undergo

1 a secondary migration in the late winter or early spring from holding areas to  
2 spawning grounds (Robinson and Bayer 2005, Clemens et al. 2012, Lampman  
3 2011). Thus, adult Pacific Lampreys with varying levels of sexual maturity may  
4 be in the Trinity River throughout the year. Ammocoetes (the larval stage of  
5 lamprey) inhabit fine substrates in depositional areas, rearing in the Trinity River  
6 and tributaries year-round for up to 7 years before outmigrating to the ocean  
7 (Moyle 2002, Reclamation and Trinity County 2006).

8 Little information is available on factors that influence populations of Pacific  
9 Lamprey in the Trinity River, but they are affected by many of the same factors as  
10 salmon and steelhead, because of parallels in their life cycles. Lack of access to  
11 historical spawning habitats caused by the mainstem dams and other migration  
12 barriers, modification of spawning and rearing habitat because of downstream  
13 impacts from dams, altered hydrology, and predation by nonnative invasive  
14 species such as Brown Trout have likely contributed to adverse effects on the  
15 Trinity River Pacific Lamprey population.

#### 16 *American Shad*

17 American Shad, an introduced, anadromous fish, has become established in the  
18 Klamath and Trinity rivers. American Shad occur in the lowermost portions of  
19 the Trinity River, but are primarily found in the lower Klamath River. Adult fish  
20 enter estuaries or streams in late spring or early summer and spawn soon  
21 afterward in fresh water. Juvenile shad have been captured regularly in the  
22 rotary-screw traps at the Pear Tree and Willow Creek sites during salmonid  
23 outmigrant monitoring (Scheiff et al. 2001, Pinnix and Quinn 2009, Pinnix et al.  
24 2013). Sport fishing for American Shad occurs seasonally throughout the lower  
25 Trinity River.

#### 26 **9.3.3.2.2 Hatcheries on the Trinity River**

27 The Trinity River Hatchery is located immediately downstream of Lewiston Dam,  
28 and is operated by CDFW and funded by Reclamation to mitigate the loss of  
29 salmonid production upstream of Lewiston Dam resulting from the Trinity Dam  
30 (Reclamation 2008a). The hatchery produces Coho Salmon, fall-run Chinook  
31 Salmon, spring-run Chinook Salmon, and steelhead. The hatchery's Coho  
32 Salmon program currently uses only endemic Coho Salmon broodstock and  
33 releases approximately 500,000 yearlings annually from March 15 to May 15.  
34 The fall-run Chinook Salmon program has a goal of releasing two million sub-  
35 yearlings in June and 900,000 yearlings in October from in-river broodstock, and  
36 the spring-run Chinook Salmon program has a goal of releasing one million  
37 subyearlings in June and 400,000 yearlings in October from in-river broodstock.  
38 The steelhead program currently uses only in-river broodstock with a goal to  
39 release 800,000 steelhead smolts (approximately six inches) from March 15 to  
40 May 1.

1     **9.3.3.3     Lower Klamath River from Trinity River to Pacific Ocean**

2     The Lower Klamath River begins where the Trinity River flows into it near  
3     Weitchpec, which is located about 43 miles upstream from the Pacific Ocean.  
4     The Trinity River is the largest tributary of the Klamath River and makes a  
5     substantial contribution to the flows in the lower Klamath River. This section of  
6     the Klamath River serves primarily as a migration corridor for salmonids, with  
7     most spawning and rearing upstream of the confluence with the Trinity River or  
8     in the larger tributaries (e.g., Blue Creek) to the mainstem Klamath River.

9     **9.3.3.3.1     Fish in the Lower Klamath River**

10    Focal fish species that occur in the lower Klamath River downstream of the  
11    Trinity River confluence are included for analysis in this EIS and include all those  
12    found in the Trinity River, as described above, with the exception of Eulachon.

13    Eulachon is a smelt species in the Klamath River system found upstream of the  
14    estuary. Eulachon are anadromous broadcast spawners that spawn in the lower  
15    reaches of rivers and tributaries and usually die after spawning. Eulachon are  
16    sexually mature at 2 years and spawn at ages 3, 4, and/or 5 (Scott and Crossman  
17    1973). Timing of the spawning migration in the Klamath River is similar to other  
18    known runs of Eulachon, beginning in December and continuing until May, with  
19    a peak in March and April (YTFP 1998, Larson and Belchik 1998).

20    In the Klamath River, adult Eulachon generally migrate as high as Brooks Riffle,  
21    about 40 kilometers (about 24 miles) upstream of the mouth, but have been  
22    observed as high as Pecwan Creek and even Weitchpec during exceptional years  
23    (YTFP 1998); specific spawning areas are unknown. Eggs hatch in 20 to 40 days  
24    depending on water temperature, taking longer at cooler temperatures. After  
25    hatching, the larvae are passively carried from spawning grounds to the ocean via  
26    river currents (Scott and Crossman 1973).

27    This species was historically important to local tribes and supported a subsistence  
28    fishery on the lower Klamath River. According to accounts of Yurok Tribal  
29    elders, there were annual runs so great that one had no problem catching “as many  
30    as you wanted;” however, the last noticeable runs of Eulachon were observed in  
31    1988 and 1989 by Tribal fishers (Larson and Belchik 1998). In 1996, YTFP  
32    sampling efforts to capture Eulachon were unsuccessful, although a Yurok Tribal  
33    member gave the YTFP a Eulachon he had caught while fishing for lamprey at the  
34    mouth of the river (Larson and Belchik 1998). However, it is likely that the  
35    Eulachon has been extirpated or nearly so on the lower Klamath River  
36    (NMFS 2015).

37    **9.3.4     Central Valley Region**

38    Fish and aquatic resources in the Central Valley Region are described in this  
39    section in accordance with the following major waterbodies.

- 40    • Shasta Lake and Keswick Reservoir
- 41    • Whiskeytown Lake
- 42    • Clear Creek

- 1 • Sacramento River from Keswick Reservoir to the Delta (near Freeport)
- 2 • Battle Creek
- 3 • Feather River
- 4 • Yuba and Bear Rivers
- 5 • American River
- 6 • Delta
- 7 • Yolo Bypass
- 8 • Millerton Lake
- 9 • San Joaquin River from the Stanislaus River confluence to the Delta (near
- 10 Vernalis)
- 11 • New Melones Reservoir, Tulloch Reservoir, and the reservoir formed by
- 12 Goodwin Dam
- 13 • Stanislaus River
- 14 • San Luis Reservoir

#### 15 **9.3.4.1 Shasta Lake and Keswick Reservoir**

16 Shasta Lake is formed by Shasta Dam, which is located on the Sacramento River  
 17 just downstream of the confluence of the Sacramento, McCloud, and Pit rivers.  
 18 Shasta Dam has no fish passage facilities; however, the dam has a fish trapping  
 19 facility that operates in conjunction with Livingston Stone National Fish Hatchery  
 20 below Shasta Dam.

##### 21 **9.3.4.1.1 Shasta Lake**

22 Shasta Lake fish species include native and introduced warm-water and cold-  
 23 water species. Major nonfish aquatic animal species assemblages in Shasta Lake  
 24 include benthic macroinvertebrates and zooplankton (Reclamation 2013b).  
 25 Shasta Lake is typically thermally stratified from April through November, during  
 26 which time the upper layer (epilimnion) can reach a peak water temperature of  
 27 80 degrees Fahrenheit (°F) (Reclamation 2003). The upper layer of Shasta Lake  
 28 supports warm-water game fish, and the lower layers (metalimnion and  
 29 hypolimnion) support cold-water fishes. Nonnative, warm-water fish species in  
 30 Shasta Lake include Smallmouth Bass, Largemouth Bass, Spotted Bass, Black  
 31 Crappie, Bluegill, Green Sunfish, Channel Catfish, White Catfish, and Brown  
 32 Bullhead (DWR et al. 2013). Cold-water species include Rainbow Trout, Brown  
 33 Trout, landlocked White Sturgeon, landlocked Coho Salmon (Reclamation et al.  
 34 2003), and landlocked Chinook Salmon (Reclamation 2013). Other fish species  
 35 in Shasta Lake include Golden Shiner, Threadfin Shad, Common Carp, and the  
 36 native Hardhead, Sacramento Sucker, and Sacramento Pikeminnow (DWR et al.  
 37 2013, Reclamation 2013).

1 Water quality in Shasta Lake is generally considered good, largely because of the  
2 continual inflow of cool, high-quality water from the major tributaries to the lake.  
3 The primary water quality concerns in the lake is turbidity, typically associated  
4 with heavy rainfall events that move soils and runoff from abandoned mines in  
5 the area into the lake.

6 Warm-water fish habitat in Shasta Lake is influenced primarily by fluctuations in  
7 the lake level and the availability of shoreline cover (Reclamation 2003). Water  
8 surface elevations in Shasta Lake can fluctuate approximately 55 feet annually as  
9 a result of operation of Shasta and Sacramento River diversions (Reclamation  
10 2003). Reservoir surface elevation fluctuations can disturb shallow, nearshore  
11 habitats, including spawning and rearing habitat for warm-water fish species. The  
12 shoreline of Shasta Lake is generally steep, which limits shallow, warm-water fish  
13 habitat, and is not conducive to the establishment of vegetation or other shoreline  
14 cover (Reclamation 2003).

#### 15 **9.3.4.1.2 Keswick Reservoir**

16 Keswick Reservoir is a re-regulating reservoir for Shasta Lake. The water surface  
17 elevation is relatively constant. Residence time for water in Keswick Reservoir is  
18 about a day, compared with a residence time of about a year for water in Shasta  
19 Lake. Consequently, water temperatures tend to be controlled by releases from  
20 Shasta Dam and average less than 55°F. Despite the cool temperatures, the  
21 reservoir supports warm-water and cold-water fishes, including Largemouth Bass,  
22 crappie and catfish, and Rainbow Trout (Reclamation 2003).

#### 23 **9.3.4.2 Whiskeytown Lake**

24 Water is diverted from the Trinity River at Lewiston Dam and discharged via the  
25 Clear Creek Tunnel into Whiskeytown Lake on Clear Creek. From Whiskeytown  
26 Lake, water is released into the lower portion of Clear Creek via Whiskeytown  
27 Dam and into Keswick Reservoir through the Spring Creek Tunnel. There are  
28 two temperature control curtains in Whiskeytown Lake: Oak Bottom and Spring  
29 Creek (Reclamation 2008a). The Oak Bottom temperature control curtain serves  
30 as a barrier to prevent warm water in the reservoir from mixing with cold water  
31 from Lewiston Lake entering through the Carr Powerhouse. The Oak Bottom  
32 curtain is damaged and cannot be fully deployed; it is scheduled to be repaired in  
33 2015. The Spring Creek temperature control curtain was replaced in 2011 and  
34 aids cold-water movement into the underwater intake for the Spring Creek  
35 Tunnel.

36 The fish assemblage in Whiskeytown Lake includes cold-water and warm-water  
37 species. Common fishes known to occur in Whiskeytown Lake include Rainbow  
38 Trout, Brown Trout, Kokanee Salmon, Largemouth Bass, crappie, sunfish,  
39 catfish, and bullhead (USFWS et al. 2004).

#### 40 **9.3.4.3 Clear Creek**

41 The project area includes the reach of Clear Creek extending from Whiskeytown  
42 Dam to the confluence with the Sacramento River. Since 1995, extensive habitat  
43 and flow restoration in Clear Creek has occurred under the Central Valley Project

1 Improvement Act (CVPIA) and CALFED programs and in accordance with the  
2 NMFS 2009 BO. The Clear Creek Technical Team has been working since 1996  
3 to facilitate implementation of CVPIA anadromous salmonid restoration actions  
4 (Brown et al. 2012). Restoration efforts have resulted in increased stocks of  
5 fall-run Chinook Salmon and re-established populations of spring-run Chinook  
6 Salmon and steelhead.

#### 7 **9.3.4.3.1 Fish in Clear Creek**

8 This analysis is focused on Chinook Salmon, steelhead, and Pacific Lamprey in  
9 Clear Creek.

##### 10 *Spring-run Chinook Salmon*

11 Clear Creek currently supports a modest run of spring-run Chinook Salmon,  
12 which since 1998 has ranged from 0 in 2001 to an estimated high of 659 fish in  
13 2013 (CDFW 2014). Adult spring-run Chinook Salmon migrate into Clear Creek  
14 from April through September. Adult fish tend to move as far upstream as  
15 possible to access cooler temperatures downstream of Whiskeytown Dam and  
16 hold over in summer until spawning in September through October. In the NMFS  
17 2009 BO, NMFS expressed concern that spring-run Chinook Salmon unable to  
18 enter Clear Creek for spawning could hybridize with fall-run Chinook Salmon  
19 spawning in the Sacramento River (NMFS 2009a).

20 NMFS (2009a) reported that insufficient instream flows could fail to attract adult  
21 spring-run holding in the Sacramento River mainstem into Clear Creek. Adult  
22 spring-run Chinook Salmon tend to spread downstream of their holding areas  
23 prior to spawning (from Whiskeytown Dam downstream to the Clear Creek Road  
24 Bridge) from September through October. Egg incubation occurs from  
25 September through December, and juveniles rear from October through April  
26 (NMFS 2009a).

27 Spawning gravel is annually augmented in Clear Creek downstream of  
28 Whiskeytown Dam under the CVPIA Clear Creek Restoration Program and in  
29 accordance with the 2009 NMFS BO (Reclamation 2013a). Additionally, water  
30 temperature criteria to protect spring-run Chinook Salmon during spawning and  
31 incubation are generally met; however, in recent years, water temperatures in  
32 Clear Creek during the spawning and incubation period (i.e., September 15 to  
33 October 31) have exceeded the temperature targets at times (Brown et al. 2012).

34 Based on rotary screw trap captures, juvenile spring-run Chinook Salmon  
35 outmigrate from Clear Creek from May through February. Peak outmigration  
36 occurs over a 9-week period from early December 2008 through early February  
37 2009 (Earley et al. 2010). Trap data indicate that the majority of juveniles  
38 identified as spring-run (based on length-at-date size criteria) leave as age-0 fish,  
39 less than 40 millimeter (mm) in fork length (USFWS 2008b, Earley et al. 2010).

##### 40 *Fall-/Late Fall-run Chinook Salmon*

41 Since 1995, restoration activities implemented in accordance with programs  
42 implemented under the CVPIA, CALFED, and the 2009 NMFS BO have  
43 increased stocks of fall-run Chinook Salmon by more than 400 percent (Brown

1 2011). In 2014, fall-run Chinook Salmon estimated escapement was 15,794  
2 compared to the average baseline (1967-1991) estimated escapement of 1,689.

3 Fall/late fall-run Chinook Salmon primarily use the lower reaches of Clear Creek  
4 for all life history phases. Fall-run Chinook migrate into Clear Creek between the  
5 spring- and late fall-runs and spawn in October through December (USFWS  
6 2015). A picket weir installed about 7.4 miles upstream of the confluence with  
7 the Sacramento River from August 1 to November 1 is used to prevent fall-run  
8 Chinook Salmon from spawning in the upper reaches with spring-run.

9 Late-fall-run Chinook Salmon migrate into Clear Creek from November through  
10 April, with peak migration in December; peak spawning occurs in January.

11 Based on rotary screw trap captures and length-at-date size criteria, fall-run  
12 Chinook Salmon make up the vast majority of all Chinook Salmon outmigrating  
13 from lower Clear Creek. Late fall-run juveniles constitute a small percentage of  
14 juvenile Chinook Salmon leaving Clear Creek. Juvenile fall-/late fall-run  
15 Chinook Salmon primarily outmigrate from Clear Creek as age-0 fish less than  
16 40 mm in fork length (USFWS 2008b, Earley et al. 2010). Peak age-0  
17 outmigration in 2008/2009 was from January and February for fall-run Chinook  
18 Salmon and during April to May for late fall-run Chinook Salmon (Earley et al.  
19 2010).

20 *Steelhead*

21 Operation of Whiskeytown Dam supports cold-water habitat for steelhead in  
22 Clear Creek, the amount of which depends on flow releases which range from  
23 30 to 200 cubic feet per second (cfs) depending on water year type (Reclamation  
24 2008a). Steelhead have recolonized the habitat that became accessible with the  
25 removal of the McCormick-Saeltzer Dam in 2000. Redd surveys conducted since  
26 2003 indicate that a small, but increasing population of steelhead resides in Clear  
27 Creek, with the highest density in the first mile below Whiskeytown Dam  
28 (USFWS 2007).

29 Adult steelhead immigration into Clear Creek usually occurs from August through  
30 March, with a peak occurring from September to November (USFWS 2008b).  
31 Adult steelhead tend to hold in the upper reaches of Clear Creek from September  
32 to December.

33 Spawning typically begins in December and continues through early March. Peak  
34 spawning occurs from late January to early February (USFWS 2007). The  
35 embryo incubation life stage begins with the onset of spawning in late December  
36 and generally extends through April.

37 Spawning distribution has recently expanded from the upper 4 miles of lower  
38 Clear Creek to the entire 17 miles of lower Clear Creek, although it appears to be  
39 concentrated in areas of newly added spawning gravels. Recently, more steelhead  
40 were observed spawning in the lowest reach of the creek where resulting juveniles  
41 can be subject to warmer water temperatures during summer (Brown 2011).

1 Summertime water temperatures are often critical for steelhead rearing and limit  
2 rearing habitat quality in many streams. Instream flow releases are intended to  
3 maintain suitable water temperatures throughout most of Clear Creek during  
4 summer. Snorkel surveys from 1999 to 2002 indicate that rearing steelhead may  
5 be present throughout all of lower Clear Creek (Good et al. 2005). Based on  
6 rotary screw trap captures, fry make up the vast majority of all steelhead/Rainbow  
7 Trout captured in lower Clear Creek. Peak outmigration of juvenile steelhead fry  
8 occurred from mid-March through April of 2009 (Earley et al. 2010).

#### 9 *Pacific Lamprey*

10 Pacific Lamprey is expected to inhabit all reaches in Clear Creek upstream to  
11 Whiskeytown Dam. The loss of access to historical habitat and apparent  
12 population declines throughout California and the Sacramento and San Joaquin  
13 River basins indicate the population is likely reduced compared with historical  
14 levels (Moyle et al. 2009). Little information is available on factors influencing  
15 populations of Pacific Lamprey in Clear Creek, but they are likely affected by  
16 many of the same factors as salmon and steelhead because of parallels in their  
17 life cycles.

18 Ocean stage adult Pacific Lampreys likely migrate into Clear Creek in summer,  
19 where they hold for approximately 1 year before spawning (Hanni et al. 2006).  
20 No information is available on spawning in Clear Creek; however, spawning  
21 period documented by Hannon and Deason (2008) for Pacific Lampreys in the  
22 American River of early January to late May, with peak spawning typically in  
23 early April, may also apply to Clear Creek. Pacific Lamprey ammocoetes rear in  
24 Clear Creek for all or part of their 5- to 7-year freshwater residence. Data from  
25 rotary screw trapping in Clear Creek suggest that some outmigration of Pacific  
26 Lampreys may occur year-round, but peak outmigration occurs from early winter  
27 through spring (Hanni et al. 2006).

#### 28 **9.3.4.3.2 Extent and Status of Aquatic Habitat**

29 Whiskeytown Dam limits the contribution of coarse sediment for transport  
30 downstream in Clear Creek, which NMFS (2009a) reported has resulted in riffle  
31 coarsening, fossilization of alluvial features, loss of fine sediments available for  
32 overbank deposition, and considerable loss of spawning gravels. These  
33 conditions affect spawning and rearing habitat on Clear Creek. Water flows and  
34 temperatures conditions on Clear Creek are presented in Chapter 5, Surface Water  
35 Resources and Water Supplies, and Chapter 6, Surface Water Quality,  
36 respectively.

#### 37 *Spawning Habitat*

38 An unpublished study conducted by USFWS (as cited in Brown 2011) suggested  
39 that gravel transport blocked by the construction of Whiskeytown Dam reduced  
40 spawning habitat in Clear Creek by 92 percent. Plans developed under CVPIA  
41 implementation included a goal to create and maintain 347,288 square feet of  
42 usable spawning habitat between Whiskeytown Dam to the former  
43 McCormick-Saeltzer Dam by 2020. This area is equivalent to the spawning  
44 habitat that existed before construction of Whiskeytown Dam (CVPIA 2014).



1 Brown (2011) noted that much of the degraded habitat has been restored by gravel  
2 augmentation, but continued augmentation will be required. Spawning gravel is  
3 annually augmented in Clear Creek downstream of Whiskeytown Dam, pursuant  
4 to CVPIA implementation and Action of I.1.3 of the 2009 NMFS BO Reasonable  
5 and Prudent Alternative (RPA). The CVPIA annual spawning gravel target is  
6 25,000 tons per year; however, an average of 9,574 tons has been placed annually  
7 since 1996. In 2012, a total of 9,974 tons of gravel was placed at four sites:  
8 Guardian Rock site, Placer Bridge, Clear Creek Road Crossing, and at Tule  
9 Backwater. A gravel injection project did not occur in 2013 (CVPIA 2014).

10 Most supplemental spawning gravel is placed into Clear Creek at long-term  
11 injection sites awaiting high flows to move gravel into the creek. These gravel  
12 addition projects have successfully created habitat suitable for spring-run Chinook  
13 Salmon spawning as evidenced by the number of redds directly observed in  
14 supplemental gravel or in supplemental gravel integrated into native gravel  
15 (USFWS 2007, 2008b). Spawning area mapping performed annually since 2000  
16 indicates the overall amount of area used by spawning fall-run Chinook Salmon  
17 has been increasing, despite the adult population abundance remaining stable.  
18 The amount of area used in 2008 was the highest measured and more than double  
19 the amount used in 2000, suggesting that the gravel augmentation program has  
20 been successful in creating new spawning habitat. Gravel augmentation also has  
21 increased the amount of steelhead spawning habitat available in the lower reaches  
22 of Clear Creek, and NMFS (2009a) has indicated that this directly relates to  
23 higher fish abundance in recent years. In most locations, gravel additions created  
24 spawning habitat that did not exist or had limited prior use.

25 Studies to determine the availability of fish habitat, expressed as Weighted  
26 Useable Area (WUA), have been conducted by USFWS for Clear Creek  
27 (USFWS 2006). For spring-run Chinook Salmon, it was determined that  
28 spawning WUA peaked at the highest modeled flow (900 cfs) in the upstream  
29 alluvial segment from Whiskeytown Dam to the NEED Camp Bridge. In the  
30 canyon segment downstream (NEED Camp Bridge to the Clear Creek Road  
31 Bridge) spawning habitat peaked at 650 cfs. The WUA for steelhead/Rainbow  
32 Trout spawning habitat peaked at 350 cfs and 600 cfs in these segments,  
33 respectively (USFWS 2007). In the lower reach downstream of the Clear Creek  
34 Road Bridge, WUA for both fall-run Chinook Salmon and steelhead/Rainbow  
35 Trout spawning habitat peaked at 300 cfs (USFWS 2011a).

36 At all flows, the amount of spawning habitat present in Clear Creek is less than  
37 the amount needed to achieve the abundance recovery goal of spring-run Chinook  
38 Salmon spawning (based on the original USFWS [2007] estimates). However,  
39 the increased spawning habitat availability due to gravel additions since 2003  
40 suggests that spawning habitat for spring-run Chinook Salmon is now more than  
41 sufficient to support the recovery goal at all flows. At flows greater than 50 cfs,  
42 the amount of spawning habitat present in Clear Creek is greater than the amount  
43 of spawning habitat needed to achieve the abundance recovery goal for steelhead.  
44 In contrast, the amount of spawning habitat present in Clear Creek is less than the

1 amount of spawning habitat needed to support 7,920 adult fall-run Chinook  
2 Salmon in Clear Creek (USFWS 2015).

### 3 *Rearing Habitat*

4 The WUA for spring-run Chinook Salmon fry rearing peaked at 600 cfs in the  
5 upstream alluvial segment from Whiskeytown Dam to the NEED Camp Bridge.  
6 In the canyon segment downstream (NEED Camp Bridge to Clear Creek Road  
7 Bridge), fry rearing habitat peaked at the highest modeled flow (900 cfs). The  
8 WUA for steelhead/Rainbow Trout fry rearing habitat peaked at 700 cfs and  
9 900 cfs (the maximum flow modeled) in these segments, respectively (USFWS  
10 2011b). The WUA for spring-run Chinook Salmon and steelhead/Rainbow Trout  
11 juvenile rearing habitat peaked at the highest modeled flow (900 cfs) in the upper  
12 alluvial segment and 650 cfs in the canyon segment downstream. In the lower  
13 reach downstream of the Clear Creek Road Bridge, WUA for both fall-run  
14 Chinook Salmon and steelhead/Rainbow Trout fry rearing habitat peaked at  
15 50 cfs; fry rearing habitat for spring-run Chinook Salmon peaked at 900 cfs.  
16 Spring-run Chinook Salmon and steelhead/Rainbow Trout juvenile rearing habitat  
17 peaked at 850 cfs, while fall-run Chinook Salmon juvenile rearing habitat peaked  
18 at 350 cfs (USFWS 2013a).

19 As described above for spawning habitat, USFWS (2015) compared the total  
20 amount of rearing habitat available for spring-run Chinook Salmon and  
21 steelhead/Rainbow Trout to the amount of rearing habitat needed to support an  
22 annual escapement of 833 adults for each species. The total amount of rearing  
23 habitat available for fall-run Chinook Salmon was compared to the amount of  
24 habitat needed to support an average escapement of 7,920 fall-run Chinook  
25 Salmon. At all flows, the amount of rearing habitat present in Clear Creek is  
26 greater than the amount needed to achieve the abundance recovery goal for  
27 spring-run Chinook Salmon and steelhead. In contrast, the amount of rearing  
28 habitat present in Clear Creek is less than the amount needed to support  
29 7,920 adult fall-run Chinook Salmon in Clear Creek.

### 30 **9.3.4.3.3 Fish Passage**

31 Whiskeytown Dam blocks access to 25 miles of historical spring-run Chinook  
32 Salmon and steelhead spawning and rearing habitat (Yoshiyama et al. 1996).  
33 Until 2000, the McCormick-Saeltzer Dam was a barrier to upstream migration for  
34 anadromous salmonids. After its removal, anadromous salmonids recolonized an  
35 additional 12 miles of habitat upstream to Whiskeytown Dam. With the removal  
36 of McCormick-Saeltzer Dam, passage of spring-run Chinook Salmon has  
37 increased. Stream surveys and juvenile monitoring results also suggest that dam  
38 removal has allowed reestablishment of spring-run Chinook Salmon and  
39 steelhead. NMFS (2009a) reported that compared to fall-run Chinook Salmon,  
40 spring-run Chinook Salmon historically spawned earlier and at locations farther  
41 upstream in Clear Creek. However, NMFS (2009a) concluded that the  
42 construction of Whiskeytown Dam likely caused a high degree of spatial overlap  
43 between the fall-run and spring-run fish during spawning, resulting in a higher  
44 probability of hybridization. To address this concern, USFWS has been

1 separating adult fall-run fish from the spring-run fish holding in the upper reaches  
2 of Clear Creek with a segregation weir that is operated from August 1 to  
3 November 1. After November 1, fall-run Chinook Salmon have access to the  
4 entire river for spawning.

5 **9.3.4.4 Sacramento River from Keswick Reservoir to the Delta near**  
6 **Freeport**

7 Aquatic resources in the Sacramento River are affected by the habitat along the  
8 river and along the tributaries that connect to the river. Habitat along the river  
9 ranges from artificial structures used for water supply and flood management to  
10 open spaces that provide more natural types of habitat. The flow regime in the  
11 Sacramento River is managed for water supply and flood management, as  
12 described in Chapter 5, Surface Water Resources and Water Supplies. The  
13 following discussion focuses on the fish in the Sacramento River and aquatic  
14 habitat conditions.

15 **9.3.4.4.1 Fish in the Sacramento River**

16 The analysis is focused on the following species:

- 17 • Chinook Salmon (winter-, spring-, and fall/late fall-run)
- 18 • Steelhead
- 19 • Green Sturgeon
- 20 • White Sturgeon
- 21 • Sacramento Splittail
- 22 • Pacific Lamprey
- 23 • Striped Bass
- 24 • American Shad

25 *Winter-run Chinook Salmon*

26 Adult winter-run Chinook Salmon return to fresh water during winter but delay  
27 spawning until spring and summer. Adults enter fresh water in an immature  
28 reproductive state, similar to spring-run Chinook, but winter-run Chinook move  
29 upstream much more quickly and then hold in the cool waters downstream of  
30 Keswick Dam for an extended period before spawning. Juveniles spend about  
31 5 to 9 months in the river and estuary systems before entering the ocean. This  
32 life-history pattern differentiates the winter-run Chinook from other Sacramento  
33 River Chinook runs and from all other populations within the range of Chinook  
34 Salmon (DFG 1985, 1998b).

35 Access to approximately 58 percent of the original winter-run Chinook Salmon  
36 habitat has been blocked by dam construction (Reclamation 2008a). The  
37 remaining accessible habitat occurs in the Sacramento River downstream of  
38 Keswick Dam and in Battle Creek. The number of winter-run Chinook Salmon in  
39 Battle Creek is unknown, but if they do occur, they are scarce (Reclamation and  
40 SWRCB 2003).

1 Escapement data indicate that the winter-run Chinook Salmon population  
2 declined from its levels in the 1970s to relatively low levels through the 1980s  
3 and 1990s, with a small rebound in the early 2000s (Azat 2012).

4 Adult winter-run Chinook Salmon migrate upstream past the location of the Red  
5 Bluff Diversion Dam (RBDD) beginning in mid-December and continuing into  
6 early August. Most of the run passes RBDD between January and May, with the  
7 peak in mid-March (DFG 1985). Winter-run Chinook Salmon spawn only in the  
8 Sacramento River, almost exclusively above RBDD, with the majority spawning  
9 upstream of Balls Ferry, based on aerial redd survey data collected after passage  
10 was provided past the Anderson-Cottonwood Irrigation District (ACID) diversion.  
11 Aerial redd surveys have indicated that the winter-run Chinook Salmon spawning  
12 distribution has shifted upstream since gravel introductions began in the upper  
13 river near Keswick Dam; a high proportion of winter run Chinook spawn on the  
14 recently placed gravel (USFWS and Reclamation 2008). Spawning occurs May  
15 through July, with the peak in early June. Fry emergence occurs from mid-June  
16 through mid-October and fry disperse to areas downstream for rearing. Juvenile  
17 migration past RBDD may begin in late July, generally peaks in September, and  
18 can continue until mid-March in drier years (Vogel and Marine 1991). The  
19 majority (75 percent) of winter-run Chinook Salmon outmigrate past RBDD as  
20 fry (Martin et al. 2001), where they rear before outmigrating to the Delta  
21 primarily in December through April (Appendix 9B). Between 44 and 81 percent  
22 (mean 65 percent) of juvenile winter-run Chinook Salmon used areas downstream  
23 of RBDD for nursery habitat, and the relative usage of rearing habitat upstream  
24 and downstream of RBDD appeared to be influenced by river flow during fry  
25 emergence (Martin et al. 2001). Winter-run Chinook Salmon usually migrate past  
26 Knight's Landing once flows at Wilkins Slough rise to about 14,000 cfs; most  
27 juvenile winter-run Chinook Salmon outmigrate past Chipps Island by the end of  
28 March (del Rosario et al. 2013).

### 29 *Spring-run Chinook Salmon*

30 Historically, spring-run Chinook Salmon in the Sacramento River Basin were  
31 found in the upper and middle reaches (1,000 to 6,000 feet) of the American,  
32 Yuba, Feather, Sacramento, McCloud and Pit rivers, as well as smaller tributaries  
33 of the upper Sacramento River downstream of present-day Shasta Dam  
34 (NMFS 2009a). Estimates indicate that 82 percent of the approximately  
35 2,000 miles of salmon spawning and rearing habitat available in the mid-1800s is  
36 unavailable or inaccessible today (Yoshiyama et al. 1996). Naturally spawning  
37 populations of spring-run Chinook Salmon currently are restricted to accessible  
38 reaches of the upper Sacramento River, Antelope Creek, Battle Creek, Beegum  
39 Creek, Big Chico Creek, Butte Creek, Clear Creek, Deer Creek, Feather River,  
40 Mill Creek, and Yuba River (DFG 1998b). Most of these reaches are outside the  
41 project area; however, all spring-run Chinook Salmon migratory life stages must  
42 pass through the project area.

43 Spring-run Chinook Salmon abundance in the Sacramento River mainstem has  
44 apparently declined sharply through time, with escapement estimates ranging  
45 from approximately 5,000 to 23,000 fish in the 1980s, 100 to 4,100 fish in the

1 1990s, and 0 to 621 fish between 2000 and 2014 (CDFW 2015). However, the  
2 criteria for run classification at RBDD have changed so no conclusions can be  
3 reached about changes in the number of spring-run Chinook Salmon in the  
4 Sacramento River. Chinook Salmon expressing spring-run timing do spawn in  
5 the mainstem Sacramento River between RBDD and Keswick Dam (NMFS  
6 2009a). The Sacramento River now serves primarily as a migratory corridor for  
7 the adult and juvenile life stages of spring-run (and other runs) of Chinook  
8 Salmon.

9 In fresh water, juvenile spring-run Chinook Salmon rear in natal tributaries, the  
10 Sacramento River mainstem, and nonnatal tributaries to the Sacramento River  
11 (DFG 1998b). Outmigration timing is highly variable, as they may migrate  
12 downstream as YOY or as juveniles or yearlings. The outmigration period for  
13 spring-run Chinook Salmon extends from November to early May, with up to  
14 69 percent of the YOY fish outmigrating through the lower Sacramento River and  
15 Delta during this period (DFG 1998b). Peak movement of juvenile spring-run  
16 Chinook Salmon in the Sacramento River at Knights Landing occurs in December  
17 and again in March (Snider and Titus 1998, 2000b, c, d; Vincik et al. 2006;  
18 Roberts 2007). Migratory cues, such as increased flows, increasing turbidity from  
19 runoff, changes in day length, or intraspecific competition from other fish in their  
20 natal streams, may spur outmigration of juveniles from the upper Sacramento  
21 River basin when they have reached the appropriate stage of maturation (NMFS  
22 2009a). Spring-run juveniles that remain in the Sacramento River over summer  
23 are confined to approximately 100 miles of the upper mainstem, where cool water  
24 temperatures are maintained by dam releases.

#### 25 *Fall-/Late Fall-run Chinook Salmon*

26 The fall-run Chinook Salmon is an ocean-maturing type of salmon adapted for  
27 spawning in lowland reaches of big rivers, including the mainstem Sacramento  
28 River; the late fall-run Chinook Salmon is mostly a stream-maturing type  
29 (Moyle 2002). Similar to spring-run, adult late fall-run Chinook Salmon typically  
30 hold in the river for 1 to 3 months before spawning, while fall-run Chinook  
31 Salmon generally spawn shortly after entering fresh water. Fall-run Chinook  
32 Salmon migrate upstream past RBDD on the Sacramento River between July and  
33 December, typically spawning in upstream reaches from October through March.  
34 Late fall-run Chinook Salmon migrate upstream past RBDD from August to  
35 March and spawn from January to April (NMFS 2009a, TCCA 2008). The  
36 majority of young fall-run Chinook Salmon migrate to the ocean during the first  
37 few months following emergence, although some may remain in fresh water and  
38 migrate as yearlings. Late fall-run juveniles typically enter the ocean after 7 to  
39 13 months of rearing in fresh water, at 150- to 170 mm in fork length,  
40 considerably larger and older than fall-run Chinook Salmon (Moyle 2002).

41 The primary spawning area used by fall- and late fall-run Chinook Salmon in the  
42 Sacramento River is the area from Keswick Dam downstream to RBDD.  
43 Spawning densities for each of the runs are generally highest in this reach.

1 Annual fall-run and late fall-run Chinook Salmon escapement to the Sacramento  
2 River and its tributaries has generally been declining in the last decade, following  
3 peaks in the late 1990s to early 2000s (Azat 2012).

#### 4 *Steelhead*

5 Although steelhead can be divided into two life history types, summer-run  
6 steelhead and winter-run steelhead, based on their state of sexual maturity at the  
7 time of river entry, only winter-run steelhead are currently found in Central  
8 Valley rivers and streams. Existing wild steelhead stocks in the Central Valley  
9 are mostly confined to the upper Sacramento River and its tributaries, including  
10 Antelope, Deer, and Mill creeks and the Yuba River. Populations may exist in  
11 other tributaries, and a few naturally spawning steelhead are produced in the  
12 American and Feather rivers (McEwan and Jackson 1996).

13 Adult steelhead migrate upstream past the Fremont Weir between August and  
14 March, primarily from August through October; they migrate upstream past  
15 RBDD during all months of the year, but primarily during September and October  
16 (NMFS 2009a). The primary spawning area used by steelhead in the Sacramento  
17 River is the area from Keswick Dam downstream to RBDD. Unlike salmon,  
18 steelhead may live to spawn more than once and generally rear in freshwater  
19 streams for 2 to 4 years before outmigrating to the ocean. Both spawning areas  
20 and migratory corridors are used by juvenile steelhead for rearing prior to  
21 outmigration. The Sacramento River functions primarily as a migration channel,  
22 although some rearing habitat remains in areas with setback levees (primarily  
23 upstream of Colusa) and flood bypasses (e.g., Yolo Bypass) (NMFS 2009a).

24 Recent steelhead monitoring data are scarce for the upper portion of the  
25 Sacramento River system. In 1989, Hallock (1989) reported that steelhead had  
26 declined drastically in the Sacramento River upstream of the Feather River  
27 confluence. In the 1950s, the average estimated spawning population size  
28 upstream of the Feather River confluence was 20,540 fish (McEwan and Jackson  
29 1996). In 1991–1992, the annual run size for the total Sacramento River system  
30 was likely fewer than 10,000 adult fish (McEwan and Jackson 1996). From 1967  
31 to 1993, the estimated number of steelhead passing the Red Bluff Pumping Plant  
32 ranged from a low of 470 to a high of 19,615 (CHSRG 2012). Steelhead  
33 escapement surveys at the site of RBDD ended in 1993.

#### 34 *Green Sturgeon*

35 The Sacramento River provides habitat for Green Sturgeon spawning, adult  
36 holding, foraging, and juvenile rearing. Suitable spawning temperatures and  
37 spawning substrate exist for Green Sturgeon in the Sacramento River upstream  
38 and downstream of RBDD (Reclamation 2008a). Although the upstream extent  
39 of historical Green Sturgeon spawning in the Sacramento River is unknown, the  
40 observed distribution of sturgeon eggs, larvae, and juveniles indicates that  
41 spawning occurs from Hamilton City to as far upstream as Ink's Creek confluence  
42 and possibly up to the Cow Creek confluence (Brown 2007, Poytress et al. 2013).  
43 Based on the distribution of sturgeon eggs, larvae, and juveniles in the  
44 Sacramento River, DFG (2002) indicated that Green Sturgeon spawn in late

1 spring and early summer. Peak spawning is believed to occur between April  
2 and June.

3 Spawning migrations and spawning by Green Sturgeon in the Sacramento River  
4 mainstem have been well documented over the last 15 years (Beamesderfer et al.  
5 2004). Anglers fishing for White Sturgeon or salmon commonly report catches of  
6 Green Sturgeon from the Sacramento River as far upstream as Hamilton City  
7 (Beamesderfer et al. 2004). Eggs, larvae, and post-larval Green Sturgeon are now  
8 commonly reported in sampling directed at Green Sturgeon and other species  
9 (Beamesderfer et al. 2004, Brown 2007). YOY Green Sturgeon have been  
10 observed annually since the late 1980s in fish sampling efforts at RBDD and the  
11 Glenn-Colusa Irrigation District (GCID) intake (Beamesderfer et al. 2004).  
12 Acoustically tagged Green Sturgeon were detected upstream of RBDD from 2004  
13 to 2006 (Heublein et al. 2009). Adult Green Sturgeon that migrate upstream in  
14 April, May, and June are completely blocked by the ACID diversion dam  
15 (NMFS 2009b), rendering approximately 3 miles of spawning habitat upstream of  
16 the diversion dam inaccessible.

17 Green Sturgeon from the Sacramento River are genetically distinct from their  
18 northern counterparts, indicating a spawning fidelity to their natal rivers (Israel  
19 et al. 2004), even though individuals can range widely (Lindley et al. 2008).  
20 Larval Green Sturgeon have been regularly captured during their dispersal stage  
21 at about 2 weeks of age (24 to 34 mm fork length) in rotary screw traps at RBDD  
22 (DFG 2002a) and at about 3 weeks old when captured at the GCID intake (Van  
23 Eenennaam et al. 2001).

24 Young Green Sturgeon appear to rear for the first 1 to 2 months in the Sacramento  
25 River between Keswick Dam and Hamilton City (DFG 2002a). Rearing habitat  
26 condition and function may be affected by variation in annual and seasonal river  
27 flow and temperature characteristics.

28 Empirical estimates of Green Sturgeon abundance are not available for the  
29 Sacramento River population or any west coast population (Reclamation 2008a),  
30 and the current population status is unknown (Beamesderfer et al. 2007,  
31 Adams et al. 2007). A genetic analysis of Green Sturgeon larvae captured in the  
32 Sacramento River resulted in an estimate of the number of adult spawning pairs  
33 upstream of RBDD ranging from 32 to 124 between 2002 and 2006 (Israel 2006).  
34 NMFS (2009b) noted that, similar to winter-run Chinook Salmon, the restriction  
35 of spawning habitat for Green Sturgeon to only one reach of the Sacramento  
36 River increases the vulnerability of this spawning population to catastrophic  
37 events. This was one of the primary reasons that the Southern DPS of Green  
38 Sturgeon was federally listed as a threatened species in 2006.

### 39 *White Sturgeon*

40 In California, White Sturgeon are most abundant within the Delta region, but the  
41 population spawns mainly in the Sacramento River; a small part of the population  
42 is also thought to spawn in the Feather River (Moyle 2002). In addition to  
43 spawning, White Sturgeon embryo development and larval rearing occur in the  
44 Sacramento River (Moyle 2002, Israel et al. 2008). White Sturgeon are found in

1 the Sacramento River primarily downstream of RBDD (TCCA 2008), with most  
2 spawning between Knights Landing and Colusa (Schaffter 1997).

3 The population status of White Sturgeon in the Sacramento River is unclear.  
4 Overall, limited information on trends in adult and juvenile abundance in the  
5 Delta population suggests that numbers are declining (Reis-Santos et al. 2008).  
6 Spawning stage adults generally move into the lower reaches of the Sacramento  
7 River during winter prior to spawning, then migrate upstream in response to  
8 higher flows to spawn from February to early June (Schaffter 1997, McCabe and  
9 Tracy 1994). Most spawning in the Sacramento River occurs in April and May  
10 (Kohlhorst 1976). YOY White Sturgeon make an active downstream migration  
11 that disperses them widely to rearing habitat throughout the lower Sacramento  
12 River and Delta (McCabe and Tracy 1994, Israel et al. 2008).

### 13 *Sacramento Splittail*

14 Historically, Sacramento Splittail were widespread in the Sacramento River from  
15 Redding to the Delta (Rutter 1908 as cited in Moyle et al. 2004). This distribution  
16 has become somewhat reduced in recent years (Sommer et al. 1997, 2007b).  
17 During drier years there is evidence that spawning occurs farther upstream  
18 (Feyrer et al. 2005). Adult splittail migrate upstream in the lower Sacramento  
19 River to above near the mouth of the Feather River and into the Sutter and Yolo  
20 bypasses (Sommer et al. 1997, Feyrer et al. 2005, Sommer et al. 2007b). Each  
21 year, mainly during the spring spawning season, a small number of individuals  
22 have been documented at the Red Bluff Pumping Plant and the entrance to the  
23 GCID intake (Moyle et al. 2004).

24 Nonreproductive adult splittail are most abundant in moderately shallow, brackish  
25 areas, but can also be found in freshwater areas with tidal or riverine flow  
26 (Moyle et al. 2004). Adults typically migrate upstream from brackish areas in  
27 January and February and spawn in fresh water on inundated floodplains in March  
28 and April (Moyle et al. 2004, Sommer et al. 2007b). In the Sacramento drainage,  
29 the most important spawning areas appear to be the Yolo and Sutter bypasses;  
30 however, some spawning occurs almost every year along the river edges and  
31 backwaters created by small increases in flow. Splittail spawn in the Sacramento  
32 River from Colusa to Knights Landing in most years (Feyrer et al. 2005).

33 Most juvenile splittail move from upstream areas downstream into the Delta from  
34 April through August (Meng and Moyle 1995, Sommer et al. 2007b). The  
35 production of YOY Sacramento Splittail is largely influenced by extent and  
36 period of inundation of floodplain spawning habitats, with abundance spiking  
37 following wet years and declining after dry years (Sommer et al. 1997, Moyle  
38 et al. 2004, Feyrer et al. 2006). Other factors that may affect the Sacramento  
39 Splittail adult population include flood control operations and infrastructure,  
40 entrainment by irrigation diversion, recreational fishing, changed estuarine  
41 hydraulics, pollutants, and nonnative species (Moyle et al. 2004,  
42 Sommer et al. 2007b).



1 *Pacific Lamprey*

2 Pacific Lampreys are anadromous, rearing in fresh water before outmigrating to  
3 the ocean, where they grow to full size prior to returning to their natal streams to  
4 spawn. Data from mid-water trawls in Suisun Bay and the lower Sacramento  
5 River indicate that adults likely migrate into the Sacramento River and tributaries  
6 from late fall (November) through early-summer (June) (Hanni et al. 2006).  
7 Adult Pacific Lampreys, either immature or spawning stage, have been detected at  
8 the GCID diversion from December through July and nearly all year at RBDD  
9 (Hanni et al. 2006). Hannon and Deason (2008) documented Pacific Lampreys  
10 spawning in the American River between early January and late May, with peak  
11 spawning typically in early April. Spawning in the Sacramento River is expected  
12 to occur during a similar timeframe. Pacific Lamprey ammocoetes rear in parts of  
13 the Sacramento River for all or part of their 5- to 7-year freshwater residence.  
14 Data from rotary screw trapping at sites on the mainstem Sacramento River  
15 indicate that outmigration of Pacific Lamprey peaks from early winter through  
16 early summer, but some outmigration is observed year-round at both RBDD and  
17 the GCID diversion dam (Hanni et al. 2006).

18 *Striped Bass*

19 Striped Bass are anadromous; adult Striped Bass are distributed mainly in the  
20 lower bays and ocean during summer, and in the Delta during fall and winter.  
21 Spawning takes place in spring from April to mid-June (Leet et al. 2001) at which  
22 time Striped Bass swim upstream to spawning grounds. Striped Bass are not  
23 believed to spawn or rear in the Sacramento River upstream of RBDD  
24 (TCCA 2008). Most Striped Bass spawning occurs in the lower Sacramento  
25 River between Colusa and the confluence of the Sacramento and Feather rivers  
26 (Moyle 2002). About one-half to two-thirds of the eggs are spawned in the  
27 Sacramento River and the remainder in the Delta (Leet et al. 2001). After  
28 spawning, most adult Striped Bass move downstream into brackish and salt water  
29 for summer and fall.

30 Eggs are free-floating and negatively buoyant, hatching as they drift downstream  
31 with larvae occurring in shallow and open waters of the lower reaches of the  
32 Sacramento and San Joaquin rivers, the Delta, Suisun Bay, Montezuma Slough,  
33 and Carquinez Strait. The Sacramento River functions primarily as a migration  
34 corridor for both adults and drifting eggs/larvae.

35 **9.3.4.4.2 Aquatic Habitat**

36 The mainstem Sacramento River provides habitat for native and introduced  
37 (nonnative) fish and other aquatic species. The diversity of aquatic habitats  
38 ranges from fast-water riffles and glides in the upper reaches to tidally influenced  
39 slow-water pools and glides in the lower reaches (Vogel 2011).

40 A few miles downstream of Keswick Dam, near Redding, the river enters the  
41 valley and the floodplain broadens. Historically, this area likely had wide  
42 expanses of riparian forests, but much of the river's riparian zone is subject to  
43 urban encroachment, particularly in the Anderson/Redding area. In the middle  
44 Sacramento River between Red Bluff and Chico Landing, the mainstem channel

1 is flanked by broad floodplains (TNC 2007a). In the lower reaches downstream  
 2 of Verona, much of the Sacramento River is constrained by levees. Dredging,  
 3 dams, levee construction, urban encroachment, and other human activities in the  
 4 Sacramento River have modified aquatic habitat, altered sediment dynamics,  
 5 simplified stream bank and riparian habitat, reduced floodplain connectivity, and  
 6 modified hydrology (NMFS 2009a). However, some complex floodplain habitats  
 7 remain in the system such as reaches with setback levees and the Yolo and  
 8 Sutter bypasses.

#### 9 *Holding Habitat*

10 An abundance of deep, cold-water pools in the mainstem Sacramento River  
 11 provide habitat for holding adult anadromous salmonids during all months of the  
 12 year (Vogel 2011). Green Sturgeon also use deep pools for holding but can  
 13 tolerate warmer water temperatures than salmon and, therefore, can hold farther  
 14 downstream. Large numbers of adult Green Sturgeon have been observed holding  
 15 during summer in deep pools in the Sacramento River near Hamilton City  
 16 (Vogel 2011).

#### 17 *Spawning Habitat*

18 Spawning habitat on the Sacramento River is affected by lack of sediment and  
 19 flow patterns as determined by the operations of the CVP and local water  
 20 diverters.

#### 21 *Sediment Conditions*

22 Shasta and Keswick dams substantially influence sediment transport in the upper  
 23 Sacramento River because they block sediment that would normally have been  
 24 transported downstream (TNC 2007a, DWR 1985). The result has been a net loss  
 25 of coarse sediment, including gravel particle sizes suitable for salmon spawning,  
 26 in the Sacramento River downstream of Keswick Dam (Reclamation 2013b).  
 27 To address the issue of spawning gravel loss downstream of Keswick Dam,  
 28 Reclamation has placed approximately 5,000 tons of washed spawning gravel into  
 29 the Sacramento River downstream of Keswick about every other year since 1997  
 30 (Reclamation 2010a).

#### 31 *Spawning Habitat Availability*

32 Winter-run Chinook Salmon spawning in the upper reaches of the Sacramento  
 33 River is affected by the operations of the seasonal ACID diversion dam, which  
 34 involves placement of flashboards in the river between April and May. Flows in  
 35 the river vary with the operation of the diversion dam and releases of water from  
 36 Shasta Lake into the river. When the dam is installed in the river, the WUA  
 37 upstream of the Cow Creek confluence is higher than when the dam is removed.  
 38 Farther downstream, there is less variability in WUA.

39 The WUA for winter-run Chinook Salmon spawning peaks at around 10,000 cfs  
 40 in the upstream reach upstream of the ACID intake when the dam flashboards are  
 41 in. With the boards out, the peak is around 5,500 cfs. In the next reach  
 42 downstream (ACID intake to Cow Creek), spawning WUA also peaked at around  
 43 10,000 cfs. In the lower reach (Cow Creek to Battle Creek), WUA spawning

1 habitat peaks at around 5,250 cfs, but there is low variability in spawning WUA  
2 from 3,250 to 8,000 cfs

3 Overall, spawning habitat WUA values differ for fall-run and late fall-run  
4 Chinook Salmon, but the flow versus habitat relationship is about the same for the  
5 two runs. Upstream of the ACID intake, spawning habitat WUA for fall- and late  
6 fall-run Chinook Salmon peaks at the lowest flow analyzed (3,250 cfs) with the  
7 dam flashboards out and at about 6,000 cfs with the flashboards in. Between the  
8 ACID intake and Cow Creek, spawning habitat WUA peaks at around 5,000 cfs  
9 for both runs. Between Cow Creek and Battle Creek, spawning habitat WUA for  
10 both runs peaks at about 3,500 cfs. The highest density of redds for fall- and late  
11 fall-run Chinook Salmon occur in the middle ACID intake to Cow Creek reach.

12 The spawning habitat WUA values for steelhead peaks at the lowest river flow  
13 analyzed (3,250 cfs) in the reach upstream of the ACID intake. This habitat  
14 relationship held regardless of whether the flashboards were in or out. In the  
15 reach between the ACID intake and Cow Creek, spawning habitat WUA peaks at  
16 river flows around 6,000 cfs. In the lower reach, from Cow Creek to Battle  
17 Creek, spawning habitat WUA also peaks at river flows of about 6,500 cfs, but do  
18 not vary substantially in a flow range between about 4,000 and 8,000 cfs.

19 USFWS (2005b) conducted limiting life-stage analyses for winter-, fall-, and  
20 late-fall-run Chinook Salmon in the Sacramento River upstream of the Battle  
21 Creek confluence and found that in most cases, juvenile habitat is limiting. In  
22 some cases (fall- and late fall-run in between the ACID intake and Cow Creek),  
23 spawning habitat may be limiting at higher flows.

24 USFWS (2005a) developed spawning flow-habitat relationships for fall-run  
25 Chinook Salmon spawning habitat in the Sacramento River between Battle Creek  
26 and Deer Creek. Between Battle Creek and RBDD, spawning habitat WUA  
27 values for fall-run Chinook Salmon peaked at approximately 3,750 cfs, but  
28 showed little variation over flows from 3,250 cfs (the lowest flow evaluated) and  
29 6,000 cfs, but declined substantially at higher flows. Between the Red Bluff  
30 Pumping Plant and Deer Creek, spawning habitat WUA values for fall-run  
31 Chinook salmon peaked at 5,500 cfs, with little variation at flows from 4,250 to  
32 8,000 cfs (USFWS 2005a).

### 33 *Rearing Habitat*

34 In the Sacramento River between Red Bluff and Chico Landing, the mainstem  
35 channel is flanked by broad floodplains. Ongoing sediment deposition in these  
36 areas provides evidence of continued inundation of floodplains in this reach  
37 (DWR 1994). Between Chico Landing and Colusa, the Sacramento River is  
38 bounded by levees that provide flood protection for cities and agricultural areas.  
39 However, the levees in this portion of the Sacramento River are, for the most part,  
40 set back from the mainstem channel such that flooding can be significant within  
41 the river corridor (TNC 2007b).

42 Fry rearing habitat WUA for winter-run Chinook Salmon fry rearing habitat peaks  
43 at around 5,500 cfs in the reach upstream of the ACID intake when the dam  
44 flashboards are in. With the boards out, the peak is around 6,500 cfs. In the next

1 reach downstream (ACID intake to Cow Creek), fry rearing habitat WUA for  
2 winter-run Chinook Salmon peaks at around 31,000 cfs (the highest flow  
3 evaluated). In the lower reach (Cow Creek to Battle Creek), fry rearing habitat  
4 WUA for winter-run Chinook Salmon also peaked at around 31,000 cfs, but there  
5 was little variation at flows.

6 The fry rearing habitat WUA values differ for fall-run and late fall-run Chinook  
7 Salmon, but the flow versus habitat relationship was similar for the two runs.  
8 Upstream of the ACID intake, fry rearing habitat WUA for fall- and late fall-run  
9 Chinook Salmon peaks at the lowest flow analyzed (3,250 cfs) with the dam  
10 flashboards in. With the flashboards out, fry rearing habitat WUA peaks at  
11 around 23,000 cfs for both species. Between the ACID intake and Cow Creek,  
12 fry rearing habitat WUA for fall- and late fall-run Chinook Salmon peaked at  
13 around 3,750 cfs for both runs, with little variation from 3,250 cfs to 6,000 cfs  
14 and only slightly lower WUA values at flows greater than 21,000 cfs. Between  
15 Cow Creek and Battle Creek, fry rearing habitat WUA for both runs peaks at  
16 3,250 cfs (the lowest flow evaluated), declining as flows increase.

17 Juvenile rearing habitat WUA for winter-run Chinook Salmon juvenile rearing  
18 habitat peaks at around 8,000 cfs in the upstream reach above the ACID intake  
19 when the dam flashboards are in. With the boards out, the peak is around  
20 9,000 cfs. However, there is little variation in juvenile winter-run Chinook  
21 Salmon rearing habitat WUA from around 5,500 to 11,000 cfs in this reach. In  
22 the next reach downstream between the ACID intake to Cow Creek, juvenile  
23 rearing habitat WUA for winter-run Chinook Salmon peaks at around 31,000 cfs  
24 (the highest flow evaluated). In the lower reach (Cow Creek to Battle Creek),  
25 juvenile rearing habitat WUA for winter-run Chinook Salmon peaks at around  
26 3,500 cfs but shows only moderate (<50 percent) reductions in WUA over the  
27 entire range of flows evaluated.

28 The juvenile rearing habitat WUA values differ for fall-run and late fall-run  
29 Chinook Salmon, but the flow versus habitat relationship is similar for the two  
30 runs. Upstream of the ACID intake, juvenile rearing habitat WUA for fall- and  
31 late fall-run Chinook Salmon peaked in the 5,000- to 6,000-cfs range with the  
32 dam flashboards in or out; there were only moderate (<50 percent) reductions in  
33 juvenile rearing WUA over the entire range of flows evaluated. Between the  
34 ACID intake and Cow Creek, fry rearing WUA peaked at around 3,250 cfs (the  
35 lowest flow evaluated) for both runs, declining to a minimum at around  
36 15,000 cfs and increasing to around 70 percent of the maximum at flows above  
37 21,000 cfs. Between Cow Creek and Battle Creek, fry rearing WUA for both runs  
38 peaked at 3,250 cfs (the lowest flow evaluated), declining as flow increased.

39 Vogel (2011) suggested that the mainstem Sacramento River may not provide  
40 adequate rearing areas for fry-stage anadromous salmonids, as evidenced by rapid  
41 displacement of fry from upstream to downstream areas and into nonnatal  
42 tributaries during increased flow events. Underwater observations of salmon fry  
43 in the mainstem Sacramento River suggest that optimal habitats for rearing may  
44 be limited at higher flows (Vogel 2011). USFWS (2005) conducted limiting  
45 life-stage analyses for winter-, fall-, and late-fall-run Chinook Salmon in the

1 Sacramento River above Battle Creek and found that in most cases, juvenile  
2 habitat is limiting. An important limitation of this analysis is that it did not take  
3 into account fry and juvenile rearing habitat below Battle Creek or in the Delta.  
4 The minimum required Sacramento River flow is 3,250 cfs. Flows during  
5 summer generally exceed this amount in order to meet temperature requirements  
6 for winter-run Chinook Salmon. The water temperature requirements established  
7 for winter-run Chinook Salmon result in water temperatures also suitable for  
8 year-round rearing of steelhead in the upper Sacramento River.

9 **9.3.4.4.3 Fish Passage and Entrainment**

10 Historically, anadromous salmonids had access to a minimum of approximately  
11 493 miles of habitat in the Sacramento River (Yoshiyama et al. 1996). After  
12 completion of Shasta Dam in 1945, access to approximately 207 miles was  
13 blocked. Keswick Dam, just downstream of Shasta Dam, is now the upstream  
14 extent of available habitat for anadromous fish in the Sacramento River.

15 Until recently, three large-scale, upper Sacramento River diversions, including the  
16 ACID and GCID intakes and RBDD, were of particular concern as potential  
17 passage or entrainment problems for Chinook Salmon, steelhead, and other  
18 migratory fish species (NRC 2012, NMFS 2009a, McEwan and Jackson 1996).  
19 Recently, RBDD was eliminated, the GCID fish screens were installed, and fish  
20 passage at the ACID intake was improved (NRC 2012). At the ACID intake, new  
21 fish ladders and fish screens were installed around the diversion and were  
22 operated starting in the summer 2001 diversion period. However, adult Green  
23 Sturgeon that migrate upstream in April, May, and June are completely blocked  
24 by the ACID intake (NMFS 2009a), rendering approximately 3 miles of spawning  
25 habitat upstream of the diversion dam inaccessible. Adult Green Sturgeon that  
26 pass upstream of the intake before April are delayed for 6 months until the  
27 flashboards are pulled before returning downstream to the ocean. Newly emerged  
28 Green Sturgeon larvae that hatch upstream of the ACID intake would need to hold  
29 for 6 months upstream of the dam or pass over it and be subjected to higher  
30 velocities and turbulent flow below the intake (NMFS 2009a).

31 Numerous other diversions are located on the Sacramento River. Herren and  
32 Kawasaki (2001) documented up to 431 diversions from the Sacramento River  
33 between Shasta Dam and the City of Sacramento. Hanson (2001) studied juvenile  
34 Chinook Salmon entrainment at unscreened diversions at the Princeton Pumping  
35 Plant and documented the entrainment of approximately 0.05 percent of juvenile  
36 Chinook Salmon passing the diversion. Similar to the results of Hanson (2001),  
37 Vogel (2013) found that entrainment of juvenile salmon in 12 unscreened  
38 diversions was low relative to other fish species. The study did not discern  
39 measurable effects of factors such as size of the diversion, longitudinal location in  
40 the river, water temperatures, localized habitat conditions, intake position in the  
41 river channel, and depth of the intakes on salmonid entrainment. It appeared that  
42 juvenile salmon were entrained in a much lower proportion than the proportion of  
43 flow diverted (Vogel 2013), similar to results noted by Hanson (2001). Mussen  
44 et al. (2014) examined the risk to Green Sturgeon from unscreened water

1 diversions and found that juvenile Green Sturgeon entrainment susceptibility (in a  
2 laboratory setting) was high relative to that estimated for Chinook Salmon,  
3 suggesting that unscreened diversions could be a contributing mortality source for  
4 threatened Southern DPS Green Sturgeon.

5 Reclamation is currently coordinating with USFWS to support improvements at  
6 other fish screens. In 2013, CVPIA funds were used to construct the Natomas  
7 Mutual Sankey Fish Screen on the Sacramento River that replaced two existing  
8 diversions on the Natomas Cross Canal. This project also resulted in the removal  
9 of an anadromous fish migration barrier (seasonal diversion dam) on the Natomas  
10 Cross Canal. The fish screening program also completed construction of four fish  
11 screens on the Sacramento River and one fish screen in the Delta.

12 Potential barriers to migration for adult Green Sturgeon into the upper reaches of  
13 the Sacramento River include structures such as the ACID intake, Sacramento  
14 River Deep Water Ship Channel locks, Fremont Weir, Sutter Bypass, and DCC  
15 gates on the Sacramento River (70 FR 17386). A set of locks at the end of the  
16 Sacramento River Deep Water Ship Channel at the connection with the  
17 Sacramento River “blocks the migration of all fish from the deep-water ship  
18 channel back to the Sacramento River” (DWR 2005).

#### 19 **9.3.4.4.4 Hatcheries**

20 The Livingston Stone NFH, located at the foot of Shasta Dam, is a conservation  
21 hatchery that has been producing and releasing juvenile winter-run Chinook  
22 Salmon since 1998. There is growing concern about the potential genetic effects  
23 that may result from the use of a conventional hatchery program to supplement  
24 winter-run Chinook Salmon populations. To maintain a low risk of compromised  
25 genetic fitness, Lindley et al. (2007) recommend that no more than 5 percent of  
26 the naturally spawning population should be composed of hatchery fish. Since  
27 2001, more than 5 percent of the winter-run Chinook Salmon run has been  
28 composed of hatchery-origin fish, and in 2005 the contribution of hatchery fish  
29 was more than 18 percent (Lindley et al. 2007).

30 The Livingston Stone NFH minimizes hatchery affects in the population by  
31 preferentially collecting wild adult winter-run Chinook Salmon for brood stock  
32 (USFWS 2011b). Up to 15 percent of the estimated run size for winter-run  
33 Chinook Salmon run may be collected for brood stock use (up to a maximum of  
34 120 natural-origin winter-run Chinook Salmon per brood year). Although  
35 there is no adult production goal, Livingston Stone NFH releases up to  
36 250,000 winter-run Chinook Salmon a year in late January or early February.  
37 Winter-run Chinook Salmon are released at the pre-smolt stage and are intended  
38 to rear in the freshwater environment prior to smoltification. The pre-smolts are  
39 released into the Sacramento River at Caldwell Park in Redding, about 10 miles  
40 downstream of the hatchery. All juvenile winter-run Chinook Salmon produced  
41 at Livingston Stone NFH are adipose fin-clipped and coded wire-tagged  
42 (CHSRG 2012).

1 The Delta Smelt propagation program at the Livingston Stone NFH is operated as  
2 a captive broodstock program. Delta Smelt propagation at Livingston Stone NFH  
3 functions as a backup refugial population. No Delta Smelt from the Livingston  
4 Stone NFH are currently released (USFWS 2011b).

#### 5 **9.3.4.4.5 Predation**

6 On the mainstem Sacramento River, high rates of predation have been known to  
7 occur at the diversion facilities and areas where rock revetment has replaced  
8 natural river bank vegetation (NMFS 2009a). Chinook Salmon fry, juveniles, and  
9 smolts are more susceptible to predation at these locations because Sacramento  
10 Pikeminnow and Striped Bass congregate in areas that provide predator refuge  
11 (Williams 2006, Tucker et al. 2003).

#### 12 **9.3.4.5 Battle Creek**

13 Battle Creek is a tributary that enters the Sacramento River about 20 miles  
14 southeast of Redding. The cold, spring-fed waters of Battle Creek historically  
15 supported large runs of Chinook Salmon and steelhead. Diversion dams  
16 constructed in the early 1900s for hydroelectric power production reduced  
17 instream flow and blocked anadromous salmonids from accessing habitat in large  
18 portions of the north and south forks of Battle Creek.

19 Coleman NFH, located on Battle Creek, was established in 1942 by Reclamation  
20 to partially mitigate habitat and fish losses from historical spawning areas caused  
21 by construction of two CVP features, Shasta and Keswick dams. The hatchery is  
22 funded by Reclamation and operated by USFWS. The steelhead program at the  
23 hatchery was initiated in 1947 to mitigate losses resulting from the CVP  
24 (USFWS 2012). The weir at the hatchery is a barrier to anadromous fish passage,  
25 as are various Pacific Gas & Electric Company (PG&E) dams (e.g., Wildcat)  
26 located on Battle Creek (Yoshiyama et al. 1996). Yoshiyama et al. (1996)  
27 reported that the Coleman South Fork Diversion Dam is the first impassible  
28 barrier on Battle Creek.

29 Beginning in 1995, planning was initiated to restore naturally spawning  
30 anadromous fish populations in Battle Creek, and construction began in 2010 on  
31 the Battle Creek Salmon and Steelhead Restoration Project (Reclamation 2014a).  
32 When complete, the Battle Creek restoration project will restore ecological  
33 processes along 42 miles of Battle Creek and 6 miles of tributaries while  
34 minimizing reductions to hydroelectric power generation, although five dams are  
35 decommissioned (Wildcat, Coleman, South, Lower Ripley, and Soap Creek  
36 feeder diversion dams). New fish screens and fish ladders that meet NMFS and  
37 CDFW criteria will be constructed at three diversion dams (North Battle Creek  
38 Feeder, Eagle Canyon, and Inskip Diversion Dams). Connectors are proposed  
39 that prevent the discharge of North Fork Battle Creek water to South Fork Battle  
40 Creek and the mixing of flow sources. Higher minimum flow requirements will  
41 increase instream flows, subsequently cooling water temperatures, increasing  
42 stream area, and providing reliable passage conditions for adult salmonids in  
43 downstream reaches. The project will result in 42 miles of newly accessible  
44 anadromous fish habitat and improved water quality for the Coleman NFH.

#### 1 **9.3.4.6 Lake Oroville and Thermalito Complex**

2 Lake Oroville on the Feather River is formed by Oroville Dam, approximately  
3 70 miles upstream from its confluence with the Sacramento River. Lake Oroville  
4 is fed by the north, middle, and south forks of the Feather River. A portion of the  
5 water released from Lake Oroville flows into the Thermalito Complex, as  
6 described in Chapter 5, Surface Water Resources and Water Supplies.

##### 7 **9.3.4.6.1 Fish in Lake Oroville**

8 Lake Oroville thermally stratifies in spring, destratifies in fall, and remains  
9 destratified throughout winter. FERC (2007b) reports indicate that surface water  
10 temperatures of the epilimnion begin to warm in the early spring, reach maximum  
11 temperatures (approximately mid-80°F) during late July, and gradually decline to  
12 winter minimums. The transition zone (i.e., metalimnion) between the upper  
13 warmer and lower colder waters typically ranges from about 30 to 50 feet below  
14 the lake surface during midsummer. The deeper water of the hypolimnion can  
15 reach a temperature of about 44°F near the reservoir bottom during periods of  
16 stratification (FERC 2007b). Cold-water fish species include Coho Salmon,  
17 Rainbow Trout, Brown Trout, and Lake Trout. The Lake Oroville cold-water  
18 fishery is not self-sustaining, possibly because of insufficient spawning and  
19 rearing habitat in the reservoir and accessible tributaries; cold-water spawning is  
20 not known to occur in Lake Oroville. The Coho Salmon fishery is sustained by a  
21 “put-and-grow” hatchery stocking program (FERC 2007b). The Lake Oroville  
22 warm-water fishery is a regionally important self-sustaining recreational fishery  
23 and is the site of several annual bass fishing tournaments. Spotted Bass are the  
24 most abundant bass species in Lake Oroville, followed by Largemouth Bass,  
25 Redeye Bass, and Smallmouth Bass, respectively. Other important warm-water  
26 species include catfish, crappie, and sunfish. Common carp are also abundant in  
27 Lake Oroville.

##### 28 **9.3.4.6.2 Fish in Thermalito Forebay and Afterbay**

29 Ambient meteorological conditions and the temperature of the water released  
30 from Lake Oroville generally affect water temperatures in the Thermalito  
31 Diversion Pool and Thermalito Forebay (FERC 2007b). Thermalito Forebay is an  
32 open, cold, shallow reservoir that remains cold throughout the year because it is  
33 supplied with water from Thermalito Diversion Pool, although pump-back  
34 operations from Thermalito Afterbay can increase water temperatures in the  
35 forebay. Thermalito Forebay provides habitat primarily for cold-water fish  
36 species, although the same warm-water fish species found in Lake Oroville are  
37 believed to exist in the forebay in low numbers (FERC 2007b). Additionally,  
38 CDFW manages a “put-and-take” trout fishery in Thermalito Forebay.

39 Thermalito Afterbay provides habitat for cold-water and warm-water fish species  
40 including Largemouth Bass, Smallmouth Bass, Rainbow Trout, Brown Trout,  
41 Bluegill, Redear Sunfish, Black Crappie, Channel Catfish, carp, and large schools  
42 of Wakasagi (FERC 2007b). A popular Largemouth Bass fishery currently exists,  
43 large trout are sometimes caught near the inlet, and an experimental steelhead  
44 fishery occurs in the Afterbay. Only limited salmonid stocking occurs at the



1 afterbay, so these fish most likely passed through the Thermalito Pumping-  
2 Generating Plant from the forebay.

3 **9.3.4.7 Feather River from Lake Oroville and the Thermalito Complex to**  
4 **the Sacramento River**

5 The Feather River is a major tributary to the Sacramento River, providing  
6 approximately 25 percent of the flow in the Sacramento River (FERC 2007b).  
7 The lower Feather River extends downstream from the Fish Barrier Dam to the  
8 confluence with the Sacramento River near Verona. The Fish Barrier Dam is  
9 located downstream of the Thermalito Diversion Dam and immediately upstream  
10 of the Feather River Fish Hatchery (FERC 2007b).

11 **9.3.4.7.1 Fish in the Feather River**

12 The Feather River below Oroville supports a variety of anadromous and resident  
13 fish species. The distribution of anadromous fish in the Feather River is limited  
14 to approximately 67 miles of river downstream from the Fish Barrier Dam. At  
15 least 44 species of fish have been reported to historically or currently occur in the  
16 lower Feather River system, including numerous resident native and introduced  
17 species and several anadromous species (FERC 2007b).

18 The analysis is focused on the following species:

- 19 • Chinook Salmon (winter-, spring-, and fall/late fall-run)
- 20 • Steelhead
- 21 • Green Sturgeon
- 22 • White Sturgeon
- 23 • Sacramento Splittail
- 24 • Pacific Lamprey
- 25 • Striped Bass
- 26 • American Shad

27 *Spring-run Chinook Salmon*

28 Approximately two-thirds of the natural spring-run and fall-run Chinook Salmon  
29 spawning occur in the low-flow channel of the lower Feather River, downstream  
30 of the Fish Barrier Dam, and one-third of the spawning occurs in the high-flow  
31 channel downstream of the Thermalito Afterbay Outlet (FERC 2007b). NMFS  
32 (2009a) indicated that significant redd superimposition occurs in the lower  
33 Feather River because of oversaturation of the natural carrying capacity of the  
34 available spawning habitat (e.g., Sommer et al. 2001b) with an overproduction of  
35 hatchery spring-run Chinook Salmon and a lack of physical separation between  
36 spring-run and fall-run Chinook Salmon adults.

37 Adult spring-run Chinook Salmon typically enter fresh water in spring, hold over  
38 summer, and spawn in fall. Juveniles typically spend a year or more in fresh  
39 water before outmigrating. Adult spring-run Chinook Salmon begin their  
40 upstream migration from the ocean in late January and early February  
41 (DFG 1998b) and migrate from the Sacramento River into spawning tributaries  
42 primarily between mid-April and mid-June (Lindley et al. 2004). Adult Chinook

1 Salmon exhibiting the typical life history of the spring-run have been found  
2 holding at the Thermalito Afterbay Outlet and the Fish Barrier Dam as early as  
3 April (FERC 2007b). Spring-run Chinook Salmon spawning occurs during  
4 September and October, depending on water temperatures (NMFS 2012a).  
5 Spring-run Chinook Salmon fry emerge from the gravel from November to March  
6 (Moyle 2002). Most juvenile spring-run Chinook Salmon outmigrate from the  
7 lower Feather River within a few days of emergence, and 95 percent of the  
8 juvenile Chinook have typically outmigrated from the Oroville facilities project  
9 area by the end of May (FERC 2007b).

10 An independent population of spring-run Chinook Salmon historically occurred in  
11 the lower Feather River downstream of Oroville Dam, and a naturally spawning  
12 population of spring-run Chinook Salmon may persist in this reach (Lindley et al.  
13 2004). The number of naturally spawning spring-run Chinook Salmon in the  
14 Feather River has been estimated only periodically since the 1960s, with estimates  
15 ranging from 2 fish in 1978 to 2,908 in 1964. However, the genetic integrity of  
16 this population is questionable because of the significant temporal and spatial  
17 overlap between spawning populations of spring-run Chinook Salmon and  
18 fall-run Chinook Salmon (Good et al. 2005).

19 Substantial numbers of spring-run Chinook Salmon, as identified by run timing,  
20 return to the Feather River Fish Hatchery. From 1986 to 2011, the median  
21 number of spring-run Chinook Salmon returning to the Feather River Fish  
22 Hatchery was 3,655, compared to a median of 7,869 spring-run Chinook Salmon  
23 returning to the entire Sacramento River Basin (NMFS 2012a). Abundance  
24 estimates of lower Feather River spring-run Chinook Salmon may be distorted by  
25 naturally occurring genetic introgression with fall-run Chinook Salmon, Feather  
26 River Fish Hatchery practices, and Federal and state escapement estimation  
27 methodology. Coded wire tags obtained from Feather River Fish Hatchery  
28 returns indicate substantial introgression has occurred between spring-run  
29 Chinook Salmon and fall-run Chinook Salmon populations within the lower  
30 Feather River (NMFS 2009a).

### 31 *Fall-run Chinook Salmon*

32 Fall-run Chinook Salmon generally begin upstream migration into the lower  
33 Feather River during summer months (FERC 2007b). Although timing of fall-run  
34 Chinook Salmon spawning may be influenced by water temperature conditions  
35 (FERC 2007b), spawning activity in the lower Feather River occurs from late  
36 August through December and generally peaks during mid- to late November  
37 (Myers et al. 1998). Concurrent spawning with spring-run Chinook Salmon,  
38 which generally occurs from September to October, has led to hybridization  
39 between the spring- and fall-run Chinook Salmon in the lower Feather River  
40 (NMFS 2012a).

41 In the lower Feather River, fall-run Chinook Salmon embryo incubation and  
42 alevin (yolk-sac fry) emergence generally occurs from mid-October through  
43 March, depending on water temperature conditions (FERC 2007b). Fall-run  
44 Chinook Salmon fry emergence generally occurs in the lower Feather River  
45 downstream of the Fish Barrier Dam from late December through March, and

1 most juvenile fall-run Chinook Salmon outmigrate from the lower Feather River  
2 within a few days of emergence (FERC 2007b).

3 *Steelhead*

4 Steelhead immigrate into the Feather River from July to March (McEwan 2001).  
5 Currently, most of the natural steelhead spawning in the lower Feather River  
6 occurs in the low-flow channel downstream of the Fish Barrier Dam; however,  
7 limited spawning also occurs downstream of the Thermalito Afterbay Outlet  
8 (FERC 2007b). Results of a 13-week redd survey conducted between January 6  
9 and April 3, 2003, indicated that redd construction generally occurs in the lower  
10 Feather River between late December and March, peaking in late January  
11 (FERC 2007b). The FERC (2007b) study suggests that nearly half (48 percent) of  
12 all redds were constructed in the uppermost mile of the low-flow channel  
13 downstream of the Fish Barrier Dam. Redd density in this 1-mile section of the  
14 low-flow channel was approximately 36 redds per mile, more than 10 times more  
15 than any other section of the lower Feather River (FERC 2007b).

16 A moderate percentage of the steelhead fry appear to outmigrate from the lower  
17 Feather River soon after emerging from the gravel. Juvenile steelhead that do not  
18 outmigrate may rear in the river for up to 1 year. Juvenile steelhead in the Feather  
19 River outmigrate from about February through September, with peak  
20 outmigration occurring from March through mid-April. In-river juvenile rearing  
21 is generally associated with secondary channels in the low-flow channel  
22 (e.g., Hatchery Ditch) (FERC 2007b).

23 *Pacific Lamprey*

24 The Pacific Lamprey inhabits accessible reaches of the lower Feather River  
25 (DWR 2003a). Information on Pacific Lamprey status in the lower Feather River  
26 is limited, but the loss of access to historical habitat and apparent population  
27 declines throughout California and the Sacramento and San Joaquin River basins  
28 indicate populations are greatly decreased compared with historical levels  
29 (Moyle et al. 2009). Little information is available on factors limiting Pacific  
30 Lamprey populations in the lower Feather River, but they are likely affected by  
31 many of the same factors as salmon and steelhead because of parallels in their  
32 life cycles.

33 Ocean-stage adults likely migrate into the lower Feather River in spring and early  
34 summer, where they hold for approximately 1 year before spawning (Hanni et al.  
35 2006). Hannon and Deason (2008) have documented Pacific Lamprey spawning  
36 in the nearby American River from between early January and late May, with  
37 peak spawning typically occurring in early April. Pacific Lamprey ammocoetes  
38 rear in the lower Feather River for all or part of their 5- to 7-year freshwater  
39 residence. Data from rotary screw trapping suggest that outmigration of Pacific  
40 Lamprey generally occurs from early winter through early summer (Hanni et al.  
41 2006), although some outmigration likely occurs year-round as observed in the  
42 mainstem Sacramento River (Hanni et al. 2006) and in other river systems  
43 (Moyle 2002).

1 *Sacramento Splittail*

2 Sacramento Splittail enter the lower Feather River, primarily in wet years, with  
3 most individuals collected in the high-flow channel downstream of Thermalito  
4 Afterbay Outlet (DWR 2004a). On the lower Feather River, February through  
5 May was assumed to encompass the period of splittail spawning, egg incubation,  
6 and initial rearing (Sommer et al. 2008, DWR 2004a). Splittail use shallow  
7 flooded vegetation for spawning and are infrequently observed in the Feather  
8 River from the confluence with the Sacramento River up to Honcut Creek. The  
9 majority of spawning activity in the Feather River is thought to occur downstream  
10 of the Yuba River confluence (FERC 2007b). The primary factor that likely  
11 limits the lower Feather River splittail population is availability of spawning and  
12 rearing habitats as related to inundation of floodplains (Moyle et al. 2004,  
13 DWR 2004a).

14 *Green Sturgeon*

15 Historically, Green Sturgeon likely spawned in the Sacramento, Feather, and San  
16 Joaquin rivers (Adams et al. 2007). A substantial amount of habitat in the Feather  
17 River was lost with the construction of Oroville Dam. Although the presence of  
18 Green Sturgeon in the Sacramento River has been supported by direct angler  
19 observations and rotary screw trapping of eggs, larvae, and YOY Green Sturgeon,  
20 only intermittent observations of Green Sturgeon have been reported in the lower  
21 Feather River (Beamesderfer et al. 2007). The occasional capture of larval Green  
22 Sturgeon in outmigrant traps suggests that Green Sturgeon spawn in the lower  
23 Feather River (Moyle 2002). However, prior to 2011 only two records of adult  
24 Green Sturgeon in the lower Feather River were confirmed (NMFS 2005b). In  
25 2011, videography monitoring conducted by the Anadromous Fish Restoration  
26 Program confirmed Green Sturgeon spawning activity in the lower Feather River  
27 and found evidence of spawning behavior in the Yuba River (AFRP 2011).  
28 Seesholtz et al. (2014) provided the first documentation of Green Sturgeon  
29 spawning in the Feather River.

30 *White Sturgeon*

31 White Sturgeon are known to use the lower Feather River primarily for spawning,  
32 embryo development, and early rearing. Limited quantitative information is  
33 available on the status of White Sturgeon in the lower Feather River, but the  
34 spawning population was most likely much larger prior to construction of  
35 Oroville Dam in 1961 (Israel et al. 2008). Seesholtz (2003) reported no evidence  
36 of sturgeon was found in the lower Feather River after an exhaustive search for  
37 their presence in 2003. However, 16 White Sturgeon were recorded from creel  
38 surveys and sightings during 2006, and more were captured by anglers in 2007  
39 (Israel et al. 2008). Numerous factors likely limit the success of the White  
40 Sturgeon population in the lower Feather River, but loss of historical habitat,  
41 alteration of temperatures and flows caused by Oroville Dam and other  
42 impoundments in the watershed, and recreational fishing and poaching are  
43 expected to be among the most important factors.

1 *Striped Bass*

2 Striped Bass occur in the lower Feather River and have been reported to occur in  
3 the Thermalito Forebay (FERC 2007b). Striped Bass are a popular sport fish in  
4 the lower Feather River during periods when they migrate upstream to spawn.

5 *American Shad*

6 American Shad enter the Feather River annually in spring to spawn and are  
7 popular for sport fishing. American Shad are present in the lower Feather River  
8 from May through mid-December during the adult immigration, spawning, and  
9 outmigration periods of their life cycle (DWR 2003a).

10 **9.3.4.7.2 Aquatic Habitat**

11 Historically, spawning habitat suitable for anadromous salmonid species likely  
12 existed above the current location of Oroville Dam on the Feather River  
13 (Yoshiyama et al. 2001). Extensive mining, irrigation, and development of  
14 hydroelectric dams significantly reduced the amount of suitable habitat for these  
15 species (Yoshiyama et al. 2001). Schick et al. (2005) estimated approximately  
16 71 miles of suitable habitat was historically available for spring-run Chinook  
17 Salmon in the lower Feather River.

18 Most Chinook Salmon and steelhead spawning is concentrated in the uppermost  
19 3 miles of accessible habitat in the lower Feather River downstream of the Feather  
20 River Fish Hatchery (FERC 2007b). As a result, salmonid spawning is  
21 concentrated to unnaturally high levels in the low-flow channel of the lower  
22 Feather River directly downstream of Oroville Dam and the Fish Barrier Dam. A  
23 physical habitat simulation analysis conducted by the California Department of  
24 Water Resources (DWR) in 2002 indicated that Chinook spawning habitat  
25 suitability in the low-flow channel reached a maximum between 800 and 825 cfs,  
26 and in the high-flow channel, it reached a maximum at 1,200 cfs. The steelhead  
27 spawning habitat index in the low-flow channel had no distinct optimum over the  
28 range of flow between 150 and 1,000 cfs. In the high-flow channel, spawning  
29 habitat suitability was maximized at a flow just under 1,000 cfs (DWR 2004b).

30 The FERC (2007b) study reported that an estimated 97 percent of the sediment  
31 from the upstream watershed is trapped in Lake Oroville, such that only very fine  
32 sediment is discharged from Lake Oroville to the lower Feather River. As a  
33 result, gravel and large woody material from upstream reaches are limited along  
34 the lower Feather River. The FERC (2007b) study reported that the median  
35 gravel diameter (D50) of surface samples suggests that gravels in the low-flow  
36 channel generally are too large for successful redd construction by steelhead or  
37 salmon and that armoring is particularly evident in this reach; however, suitability  
38 of gravel sizes for spawning Chinook Salmon generally increased with distance  
39 downstream of Oroville Dam. The study suggested that size distributions of  
40 subsurface gravel samples were similar in the low- and high-flow channels.  
41 Analyses of fine sediment (less than 6 mm in diameter) suggested that fine  
42 sediment within gravels in the lower Feather River were suitable for incubating  
43 Chinook Salmon and steelhead embryos (FERC 2007b).

#### 1 **9.3.4.7.3 Fish Passage**

2 The Oroville facilities, including Oroville Dam, Thermalito Diversion Dam, and  
3 the Fish Barrier Dam, currently block the upstream migration of anadromous fish  
4 to historically available spawning areas in the upstream tributaries of the Feather  
5 River. In a study of Green Sturgeon passage impediments, FERC identified three  
6 potential physical barriers to upstream migration by Green Sturgeon in the lower  
7 Feather River during representative low-flow conditions (approximately 2,074 cfs  
8 during November 2002) and high-flow conditions (approximately 9,998 cfs  
9 during July 2003) (FERC 2007b). The three potential physical barriers are  
10 Shanghai Bench, the Sunset Pumps, and Steep Riffle (located 2 miles upstream of  
11 the Thermalito Afterbay Outlet). However, the study also noted that  
12 determinations of potential passage barriers in the lower Feather River are  
13 speculative.

#### 14 **9.3.4.7.4 Hatcheries**

15 The Feather River Fish Hatchery is part of the SWP Oroville Complex and is a  
16 mitigation hatchery for loss of habitat upstream of DWR's Oroville Dam that is  
17 no longer accessible to anadromous fish species (NMFS 2009a). Three hatchery  
18 programs are conducted here, producing fall-run Chinook Salmon, spring-run  
19 Chinook Salmon, and steelhead. The Feather River Fish Hatchery supports the  
20 only spring-run Chinook Salmon hatchery program currently in the Central Valley  
21 (CHSRG 2012). Spring-run Chinook Salmon produced at the Feather River Fish  
22 Hatchery are included in the listed spring-run Chinook Salmon ESU  
23 (70 FR 37160). FERC is in consultation with NMFS on the effects of  
24 relicensing Oroville Dam (including the effects of Feather River Fish Hatchery).

25 Fall-run Chinook Salmon in the Feather River are trapped and spawned at the  
26 hatchery with a goal of producing 6 million fall-run Chinook Salmon smolts for  
27 release into Carquinez Straits between April and June. Up to 2 million additional  
28 fish may be reared as part of a separate ocean enhancement program. Feather  
29 River fall-run Chinook Salmon are currently marked at a 25 percent rate (constant  
30 fractional marking) with an adipose fin-clip and a coded wire-tag (CHSRG 2012).

31 Adult hatchery-produced spring-run Chinook are intended to spawn naturally or  
32 to be genetically integrated with the natural population through artificial  
33 propagation. There are no specific goals for the number of adult spring-run  
34 Chinook Salmon; however, the juvenile production goal is to release 2 million  
35 smolts during April or May. These fish are all released into the Feather River  
36 south of Yuba City at the Boyd's Pump Boat Launch (44 miles downstream of the  
37 hatchery). Juvenile hatchery-produced spring-run Chinook Salmon are currently  
38 100 percent marked with an adipose fin-clip and a coded wire-tag  
39 (CHSRG 2012).

40 The steelhead program at the Feather River Hatchery traps and artificially spawns  
41 both marked hatchery-origin and unmarked natural-origin steelhead. Only a few  
42 unmarked fish are trapped annually. Currently, only fish returning to the Feather  
43 River Basin are used for broodstock. There are no specific goals for the number  
44 of adult steelhead produced by this program; however, the juvenile production

1 goal is to release 450,000 yearling steelhead annually during late January or  
2 February. All Feather River Hatchery steelhead are marked with an adipose  
3 fin-clip prior to release. These fish are all released into the Feather River south of  
4 Yuba City at the Boyd's Pump Boat Launch or at the confluence of the Feather  
5 and Sacramento rivers (Verona Marina) (CHSRG 2012).

6 Prior to 2004, separation of spring-run and fall-run Chinook Salmon returning to  
7 the Feather River Fish Hatchery was solely based on run timing, which resulted in  
8 considerable mixing of fall-run and spring-run Chinook Salmon stocks (DWR  
9 2009, NMFS 2012a). In 2005, the Feather River Fish Hatchery implemented a  
10 methodology change for distinguishing spring-run Chinook Salmon from fall-run  
11 Chinook Salmon (CHSRG 2012). To maintain genetic integrity, fish entering the  
12 Feather River Fish Hatchery prior to July 1 receive an external tag, and only these  
13 externally tagged fish are used as spring-run Chinook Salmon broodstock  
14 (DWR 2009). Since 2005, the hatchery has attempted to mark 100 percent of  
15 spring-run Chinook Salmon produced at the hatchery with an adipose fin-clip,  
16 coded wire-tag (CHSRG 2012) and race and brood year specific otolith thermal  
17 marks (DWR 2009).

18 The Feather River Fish Hatchery employs best management practices and  
19 protocols to avoid the spread of diseases from the hatchery. The hatchery has  
20 been successful in adaptively managing disease concerns as they arise by the  
21 installing an ultraviolet treatment system, modifying the stocking of Lake  
22 Oroville, conducting periodic testing, and using prescribed therapeutic treatments  
23 (DWR 2004c).

#### 24 **9.3.4.7.5 Disease**

25 Several endemic salmonid pathogens and diseases occur in the Feather River  
26 Basin, including *Ceratomyxa shasta* (salmonid ceratomyxosis), *Flavobacterium*  
27 *columnare* (columnaris), Infectious Hematopoietic Necrosis (IHN) virus,  
28 *Renibacterium salmoninarum* (bacterial kidney disease), and *Flavobacterium*  
29 *psychrophilum* (cold-water disease) (DWR 2004c). Each of these diseases has  
30 been shown to infect stocked and native salmonids in the Feather River; however,  
31 these diseases are not known to infect non-salmonids (FERC 2007b). Whirling  
32 disease has never been detected in the lower Feather River downstream of  
33 Oroville Dam, but has been found in upstream tributaries such as the north and  
34 south forks of the Feather River (DWR 2004c). Of the fish diseases in the Feather  
35 River Basin, IHN and salmonid ceratomyxosis are main contributors to fish  
36 mortality at the Feather River Fish Hatchery and are of highest concern for  
37 fisheries management in the region (DWR 2004c). The Feather River Fish  
38 Hatchery experienced severe IHN outbreaks in 2000 and 2001. A study by the  
39 University of California at Davis and USFWS indicated that although there were  
40 no clinical signs of disease, adult salmonids returning to either the Yuba or the  
41 Feather rivers demonstrated IHN infection rates of 28 percent and 18 percent,  
42 respectively (Brown et al. 2004).

1 Salmonid ceratomyxosis is endemic to the Feather River Basin; local salmonid  
2 stocks have co-evolved with this pathogen and exhibit some natural resistance.  
3 Salmonid ceratomyxosis causes mortality in all ages of anadromous and resident  
4 trout and salmon, although Rainbow Trout and steelhead are more susceptible to  
5 the disease than are Chinook and Coho Salmon (DWR 2004c). Mortality  
6 generally occurs when water temperatures exceed 50°F; however, fish can  
7 become infected at temperatures as low as 39°F (Bartholomew 2012).

#### 8 **9.3.4.7.6 Predation**

9 The FERC (2007b) study suggests that the Fish Barrier Dam, which directs most  
10 anadromous salmonid spawning to occur in the low-flow channel, concentrates  
11 juvenile salmonids within this reach. Counts of known predators on juvenile  
12 anadromous salmonids in the low-flow channel are reported to be low; however,  
13 significant numbers of predators reportedly do exist in the high-flow channel  
14 downstream of Thermalito Afterbay Outlet (Seesholtz et al. 2004). Limited  
15 information is available to estimate the current rate of predation on juvenile  
16 salmonids in the lower Feather River.

#### 17 **9.3.4.8 Yuba River**

18 Portions of the Yuba River watershed along the North Yuba River between New  
19 Bullards Bar Reservoir and Englebright Lake and along the Lower Yuba River  
20 between Englebright Lake and the Feather River could be affected by operation of  
21 the Lower Yuba River Water Accord (DWR et al. 2007), as described in  
22 Chapter 5, Surface Water Resources and Water Supplies.

23 Fish species found in the New Bullards Bar Reservoir include Rainbow Trout,  
24 Brown Trout, Kokanee Salmon, bass, Bluegill, crappie, and bullhead (DWR et al.  
25 2007). A similar mix of species is found in Englebright Reservoir. Fall-run and  
26 spring-run Chinook Salmon and steelhead occur in the Yuba River downstream of  
27 Englebright Dam (YCWA 2009). Sacramento Splittail have been documented  
28 only in the lower Feather River and not in the Yuba River. Low numbers of  
29 Green Sturgeon and White Sturgeon occasionally range into the Yuba River  
30 (Beamesderfer et al. 2004). Other species found in the lower Yuba River include  
31 American Shad, Smallmouth Bass, and Striped Bass (DWR et al. 2007).

#### 32 **9.3.4.9 Bear River**

33 The Bear River flows into the Feather River downstream of the confluence of the  
34 Feather and Yuba rivers. The Bear River includes Nevada Irrigation District's  
35 Rollins and Combie reservoirs along the upper and middle reaches of the Bear  
36 River and South Sutter Water District's Camp Far West Reservoir along the lower  
37 reach of the Bear River (FERC 2013, NID 2005).

38 Fall-run and spring-run Chinook Salmon and steelhead occur in the Bear River  
39 (YCWA 2009). Sacramento Splittail have been documented only in the lower  
40 Feather River and not in the Bear River. Low numbers of Green Sturgeon and  
41 White Sturgeon occasionally range into the Bear River (Beamesderfer et al.  
42 2004). Rollins Reservoir is currently managed as a put-and-take fishery for  
43 rainbow and Brown Trout. Kokanee reproduce naturally in the lake. Gill net



1 surveys from 1970 to 1983 documented numerous other species including bass,  
2 catfish, sunfish, Golden Shiner, Tui Chub, Pond Smelt, crappie, and Bluegill  
3 (DFG 1974-1983 in NID 2008). Native fishes found in Combie Reservoir may  
4 include Sacramento Pikeminnow, Sacramento Sucker, Hardhead, Tui Chub,  
5 Hitch, and Inland Silverside. Nonnative fishes likely include Bluegill, Green  
6 Sunfish, Largemouth Bass, Spotted Bass, Smallmouth Bass, common carp,  
7 Golden Shiner, Threadfin Shad, Black Crappie, Brown Bullhead, White Catfish,  
8 Channel Catfish, Western Mosquitofish, and stocked Rainbow Trout (NID 2009).

9 **9.3.4.10 Folsom Lake and Lake Natoma**

10 The American River watershed encompasses approximately 2,100 square miles  
11 (Reclamation et al. 2006). The three forks of the American River (north, middle,  
12 and south forks) converge upstream of Folsom Dam, with the combined flow  
13 moving through Lake Natoma and the lower American River for about 23 miles  
14 before entering the Sacramento River.

15 Water surface elevations vary annually as a result of seasonal inflow and water  
16 release and are generally the least variable during spring and most variable during  
17 summer (USACE et al. 2012). Thermal stratification of the reservoir generally  
18 begins during April and usually persists throughout summer until November,  
19 when cooler temperatures, winter rains, and high inflows create mixing and result  
20 in “turnover” (Reclamation 2005, USACE et al. 2012). During summer, a  
21 thermocline develops that separates the epilimnion (i.e., upper layer of warm  
22 water) and the hypolimnion (i.e., lower layer of cooler water). This thermal  
23 stratification and segregation of habitats allow for both cold-water and  
24 warm-water species to coexist in Folsom Lake (USACE et al. 2012).

25 Warm-water fish species include native Hardhead, California Roach, Sacramento  
26 Pikeminnow, and Sacramento Sucker, as well as nonnative Largemouth Bass,  
27 Smallmouth Bass, Spotted Bass, sunfish, Black Crappie, and White Crappie  
28 (Reclamation 2007). Cold-water fish species include native Rainbow Trout and  
29 planted Chinook and Kokanee Salmon, as well as nonnative Brown Trout  
30 (Reclamation 2007).

31 Nimbus Dam creates Lake Natoma, which serves as a regulating afterbay to the  
32 Folsom power plant, maintaining more uniform flows in the lower American  
33 River. Lake Natoma is a shallow reservoir with an average depth of about 16 feet  
34 (Reclamation 2005). Surface water elevations in Lake Natoma may fluctuate  
35 between 4 and 7 feet daily (USACE et al. 2012). Lake Natoma has relatively low  
36 productivity as a fishery due to the effects of wide water temperature variability  
37 associated with the lake fluctuating elevation. Reclamation (2007) reports that  
38 fish species found in Lake Natoma are generally the same as those in Folsom  
39 Lake. Although CDFW annually stocks Lake Natoma with hatchery Rainbow  
40 Trout, conditions in Lake Natoma are more favorable for warm-water fish species  
41 (Reclamation 2007).

1 **9.3.4.11 Lower American River between Lake Natoma and the**  
 2 **Sacramento River**

3 The lower American River extends approximately 23 miles from Nimbus Dam  
 4 downstream to the confluence with the Sacramento River. Access to the upper  
 5 reaches of the river by anadromous fish is blocked at Nimbus Dam.

6 **9.3.4.11.1 Fish in the Lower American River**

7 The lower American River system supports numerous resident native and  
 8 introduced species as well as several anadromous species.

9 The analysis is focused on the following species:

- 10 • Fall-run Chinook Salmon
- 11 • Steelhead
- 12 • White Sturgeon
- 13 • Sacramento Splittail
- 14 • Pacific Lamprey
- 15 • Striped Bass
- 16 • American Shad

17 *Fall-run Chinook Salmon*

18 Historically, the American River supported fall-run and perhaps late fall-run  
 19 Chinook Salmon (Williams 2001). Both naturally and hatchery produced  
 20 Chinook Salmon spawn in the lower American River. Recent analysis by DFG  
 21 and USFWS (2010) indicated that approximately 84 percent of the natural fall-run  
 22 Chinook Salmon spawners in the American River are hatchery-origin fish.  
 23 Kormos et al. (2012) reported that 79 percent of the fall-run Chinook Salmon  
 24 entering the Nimbus Fish Hatchery in 2010 and 32 percent of the fish spawning in  
 25 the American River were of hatchery origin.

26 Adult fall-run Chinook Salmon enter the lower American River from about  
 27 mid-September through January, with peak migration from approximately  
 28 mid-October through December (Williams 2001). Spawning occurs from about  
 29 mid-October through early February, with peak spawning from mid-October  
 30 through December. Chinook Salmon spawning occurs within an 18-mile stretch  
 31 from Paradise Beach to Nimbus Dam; however, most spawning occurs in the  
 32 uppermost 3 miles (DFG 2012a). Chinook Salmon egg and alevin incubation  
 33 occurs in the lower American River from about mid-October through April.  
 34 There is high variability from year to year; however, most incubation occurs from  
 35 about mid-October through February. Chinook Salmon fry emergence occurs  
 36 from January through mid-April, and juvenile rearing extends from January to  
 37 about mid-July (Williams 2001). Most Chinook Salmon outmigrate from the  
 38 lower American River as fry between December and July, peaking in February to  
 39 March (Snider and Titus 2002, PSMFC 2014).

1 *Steelhead*

2 Natural spawning by steelhead in the American River occurs (Hannon and  
3 Deason 2008), but the population is supported primarily by the Nimbus Fish  
4 Hatchery. The total estimated steelhead return to the river (spawning naturally  
5 and in the hatchery) has ranged from 946 to 3,426 fish, averaging 2,184 fish per  
6 year from 2002 to 2010 (CHSRG 2012). Steelhead spawning surveys have shown  
7 approximately 300 steelhead spawning in the river each year (Hannon and Deason  
8 2008). Lindley et al. (2007) classifies the listed (i.e., naturally spawning)  
9 population of American River steelhead at a high risk of extinction because it is  
10 reportedly mostly composed of steelhead originating from Nimbus Fish Hatchery.  
11 NMFS views the American River population as important to the survival and  
12 recovery of the species (NMFS 2009a).

13 Nielsen et al. (2005) found steelhead in the American River to be genetically  
14 different from other Central Valley stocks. Eel River steelhead were used to  
15 found the Nimbus Hatchery stock, and steelhead from the American River  
16 (collected from both the Nimbus Fish Hatchery and the American River) are  
17 genetically more similar to Eel River steelhead than other Central Valley  
18 Steelhead stocks. Based on studies by Hallock et al. (1961), Staley (1976), and  
19 Neilsen (2005), Lee and Chilton (2007) reported that American River winter-run  
20 steelhead are genetically and phenotypically different, and demonstrate a later  
21 upstream migration period than Central Valley Steelhead. Zimmerman et al.  
22 (2008) also noted that there remains a strong resident component (i.e., fish that do  
23 not migrate to the ocean) of the *O. mykiss* population that interacts with and  
24 produces anadromous individuals. Steelhead and Rainbow Trout are the same  
25 species and when juveniles of the species are found in fresh water, it is unclear if  
26 they will exhibit an anadromous (steelhead) or resident (Rainbow Trout) life  
27 history strategy. Thus, they are often collectively referred to as *O. mykiss* at this  
28 stage to indicate this uncertainty.

29 Adult steelhead enter the American River from November through April with a  
30 peak occurring from December through March (SWRI 2001). Steelhead have  
31 been trapped at Nimbus Fish Hatchery as early as the first week of October.  
32 Results of a spawning survey conducted from 2001 through 2007 indicate that  
33 steelhead spawning occurs in the lower American River from late December  
34 through early April, with the peak occurring in late February to early March  
35 (Hannon and Deason 2008). Spawning density is highest in the upper 7 miles of  
36 the river, but spawning occurs as far downstream as Paradise Beach. About  
37 90 percent of spawning occurs upstream of the Watt Avenue Bridge (Hannon and  
38 Deason 2008).

39 Embryo incubation begins with the onset of spawning in late December and  
40 generally extends through May, although incubation can occur into June in some  
41 years (SWRI 2001). Steelhead embryo and alevin mortality associated with high  
42 flows in the American River has not been documented, but flows high enough to  
43 mobilize spawning gravels do occur during the spawning and embryo incubation  
44 periods (i.e., late December through early April) (NMFS 2009a).

1 Juvenile *O. mykiss* have been documented year-round throughout the lower  
2 American River, with rearing generally upstream of spawning areas. Juveniles  
3 reportedly can rear in the lower American River for a year or more before  
4 outmigrating as smolts from January through June (Snider and Titus 2000a,  
5 SWRI 2001). However, Snider and Titus (2002) reported only 1 yearling  
6 steelhead capture, and PSMFC (2014) reported capturing primarily YOY fry and  
7 parr. Peak outmigration occurs from March through May (McEwan and Jackson  
8 1996, SWRI 2001, PSMFC 2014).

9 Rearing habitat for juvenile steelhead in the lower American River occurs  
10 throughout the upper reaches downstream to Paradise Beach. In summer,  
11 juveniles occur in most major riffle areas, with the highest concentrations near the  
12 higher density spawning areas (Reclamation 2008a). The number of juveniles in  
13 the American River decreases throughout summer (Reclamation 2008a). Warm  
14 water temperatures stress juvenile steelhead rearing in the American River,  
15 particularly during summer and early fall (LARTF 2002, Water Forum 2005c,  
16 NMFS 2014b). However, laboratory studies suggest that American River  
17 steelhead may be more tolerant of high temperatures than steelhead from regions  
18 farther north (Myrick and Cech 2004).

#### 19 *Pacific Lamprey*

20 The Pacific Lamprey inhabits accessible reaches of the American River.  
21 Information on the status of Pacific Lamprey in the American River is limited, but  
22 the loss of historical habitat and apparent population declines throughout  
23 California indicate populations are greatly decreased compared to historical levels  
24 (Moyle et al. 2009).

25 Hannon and Deason (2008) documented Pacific Lamprey spawning in the  
26 American River between early January and late May, with peak spawning  
27 typically in early April. Pacific Lamprey ammocoetes rear in the American River  
28 for all or part of their 5- to 7-year freshwater residence. Data from rotary screw  
29 trapping in the nearby Feather River suggest that outmigration of Pacific Lamprey  
30 generally occurs from early winter through early summer (Hanni et al. 2006),  
31 although some outmigration likely occurs year-round, as observed at sites on the  
32 mainstem Sacramento River (Hanni et al. 2006) and in other river systems  
33 (Moyle 2002).

34 Because of the parallels in their life cycles, particularly spawning, lampreys may  
35 be affected by many of the same factors as salmon and steelhead. Little  
36 information is available on factors influencing Pacific Lamprey populations in the  
37 American River, but the dams likely play an important role. Moyle et al. (2009)  
38 suggested that in addition to blocking upstream migration, dams may disrupt  
39 upstream sediment inputs required to maintain habitat for ammocoetes and subject  
40 ammocoetes to rapid decreases in stream flow. Moyle et al. (2009) also indicated  
41 that ramping rates sufficient to protect salmonids may not be adequate to prevent  
42 the stranding of ammocoetes and metamorphosing individuals, which are  
43 vulnerable to desiccation and avian predation. Additionally, commercial harvest  
44 of lampreys on the American River (presumably for bait) may reduce spawning  
45 success in some years (Hannon and Deason 2008).

1 *Sacramento Splittail*

2 Splittail likely spawn in the lower reaches of the American River (Sommer et al.  
3 1998, 2008; Moyle et al. 2004). During wet years, upstream migration is more  
4 directed and fish tend to swim farther upstream (Moyle 2002), thus more  
5 individuals are expected to use the American River in wet years. Although  
6 juvenile splittail are known to rear in upstream areas for a year or more (Baxter  
7 1999), most move to the Delta after only a few weeks of rearing on floodplain  
8 habitat (Reclamation 2008a). Most juveniles move downstream into the Delta  
9 from April to August (Meng and Moyle 1995). The primary factor potentially  
10 limiting the American River population of Sacramento Splittail is availability of  
11 inundated floodplains for spawning and rearing habitats (Moyle et al. 2004).

12 *White Sturgeon*

13 Limited quantitative information is available on the distribution and status of  
14 White Sturgeon in the American River; however, small numbers of adults  
15 apparently use the American River, as evidenced by sturgeon report cards  
16 submitted to CDFW by anglers in recent years (e.g., DFG 2012b).

17 *Striped Bass*

18 Striped Bass are found in the American River throughout the year, with the  
19 greatest abundance in summer (SWRI 2001). Although the occurrence of  
20 spawning in the American River is uncertain, the river is believed to serve as a  
21 nursery area for YOY and subadult Striped Bass (SWRI 2001). Striped Bass are  
22 distributed from the confluence with the Sacramento River to Nimbus Dam  
23 (Moyle 2002), and they provide a locally important sportfishing resource.

24 *American Shad*

25 Adult American Shad ascend the lower American River to spawn during the late  
26 spring. During this period, they provide an important sport fishery. The shortage  
27 of adequate attraction flows in major tributaries such as the American River may  
28 be contributing to declines in the population (Moyle 2002).

29 **9.3.4.11.2 Aquatic Habitat**

30 Since 1955, Nimbus Dam has blocked upstream passage by anadromous fish and  
31 restricted available habitat in the lower American River to the approximately  
32 23 river miles between the dam and the confluence with the Sacramento River.  
33 Additionally, Folsom Dam has blocked the downstream transport of sediment that  
34 contributes to the formation and maintenance of habitat for aquatic species.

35 In 2008, Reclamation, in coordination with USFWS and the Sacramento Water  
36 Forum, began implementation of salmonid habitat improvement in the lower  
37 American River. An estimated 5,000 cubic yards of gravel and cobble were  
38 placed just upstream of Nimbus Fish Hatchery in 2008, followed by an estimated  
39 7,000 cubic yards adjacent to the Nimbus Fish Hatchery in fall 2009. In  
40 September 2010, approximately 11,688 cubic yards (approximately 16,200 tons)  
41 of gravel and cobble were placed at Sailor Bar to enhance spawning habitat for  
42 Chinook Salmon and steelhead in the lower American River (Merz et al. 2012).  
43 Additionally, the 2010 augmentation site contained a constructed cobble island

1 and “scallop” in the substrate designed to add habitat heterogeneity to the main  
2 channel and rearing habitat for juvenile Chinook Salmon and steelhead.  
3 Additionally, approximately 5,500 tons of cleaned cobble were placed  
4 downstream of the 2010 augmentation site. The specific purpose of this  
5 placement was to divert flow into an adjacent, perched side channel, thereby  
6 preventing the dewatering of salmonid redds in a historically important spawning  
7 and rearing area during low-flow conditions.

8 During higher flows, channel geomorphology in the lower American River is  
9 characterized by bar complexes and side channel areas, which may become  
10 limited at lower flows (NMFS 2009a). Spawning bed materials in the lower  
11 American River may begin to mobilize at flows of 30,000 cfs, with more  
12 substantial mobilization at flows of 50,000 cfs or greater (Reclamation 2008a).  
13 At 115,000 cfs (the highest flow modeled), particles up to 70 mm median  
14 diameter would be moved in the high-density spawning areas around Sailor Bar  
15 and Sunrise Avenue. Flood frequency analysis for the American River at Fair  
16 Oaks gage shows that, on average, flood control releases exceed 30,000 cfs about  
17 once every 4 years and exceed 50,000 cfs about once every 5 years  
18 (Reclamation 2008a).

19 In 2008, Reclamation began implementing floodplain and spawning habitat  
20 restoration projects in the American River to assist in meeting the requirements of  
21 the 1992 CVPIA, Section 3406 (b)(13). The side channel at Upper Sunrise was  
22 identified as a suitable site for steelhead spawning habitat restoration. In 2008,  
23 the CVPIA (b)(13) program cut and widened the side channel so that it inundated  
24 at a greater range of flows. The project reduced steelhead stranding, but also  
25 inadvertently reduced Chinook Salmon and steelhead spawning and rearing  
26 habitat (AFRP 2012). Consequently, the main channel was filled at the head-cut  
27 to create greater head pressure, thereby allowing flow once again through the side  
28 channel. Monitoring at the Upper Sunrise project revealed immediate response  
29 from Chinook Salmon and steelhead moving up into the side channel to spawn  
30 after completion of the project. Spawning and rearing habitat enhancement  
31 projects occurred each year from 2008 through 2014 in the reach from Nimbus  
32 Dam down to River Bend Park. These annual projects are planned to continue.

### 33 **9.3.4.11.3 Fish Passage**

34 Including the mainstem, north, middle, and south forks, more than 125 miles of  
35 riverine habitat historically were available for anadromous salmonids in the  
36 American River watershed (Yoshiyama et al. 1996). Access to the upper reaches  
37 of the river has been blocked by a series of impassable dams, including Old  
38 Folsom Dam, first constructed in the American River between 1895 and 1939.

39 Reclamation operates a fish diversion weir approximately 0.25 mile downstream  
40 of Nimbus Dam, which functions to divert adult steelhead and Chinook Salmon  
41 into Nimbus Fish Hatchery. The weir is annually installed during September  
42 prior to the arrival of fall-run Chinook Salmon and steelhead and is removed at  
43 the conclusion of fall-run Chinook Salmon immigration in early January  
44 (Reclamation and DFG 2011). Some steelhead may be trapped prior to weir

1 removal, but they are returned to the river. A new fish passageway is being  
2 implemented in the Nimbus Dam stilling basin, commonly referred to as Nimbus  
3 Shoals. The passageway will replace the existing fish diversion weir with a new  
4 flume and fish ladder that will connect to the existing fish ladder near Nimbus  
5 Fish Hatchery.

#### 6 **9.3.4.11.4 Hatcheries**

7 CDFW operates the Nimbus Salmon and Steelhead Hatchery and American River  
8 Trout Hatchery, located immediately downstream from Nimbus Dam. Facilities  
9 associated with Nimbus Fish Hatchery include a fish weir, fish ladder, gathering  
10 and handling tanks, hatchery-specific buildings, and rearing ponds. Nimbus Fish  
11 Hatchery was constructed primarily to mitigate the loss of spawning habitat for  
12 Chinook Salmon and Central Valley Steelhead that were blocked by the  
13 construction of Nimbus Dam (Reclamation and DFG 2011); it does not address  
14 lost habitat upstream from Folsom Dam (CHSRG 2012). The hatchery operations  
15 include the trapping, artificial spawning, rearing, and release of steelhead and fall-  
16 /late fall-run Chinook Salmon. Propagation programs for American River winter-  
17 run steelhead and Central Valley fall/ late fall-run Chinook Salmon are operated  
18 by CDFW under contract with Reclamation (Lee and Chilton 2007). The Nimbus  
19 Fish Hatchery Winter-run Steelhead Program is an isolated-harvest program  
20 (i.e., it does not include natural-origin steelhead in the broodstock), designed and  
21 implemented to artificially spawn the adipose fin-clipped adult steelhead that  
22 seasonally enter the trapping facilities (CHSRG 2012). These fin-clipped fish are  
23 not part of the Central Valley Steelhead DPS. The Nimbus Fish Hatchery  
24 Winter-run Steelhead Program propagates fish for recreational fishing  
25 opportunities and harvest (CHSRG 2012).

26 Steelhead have been trapped at Nimbus Fish Hatchery as early as the first week of  
27 October; however, since 2000, the ladder has been opened in early November.  
28 Trapping of steelhead has continued to occur as late as the second week of March.  
29 Presently, winter-run steelhead are trapped at Nimbus Fish Hatchery, and  
30 artificially spawned adults are marked with an adipose fin clip (CHSRG 2012).  
31 Unmarked steelhead adults are not retained at Nimbus Fish Hatchery for use in  
32 the annual broodstock and are released back to the river (CHSRG 2012). In  
33 addition, marked or unmarked *O. mykiss* that are less than 16 inches long may be  
34 resident hatchery-origin trout and are returned to the river (CHSRG 2012).

35 On average, the program has raised and released approximately 422,000 yearling  
36 steelhead since brood year 1999 (CHSRG 2012). Since 1998, all  
37 steelhead/Rainbow Trout produced in Nimbus Fish Hatchery have been marked  
38 with an adipose fin-clip to aid in subsequently identifying hatchery-origin fish.

39 Juvenile steelhead yearlings are not held past March 30 because of increasing  
40 hatchery water temperatures and to encourage outmigration during spring. If  
41 releases occur during periods of low flows in the Sacramento River and possibly  
42 the American River, some released fish migrate back to Nimbus Fish Hatchery  
43 and may take up residency rather than migrating downstream (Lee and Chilton  
44 2007). Additionally, juvenile fish are released in February and early March to

1 coincide with State Water Resources Control Board (SWRCB) D-1641 closures  
2 of the DCC gates from February 1 through May 20 to reduce straying into the  
3 Delta. Reclamation determines the exact timing and duration of the gate closures  
4 after discussion with USFWS, CDFW, and NMFS.

5 Reclamation is implementing a genetic screening study of Nimbus Fish Hatchery  
6 steelhead. Reclamation, in contract with NMFS, is conducting a parental-based  
7 tagging study of American River steelhead and continuing a study to determine a  
8 more genetically appropriate stock.

9 CDFW releases all hatchery-produced steelhead juveniles into the American  
10 River at boat ramps on the American River or at the confluence of the Sacramento  
11 and American rivers and releases all unclipped steelhead adults returning to  
12 Nimbus Fish Hatchery into the lower American River via the river return tube that  
13 is just downstream of the fish ladder. In accordance with California law, the  
14 current protocol of Nimbus Fish Hatchery is to destroy all surplus eggs to prevent  
15 inter-basin transfer of eggs or juveniles to other hatcheries or waters.

16 The goal of the Nimbus Fish Hatchery Integrated Fall/Late Fall-run Chinook  
17 Salmon Program is to release 4 million smolts. Each fall, Nimbus Hatchery staff  
18 collect approximately 10,000 adult fall-run Chinook Salmon, with an annual goal  
19 of harvesting 8,000,000 eggs and releasing the 4,000,000 smolts. All adult  
20 fall-run Chinook Salmon collected at the hatchery are euthanized, and no trapped  
21 salmon are returned to the American River (Reclamation 2008a).

#### 22 **9.3.4.11.5 Disease**

23 The occurrence of a bacterial-caused inflammation of the anal vent (commonly  
24 referred to as “rosy anus”) of steelhead in the lower American River has been  
25 reported by CDFW to be associated with relatively warm water temperatures  
26 (Water Forum 2005b). Anal vent inflammation of steelhead in the lower  
27 American River was observed in 2004 during periods when water temperatures  
28 were measured between 65°F and 68°F (Water Forum 2005a, 2005b). The Water  
29 Forum (2005b) suggested that, in addition to possible diminished immune system  
30 responses and incidences of diseases associated with elevated water temperatures,  
31 disease transmission may be exacerbated by crowding under conditions when  
32 water flows are reduced.

#### 33 **9.3.4.11.6 Predation**

34 Reduced cold-water storage in Folsom Lake and using Folsom Lake to meet Delta  
35 water quality objectives and demands influence habitat conditions in the lower  
36 American River for warm-water predator species that feed on juvenile salmonids  
37 and potentially alter predation pressure (Water Forum 2005b). Additionally,  
38 isolation of redds in side channels resulting from fluctuations in Folsom Lake  
39 releases may increase predation of emergent fry (Water Forum 2005b).



1     **9.3.4.12   Delta**

2     Ecologically, the Delta consists of three major landscapes and geographic regions:  
3     (1) the north Delta freshwater flood basins composed primarily of freshwater  
4     inflow from the Sacramento River system; (2) the south Delta distributary  
5     channels composed of predominantly San Joaquin River system inflow; and  
6     (3) the central Delta tidal islands landscape wherein the Sacramento, San Joaquin,  
7     and east side tributary flows converge and tidal influences from San Francisco  
8     Bay are greater.

9     **9.3.4.12.1 Fish in the Delta**

10    The Delta provides unique and, in some places, highly productive habitats for a  
11    variety of fish species, including euryhaline and oligohaline resident species and  
12    anadromous species. For anadromous species, the Delta is used by adult fish  
13    during upstream migration and by rearing juvenile fish that are feeding and  
14    growing as they migrate downstream to the ocean. Conditions in the Delta  
15    influence the abundance and productivity of all fish populations that use the  
16    system. Fish communities currently in the Delta include a mix of native species,  
17    some with low abundance, and a variety of introduced fish, some with high  
18    abundance (Matern et al. 2002, Feyrer and Healey 2003, Nobriga et al. 2005,  
19    Brown and May 2006, Moyle and Bennett 2008, Grimaldo et al. 2012).

20    The analysis is focused on the following species:

- 21    • Chinook Salmon (winter-, spring-, and fall-/late fall-run)
- 22    • Steelhead
- 23    • Green Sturgeon
- 24    • White Sturgeon
- 25    • Sacramento Splittail
- 26    • Pacific Lamprey
- 27    • Striped Bass
- 28    • American Shad
- 29    • Delta Smelt
- 30    • Longfin Smelt
- 31    • Sacramento Splittail

32    The Interagency Ecological Program (IEP) has been monitoring fish populations  
33    in the San Francisco Estuary for decades. Survey methods have included beach  
34    seining, midwater trawls, Kodiak trawls, otter trawls, and other methods (Honey  
35    et al. 2004) to sample the pelagic fish assemblage throughout the estuary. Three  
36    of the most prominent resident pelagic fishes captured in the surveys (Delta  
37    Smelt, Longfin Smelt, and Striped Bass) have shown substantial long-term  
38    population declines (Kimmerer et al. 2000, Bennett 2005, Rosenfield and  
39    Baxter 2007). Reductions in pelagic fish abundance since 2002 have been  
40    recognized as a serious water and fish management issue and have become known  
41    as the Pelagic Organism Decline (POD) (Sommer et al. 2007a).

1 In response to the POD, the IEP formed a study team in 2005 to evaluate the  
2 potential causes of the decline. Since completion of the first set of studies in late  
3 2005, alternative models have been developed based on the available data and at  
4 professional judgment of the POD-Modeling Team regarding the extent to which  
5 individual drivers are likely to affect each species-life stage. The nine drivers  
6 identified (Baxter et al. 2010) were: (1) mismatch of larvae and food; (2) reduced  
7 habitat space; (3) adverse water movement/transport; (4) entrainment; (5) toxic  
8 effects on fish; (6) toxic effects on fish food items; (7) harmful *Microcystis*  
9 *aeruginosa* blooms; (8) *Potamocorbula amurensis* effects on food availability;  
10 and (9) disease and parasites.

11 An overall negative trend in habitat quality has occurred for Delta Smelt and  
12 Striped Bass (and potentially other fish species) as measured by water quality  
13 attributes and midwater trawl catch data since 1967, with Delta Smelt and Striped  
14 Bass experiencing the most apparent declines in abundance, distribution, and a  
15 related index of environmental quality (Feyrer et al. 2007, 2010). More  
16 specifically, the position of X2 and water clarity may be important factors  
17 influencing the quality of habitat for these species (McNally et al. 2010). Other  
18 factors, such as the introduction of nonnative clam species, also contribute to  
19 reducing habitat quality. Pelagic habitat suitability in the San Francisco Estuary  
20 has been characterized by changes in X2 (Feyrer et al. 2007, 2010). The  
21 abundance of several taxa increases in years when flows into the estuary are high  
22 and X2 is pushed seaward (Jassby et al. 1995; Kimmerer 2002a, b), implying that  
23 the quantity or suitability of estuarine habitat increases when outflows are high.  
24 Recent analyses by Kimmerer et al. (2009) indicated that neither changes in area  
25 or volume of low salinity water (habitat) account for this relationship, except for  
26 striped bass and American shad. This suggests that X2 is indexing other  
27 environmental variables or processes rather than simple extent of habitat (Baxter  
28 et al. 2010).

### 29 *Winter-run Chinook Salmon*

30 Winter-run Chinook Salmon use the Delta for upstream migration as adults and  
31 for downstream migration and rearing as juveniles (del Rosario et al. 2013).  
32 Adults migrate through the Delta during winter and into late spring (May/June)  
33 enroute to their spawning grounds in the mainstem Sacramento River downstream  
34 of Keswick Dam (USFWS 2001b, 2003b). Adults are believed to primarily use  
35 the mainstem Sacramento River for passage through the Delta (NMFS 2009a).  
36 After entry into the Delta, juvenile winter-run Chinook Salmon remain and rear in  
37 the Delta until they are 5 to 10 months of age (based on scale analysis) (Fisher  
38 1994, Myers et al. 1998). Although the duration of residence in the Delta is not  
39 precisely known, del Rosario et al. (2013) suggested that it can be up to several  
40 months. Winter-run Chinook Salmon juveniles have been documented in the  
41 north Delta (e.g., Sacramento River, Steamboat Slough, Sutter Slough, Miner  
42 Slough, Yolo Bypass, and Cache Slough complex); the central Delta  
43 (e.g., Georgiana Slough, DCC, Snodgrass Slough, and Mokelumne River complex  
44 below Dead Horse Island); south Delta channels, including Old and Middle rivers,  
45 and the joining waterways between Old and Middle rivers (e.g., Victoria Canal,

1 Woodward Canal, and Connection Slough); and the western central Delta,  
2 including the mainstem channels of the Sacramento and San Joaquin rivers and  
3 Threemile Slough (NMFS 2009a).  
4 Sampling at Chipps Island in the western Delta suggests that winter-run Chinook  
5 Salmon exit the Delta as early as December and as late as May, with a peak in  
6 March (Brandes and McLain 2001, del Rosario et al. 2013). The peak timing of  
7 the outmigration of juvenile winter-run Chinook Salmon through the Delta is  
8 corroborated by recoveries of winter-run-sized juvenile Chinook Salmon from the  
9 SWP Skinner Delta Fish Protection Facility and the CVP Tracy Fish Collection  
10 Facility in the south Delta (NMFS 2009a).

#### 11 *Spring-run Chinook Salmon*

12 The Delta is an important migratory route for all remaining populations of spring-  
13 run Chinook Salmon. Like all salmonids migrating up through the Delta, adult  
14 spring-run Chinook Salmon must navigate the many channels and avoid direct  
15 sources of mortality (e.g., fishing and predation), but also must minimize  
16 exposure to sources of nonlethal stress (e.g., high temperatures) that can  
17 contribute to prespawn mortality in adult salmonids (Budy et al. 2002, Naughton  
18 et al. 2005, Cooke et al. 2006, NMFS 2009a). Habitat degradation in the Delta  
19 caused by factors such as channelization and changes in water quality can present  
20 challenges for outmigrating juveniles. Additionally, outmigrating juveniles are  
21 subjected to predation and entrapment in the project export facilities and smaller  
22 diversions (NMFS 2009a). Further detail is provided later in this section.

23 Spring-run Chinook Salmon returning to spawn in the Sacramento River system  
24 enter the San Francisco Estuary from the ocean in January to late February and  
25 move through the Delta prior to entering the Sacramento River. Several  
26 populations of spring-run Chinook Salmon occur in the Sacramento River Basin,  
27 but historical populations that occurred in the San Joaquin River and tributaries  
28 have been extirpated. The Sacramento River channel is the main spring-run  
29 Chinook Salmon migration route through the Delta. However, adult spring-run  
30 Chinook Salmon may stray into the San Joaquin River side of the Delta in  
31 response to water from the Sacramento River Basin flowing into the  
32 interconnecting waterways that join the San Joaquin River channel through the  
33 DCC, Georgiana Slough, and Threemile Slough. Closure of the DCC radial gates  
34 is intended to minimize straying, but some southward net flow still occurs  
35 naturally in Georgiana and Threemile sloughs.

36 Juvenile spring-run Chinook Salmon show two distinct outmigration patterns in  
37 the Central Valley: outmigrating to the Delta and ocean during their first year of  
38 life as YOY, or holding over in their natal streams and outmigrating the following  
39 fall/winter as yearlings. Peak movement of juvenile spring-run Chinook Salmon  
40 in the Sacramento River at Knights Landing generally occurs in December, and  
41 again in March. However, juveniles also have been observed migrating between  
42 November and the end of May (Snider and Titus 1998, 2000b, c, d; Vincik et al.  
43 2006; Roberts 2007).

1 YOY spring-run Chinook Salmon presence in the Delta peaks during April and  
2 May, as suggested by the recoveries of Chinook Salmon in the CVP and SWP  
3 salvage operations and the Chipps Island trawls of a size consistent with the  
4 predicted size of spring-run fish at that time of year. However, it is difficult to  
5 distinguish the YOY spring-run Chinook Salmon outmigration from that of the  
6 fall-run due to the similarity in their spawning and emergence times and size.  
7 Together, these two runs generate an extended pulse of Chinook Salmon smolts  
8 outmigrating through the Delta throughout spring, frequently lasting into June.  
9 Spring-run Chinook Salmon juveniles also overlap spatially with juvenile winter-  
10 run Chinook Salmon in the Delta (NMFS 2009a). Typically, juvenile spring-run  
11 Chinook Salmon are not found in the channels of the eastern side of the Delta or  
12 the mainstem of the San Joaquin River upstream of Columbia and Turner Cuts.

### 13 *Fall-/Late fall-run Chinook Salmon*

14 Central Valley fall- and late fall-run Chinook Salmon pass through the Delta as  
15 adults migrating upstream and juveniles outmigrating downstream. Adult fall-  
16 and late fall-run Chinook Salmon migrating through the Delta must navigate the  
17 many channels and avoid direct sources of mortality and minimize exposure to  
18 sources of nonlethal stress. Additionally, outmigrating juveniles are subject to  
19 predation and entrainment in the project export facilities and smaller diversions.

20 Adult fall-run Chinook Salmon migrate through the Delta and into Central Valley  
21 rivers from June through December. Adult late fall-run Chinook Salmon migrate  
22 through the Delta and into the Sacramento River from October through April.  
23 Adult Central Valley fall- and late fall-run Chinook Salmon migrating into the  
24 Sacramento River and its tributaries primarily use the western and northern  
25 portions of the Delta, whereas adults entering the San Joaquin River system to  
26 spawn use the western, central, and southern Delta as a migration pathway.

27 Most fall-run Chinook Salmon fry rear in fresh water from December through  
28 June, with outmigration as smolts primarily from January through June. In  
29 general, fall-run Chinook Salmon fry abundance in the Delta increases following  
30 high winter flows. Smolts that arrive in the estuary after rearing upstream migrate  
31 quickly through the Delta and Suisun and San Pablo bays. A small number of  
32 juvenile fall-run Chinook Salmon spend over a year in fresh water and outmigrate  
33 as yearling smolts the following November through April. Late fall-run fry rear  
34 in fresh water from April through the following April and outmigrate as smolts  
35 from October through February (Snider and Titus 2000b). Juvenile Chinook  
36 Salmon were found to spend about 40 days migrating through the Delta to the  
37 mouth of San Francisco Bay (MacFarlane and Norton 2002).

38 Results of mark-recapture studies conducted using juvenile Chinook Salmon  
39 released into both the Sacramento and San Joaquin rivers have shown high  
40 mortality during passage downstream through the rivers and Delta (Brandes and  
41 McLain 2001, Newman and Rice 2002, Buchanan et al. 2013). Juvenile salmon  
42 migrating from the San Joaquin River generally experience greater mortality than  
43 fish outmigrating from the Sacramento River. In years when spring flows are  
44 reduced and water temperatures are increased, mortality is typically higher in both  
45 rivers. Closing the DCC gates and installation of the Head of Old River Barrier to

1 reduce the movement of juvenile salmon into the south Delta from the  
2 Sacramento and San Joaquin rivers, respectively, may contribute to improved  
3 survival of outmigrating juvenile Chinook Salmon from these watersheds (see  
4 Section 9.3.4.12.6).

5 Although not directly comparable to these previous coded-wire tag studies in the  
6 San Joaquin River, Buchanan et al. (2013, 2015) found that survival of  
7 acoustically tagged hatchery-origin (Feather River) juvenile Chinook Salmon was  
8 either not statistically different between routes (2009) or was higher through the  
9 south Delta via the Old River route than via the San Joaquin River (2010).  
10 Additionally, most fish in the Old River that survived to the end of the Delta had  
11 been salvaged from the federal water export facility on the Old River and trucked  
12 around the remainder of the Delta (Buchanan et al. 2013, SJRGA 2013).  
13 Buchanan et al. 2013 indicated that the differences in their results compared to  
14 past CWT studies may reflect that an alternative non-physical barrier was being  
15 used during their investigation to examine its ability to keep fish out of the Old  
16 River instead of the HORB which is a physical barrier that reduces not only the  
17 number of fish, but also the majority of flows, from entering the Old River.  
18 Nonphysical barriers may deprive smolts routed to the San Joaquin River of the  
19 increased flows needed for improved survival and created habitat for increased  
20 predation at the site (Buchanan et al. 2013).

21 Juvenile fall- and late fall-run Chinook Salmon migrating through the Delta  
22 toward the Pacific Ocean use the Delta, Suisun Marsh, and the Yolo Bypass for  
23 rearing to varying degrees, depending on their life stage (fry versus juvenile),  
24 size, river flows, and time of year. Movement of juvenile Chinook Salmon in the  
25 estuarine environment is driven by the interaction between tidally influenced  
26 saltwater intrusion through San Francisco Bay and freshwater outflow from the  
27 Sacramento and San Joaquin rivers (Healey 1991).

28 In the Delta, tidal and floodplain habitat areas provide important rearing habitat  
29 for foraging juvenile salmonids, including fall-run Chinook Salmon. Studies have  
30 shown that juvenile salmon may spend 2 to 3 months rearing in these habitat  
31 areas, and losses resulting from land reclamation and levee construction are  
32 considered to be major stressors (Williams 2010). The channeled, leveed, and  
33 riprapped river reaches and sloughs common in the Delta typically have low  
34 habitat diversity and complexity, have low abundance of food organisms, and  
35 offer little protection from predation by fish and birds.

### 36 *Steelhead*

37 Upstream migration of steelhead begins with estuarine entry from the ocean as  
38 early as July and continues through February or March in most years (McEwan  
39 and Jackson 1996, NMFS 2009a). Populations of steelhead occur primarily  
40 within the watersheds of the Sacramento River Basin, although not exclusively.  
41 Steelhead can spawn more than once, with postspawn adults (typically females)  
42 potentially moving back downstream through the Delta after completion of  
43 spawning in their natal streams.

1 Adult steelhead can be present in portions of the Delta with suitable conditions  
2 during any month of the year. Upstream migrating adult steelhead enter the  
3 Sacramento and San Joaquin River basins through their respective mainstem river  
4 channels. Steelhead entering the Mokelumne River system (including Dry Creek  
5 and the Cosumnes River) and the Calaveras River system to spawn are likely to  
6 move up the mainstem San Joaquin River channel before branching off into the  
7 channels of their natal rivers, although some may detour through the South Delta  
8 waterways and enter the San Joaquin River through the Head of Old River.

9 Steelhead entering the San Joaquin River Basin appear to have a later spawning  
10 run, with adults entering the system starting in late October through December,  
11 indicating that migration up through the Delta may begin a few weeks earlier.  
12 During fall, warm water temperatures in the south Delta waterways and water  
13 quality impairment because of low dissolved oxygen at Stockton have been  
14 suggested as potential barriers to upstream migration (NMFS 2009a). Reduced  
15 water temperatures, as well as rainfall runoff and flood control release flows,  
16 provide the stimulus to adult steelhead holding in the Delta to move upriver  
17 toward their spawning reaches in the San Joaquin River tributaries. Adult  
18 steelhead may continue entering the San Joaquin River Basin through winter.

19 Juvenile steelhead can be found in all waterways of the Delta, but particularly in  
20 the main channels leading from their natal river systems (NMFS 2009a). Juvenile  
21 steelhead are recovered in trawls from October through July at Chipps Island and  
22 at Mossdale. Chipps Island catch data indicate there is a difference in the  
23 outmigration timing between wild and hatchery-reared steelhead smolts from the  
24 Sacramento and eastside tributaries. Hatchery fish are typically recovered at  
25 Chipps Island from January through March, with a peak in February and March  
26 corresponding to the schedule of hatchery releases of steelhead smolts from the  
27 Central Valley hatcheries (Nobriga and Cadrett 2001, Reclamation 2008a). The  
28 timing of wild (unmarked) steelhead outmigration is more spread out, and based  
29 on salvage records at the CVP and SWP fish collection facilities, outmigration  
30 occurs over approximately 6 months with the highest levels of recovery in  
31 February through June (Aasen 2011, 2012). Steelhead are salvaged annually at  
32 the project export facilities (e.g., 4,631 fish were salvaged in 2010, and 1,648 in  
33 2011) (Aasen 2011, 2012).

34 Outmigrating steelhead smolts enter the Delta primarily from the Sacramento or  
35 San Joaquin River. Mokelumne River steelhead smolts can either follow the  
36 north or south branches of the Mokelumne River through the central Delta before  
37 entering the San Joaquin River, although some fish may enter farther upstream if  
38 they diverge from the south branch of the Mokelumne River into Little Potato  
39 Slough. Calaveras River steelhead smolts enter the San Joaquin River  
40 downstream of the Port of Stockton. Although steelhead have been routinely  
41 documented by CDFW in trawls at Mossdale since 1988 (SJRG 2011), it is  
42 unknown whether successful outmigration occurs outside the seasonal installation  
43 of the barrier at the Head of Old River (between April 15 and May 15 in most  
44 years). Prior to the installation of the Head of Old River barrier, steelhead smolts  
45 exiting the San Joaquin River Basin could follow one of two routes to the ocean,

1 either staying in the mainstem San Joaquin River through the central Delta, or  
2 entering the Head of Old River and migrating through the south Delta and its  
3 associated network of channels and waterways.

4 *Green Sturgeon*

5 Green Sturgeon reach maturity around 14 to 16 years of age and can live to be  
6 70 years old, returning to their natal rivers every 3 to 5 years for spawning  
7 (Van Eenennaam et al. 2005). Adult Green Sturgeon move through the Delta  
8 from February through April, arriving at holding and spawning locations the  
9 upper Sacramento River between April and June (Heublein 2006, Kelly et al.  
10 2007). Following their initial spawning run upriver, adults may hold for a few  
11 weeks to months in the upper river before moving back downstream in fall  
12 (Vogel 2008, Heublein et al. 2009), or they may migrate immediately back  
13 downstream through the Delta. Radio-tagged adult Green Sturgeon have been  
14 tracked moving downstream past Knights Landing during summer and fall,  
15 typically in association with pulses of flow in the river (Heublein et al. 2009),  
16 similar to behavior exhibited by adult Green Sturgeon on the Rogue River and  
17 Klamath River systems (Erickson et al. 2002, Benson et al. 2007).

18 Similar to other estuaries along the west coast of North America, adult and sub-  
19 adult Green Sturgeon frequently congregate in the San Francisco Estuary during  
20 summer and fall (Lindley et al. 2008). Specifically, adults and subadults may  
21 reside for extended periods in the central Delta as well as in Suisun and San Pablo  
22 bays, presumably for feeding, because bays and estuaries are preferred feeding  
23 habitat rich in benthic invertebrates (e.g., amphipods, bivalves, and insect larvae).  
24 In part because of their bottom-oriented feeding habits, sturgeon are at risk of  
25 harmful accumulations of toxic pollutants in their tissues, especially pesticides  
26 such as pyrethroids and heavy metals such as selenium and mercury (Israel and  
27 Klimley 2008, Stewart et al. 2004).

28 Juvenile Green Sturgeon and White Sturgeon are periodically (although rarely)  
29 collected from the lower San Joaquin River at south Delta water diversion  
30 facilities and other sites (NMFS 2009a; Aasen 2011, 2012). Green Sturgeon are  
31 salvaged from the south Delta Project diversion facilities and are generally  
32 juveniles greater than 10 months but less than 3 years old (Reclamation 2008a).  
33 NMFS (2005b) suggested that the high percentage of San Joaquin River flows  
34 contributing to the Tracy Fish Collection Facility could mean that some entrained  
35 Green Sturgeon originated in the San Joaquin River Basin. Jackson (2013)  
36 reported spawning by White Sturgeon in the San Joaquin River, and anglers have  
37 reported catching a few Green Sturgeon in recent years in the San Joaquin River  
38 (DFG 2012b).

39 After hatching, larvae and juveniles migrate downstream toward the Delta.  
40 Juveniles are believed to use the Delta for rearing for the first 1 to 3 years of their  
41 lives before moving out to the ocean and are likely to be found in the main  
42 channels of the Delta and the larger interconnecting sloughs and waterways,  
43 especially within the central Delta and Suisun Bay/Marsh. Project operations at  
44 the DCC have the potential to reroute Green Sturgeon as they outmigrate through  
45 the lower Sacramento River to the Delta (Israel and Klimley 2008, Vogel 2011).

1 When the DCC is open, there is no passage delay for adults, but juveniles could  
2 be diverted from the Sacramento River into the interior Delta. This has been  
3 shown to reduce the survival of juvenile Chinook Salmon (Brandes and McLain  
4 2001, Newman and Brandes 2010, Perry et al. 2012), but it is unknown whether it  
5 has similar effects on Green Sturgeon.

#### 6 *White Sturgeon*

7 White Sturgeon are similar to Green Sturgeon in terms of their biology and life  
8 history. Like Green Sturgeon and other sturgeon species, White Sturgeon are  
9 late-maturing and infrequent spawners, which makes them vulnerable to  
10 overexploitation and other sources of adult mortality. White Sturgeon are  
11 believed to be most abundant within the San Francisco Bay-Delta region  
12 (Moyle 2002). Both nonspawning adults and juveniles can be found throughout  
13 the Delta year-round (Radtke 1966, Kohlhorst et al. 1991, Moyle 2002,  
14 DWR et al. 2013). When not undergoing spawning or ocean migrations, adults  
15 and subadults are usually most abundant in brackish portions of the Bay-Delta  
16 (Kohlhorst et al. 1991). The population status of White Sturgeon in the Delta is  
17 unclear, but it is not presently listed. Overall, information on trends in adults and  
18 juveniles suggests that numbers are declining (Moyle 2002, NMFS 2009a).

19 The Delta population of White Sturgeon spawns mainly in the Sacramento and  
20 Feather rivers, with occasional spawning in the San Joaquin River (Moyle 2002,  
21 Jackson 2013). Spawning-stage adults generally move into the lower reaches of  
22 rivers during winter prior to spawning and migrate upstream in response to higher  
23 flows to spawn from February to early June (McCabe and Tracy 1994,  
24 Schaffter 1997).

25 After absorbing yolk sacs and initiating feeding, YOY White Sturgeon make an  
26 active downstream migration that disperses them widely to rearing habitat  
27 throughout the lower rivers and the Delta (McCabe and Tracy 1994). White  
28 Sturgeon larvae have been observed to be flushed farther downstream in the Delta  
29 and Suisun Bay in high outflow years, but are restricted to more interior locations  
30 in low outflow years (Stevens and Miller 1970).

31 Salinity tolerance increases with increasing age and size (McEnroe and Cech  
32 1985), allowing White Sturgeon to access a broader range of habitat in the San  
33 Francisco Estuary (Israel et al. 2008). During dry years, White Sturgeon have  
34 been observed following brackish waters farther upstream, while the opposite  
35 occurs in wet years (Kohlhorst et al. 1991). Adult White Sturgeon tend to  
36 concentrate in deeper areas and tidal channels with soft bottoms, especially during  
37 low tides, and typically move into intertidal or shallow subtidal areas to feed  
38 during high tides (Moyle 2002). These shallow water habitats provide  
39 opportunities for feeding on benthic organisms, such as opossum shrimp,  
40 amphipods, and even invasive overbite clams, and small fishes (Israel et al. 2008,  
41 Kogut 2008). White Sturgeon also have been found in tidal habitats of  
42 medium-sized tributary streams to the San Francisco Estuary, such as Coyote  
43 Creek and Guadalupe River in the south bay and Napa and Petaluma rivers and  
44 Sonoma Creek in the north bay (Leidy 2007).

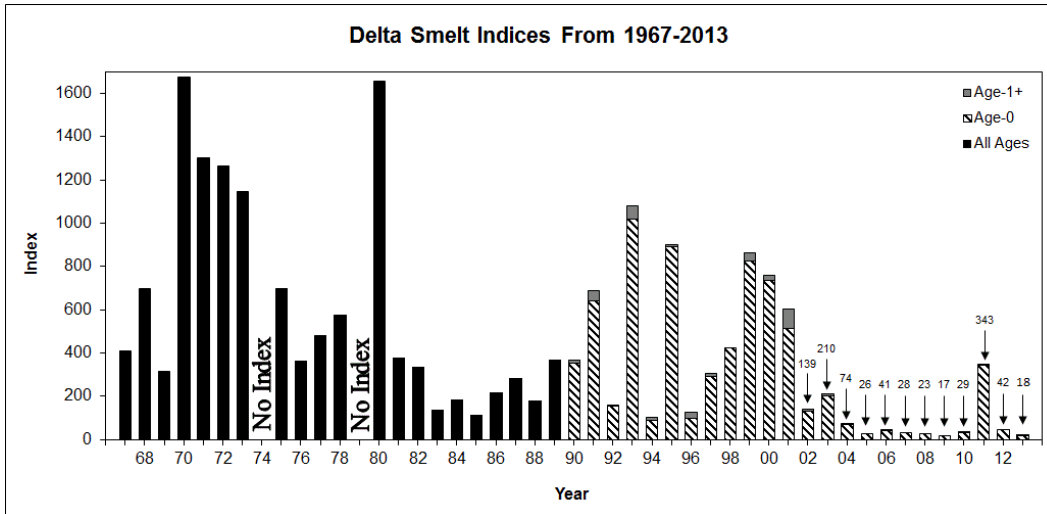


1 Numerous factors likely affect the White Sturgeon population in the Delta, similar  
2 to those for Green Sturgeon. Survival during early life history stages may be  
3 adversely affected by insufficient flows, lack of rearing habitat, predation, warm  
4 water temperatures, decreased dissolved oxygen, chemical toxicants in the water,  
5 and entrainment at diversions (Cech et al. 1984, Israel et al. 2008). Historical  
6 habitats, including shallow intertidal feeding habitats, have been lost in the Delta  
7 because of channelization. Over-exploitation by recreational fishing and  
8 poaching also likely has been an important factor adversely affecting numbers of  
9 adult sturgeon (Moyle 2002), although new regulations were implemented in  
10 2007 by CDFW to reduce harvest. Like Green Sturgeon, there are substantial  
11 passage problems for White Sturgeon such as the Fremont Weir  
12 (Sommer et al. 2014).

### 13 *Delta Smelt*

14 Delta Smelt are endemic to the Delta (Moyle et al. 1992, Bennett 2005). Delta  
15 Smelt were once regarded as one of the most common pelagic fish in the Delta,  
16 but declines in their population led to their listing under the ESA as threatened in  
17 1993 (USFWS 2008a). Delta Smelt are one of four pelagic fish species (including  
18 Longfin Smelt, Threadfin Shad, and juvenile Striped Bass) documented to be in  
19 decline based on fall midwater trawl abundance indices (Sommer et al. 2007a).  
20 The causes of the declines have been extensively studied and are thought to  
21 include a combination of factors, such as decreased habitat quantity and quality,  
22 increased mortality rates, and reduced food availability (Feyrer et al. 2007,  
23 Sommer et al. 2007a, Moyle and Bennett 2008, Baxter et al. 2010, MacNally et al.  
24 2010, Rose et al. 2013a, b, Sommer and Mejia 2013). Two statistical analyses  
25 that used similar data but different statistical methods, (MacNally et al. 2010;  
26 Thomson et al. 2010) examined the dynamics of the four fish species. Both  
27 analyses identified several covariates that were related to abundance of the fish,  
28 but they could not resolve the cause of the recent declines. The analysis of model  
29 results and data for 1995–2005 conducted by Rose et al. (2013a) indicated that it  
30 has been difficult to ascribe the Delta Smelt’s decline to a single cause, either  
31 over the long term or as part of the recent 2002 decline.

32 The status of the Delta Smelt is uncertain, as indicators of Delta Smelt abundance  
33 have continued to decline and the number of fish collected in sampling programs,  
34 such as the trawl surveys conducted by the IEP, have dropped even lower in  
35 recent years. The Fall Midwater Trawl (FMWT) Survey is recognized by some as  
36 the best available long-term index of Delta Smelt relative abundance  
37 (USFWS 2008). Figure 9.1 presents the FMWT abundance indices for Delta  
38 Smelt from 1967 to 2013 (CDFW 2014b). Fewer than 10 Delta Smelt were  
39 collected in these surveys in 2014; the 2014 Delta Smelt index was 9, making it  
40 the lowest in FMWT history (CDFW 2014a, 2015). Results for Delta Smelt from  
41 the 2015 spring Kodiak trawl, 20-mm survey, and summer townet survey reported  
42 in the June 2015 Smelt Working Group meeting summary were similarly low  
43 (Smelt Working Group 2015).



1

2 **Figure 9.1 Fall Midwater Trawl Abundance Indices for Delta Smelt from 1967**  
 3 **to 2013**

4 Source: California Department of Fish and Wildlife, Trends in Abundance of Selected  
 5 Species, January 15, 2014. <http://www.dfg.ca.gov/delta/data/fmwt/Indices/>

6 Studies conducted to synthesize available information about Delta Smelt indicate  
 7 that Delta Smelt have been documented throughout their geographic range during  
 8 much of the year (Merz et al. 2011, Sommer and Mejia 2013, Brown et al. 2014).  
 9 Studies indicate that in fall, prior to spawning, Delta Smelt are found in the Delta,  
 10 Suisun and San Pablo bays, the Sacramento River and San Joaquin River  
 11 confluence, Cache Slough, and the lower Sacramento River (Murphy and  
 12 Hamilton 2013). By spring, they move to freshwater areas of the Delta region,  
 13 including the Sacramento River and San Joaquin River confluence, the Upper  
 14 Sacramento River, and Cache Slough (Brown et al. 2014, Murphy and  
 15 Hamilton 2013).

16 Sommer et al. 2011 described that during winter, adult Delta Smelt initiate  
 17 upstream spawning migrations in association with “first flush” freshets. Others  
 18 report this seasonal change as a multi-directional and more circumscribed  
 19 dispersal movement to freshwater areas throughout the Delta region (Murphy and  
 20 Hamilton 2013). After arriving in freshwater staging habitats, adult Delta Smelt  
 21 hold until spawning commences during favorable water temperatures in the late  
 22 winter-spring (Bennett 2005, Grimaldo et al. 2009, Sommer et al. 2011). Delta  
 23 Smelt spawn over a wide area throughout much of the Delta, including some areas  
 24 downstream and upstream as conditions allow. Although the specific substrates  
 25 or habitats used for spawning by Delta Smelt are not known, spawning habitat  
 26 preferences of closely related species (Bennett 2005) suggest that spawning may  
 27 occur in shallow areas over sandy substrates. The nonpelagic habitats used by  
 28 larval Delta Smelt before they move into the pelagic areas also are not known  
 29 (Swanson et al. 1998, Sommer et al. 2011).

1 During and after larval rearing in fresh water, many young Delta Smelt move with  
2 river and tidal currents to remain in favorable rearing habitats, often moving  
3 increasingly into the low salinity zone to avoid seasonally warm and highly  
4 transparent waters that typify many areas in the central Delta (Nobriga et al.  
5 2008). Bennett and Burau (2014) showed that during winter, delta smelt  
6 aggregate near frontal zones at the shoal-channel interface moving laterally into  
7 the shoals on ebb tides and back into the channel on flood tides. They suggest  
8 that this migration strategy can minimize the energy spent swimming against  
9 strong river and tidal currents, as well as predation risks by remaining in  
10 turbid water.

11 During summer and fall, many juvenile Delta Smelt continue to grow and rear in  
12 the low salinity zone until maturing the following winter (Bennett 2005). Some  
13 Delta Smelt also rear in upstream areas such as the Cache Slough complex and  
14 Sacramento Deepwater Ship Channel, depending on habitat conditions (Sommer  
15 and Mejia 2013).

16 During summer and fall, the distribution of juvenile Delta Smelt rearing is  
17 influenced by the position of the low salinity zone (as indexed by the position of  
18 X2), although their distribution can also be influenced by temperature and  
19 turbidity (Bennett 2005; Feyrer et al. 2007, 2010; Kimmerer et al. 2009; Sommer  
20 and Mejia 2013). The geographical position of the low salinity zone varies  
21 primarily as a function of freshwater outflow; thus, X2 typically lies farther east  
22 in summer and fall during low outflow conditions and drier water years and  
23 farther west during high outflow conditions (Jassby et al. 1995).

24 Higher outflow causes X2 and the low salinity zone to more frequently overlap  
25 with the Suisun Bay/Marsh region, which is broader and shallower and typically  
26 has greater turbidity than the mainstem Sacramento and San Joaquin rivers. The  
27 overlap of the low salinity zone (or X2) with the Suisun Bay/Marsh results in a  
28 dramatic increase in the habitat index (Feyrer et al. 2010); however others (see  
29 Manly et al. 2015) have questioned the use by Feyrer et al. (2010) of outflow and  
30 X2 location as an indicator of Delta Smelt habitat because other factors may be  
31 influencing survival.

32 In addition to salinity, turbidity is an important factor associated with habitat use;  
33 Delta Smelt show a strong preference for higher turbidity water (Feyrer et al.  
34 2007, 2010; Sommer and Mejia 2013) and turbidity may be a key habitat feature  
35 and cue initiating the delta smelt spawning migration (Bennett and Burau 2014).  
36 Turbidity has decreased in recent decades within the Delta (Kimmerer 2004,  
37 Schoellhamer 2011), which has likely contributed to declines in environmental  
38 quality of Delta Smelt habitat (Feyrer et al. 2007, 2010). Higher turbidities are  
39 believed to allow Delta Smelt to hide from open-water predators, such as Striped  
40 Bass (Gregory and Levings 1998, Nobriga et al. 2005), and contribute to feeding  
41 success (Lindberg et al. 2000, IEP 2015).

42 Water temperature is another important environmental factor that affects Delta  
43 Smelt habitat and population dynamics (Sommer and Mejia 2013). A longer  
44 period of optimal water temperatures in cooler years increases the number of

1 spawning events and cohorts produced (Bennett 2005). During rearing, summer  
2 water temperatures also have been shown to be an important predictor of Delta  
3 Smelt occurrence, based on multi-decadal analyses of summer tow net survey data  
4 (Nobriga et al. 2008).

5 The quality and availability of food also have important effects on the abundance  
6 and distribution of Delta Smelt (Sommer and Mejia 2013, Kimmerer 2008). Delta  
7 Smelt feed primarily on zooplankton, and Nobriga (2002) showed that Delta  
8 Smelt larvae with food in their guts typically co-occurred with higher calanoid  
9 copepod densities. Food quality and availability have varied substantially, largely  
10 because of the history of nonnative species introduction into the San Francisco  
11 Estuary (Baxter et al. 2008, Winder and Jassby 2011). The decline of  
12 zooplankton in the western Delta has been hypothesized to be related to several  
13 factors, including increased ammonium concentrations from wastewater effluent  
14 and agricultural runoff (Wilkerson et al. 2006; Dugdale et al. 2007; Miller et al.  
15 2012; Glibert 2010; Glibert et al. 2011, 2014).

16 In 2011 and 2012, an unanticipated change in water management operations led to  
17 relatively large phytoplankton blooms in the western Delta, including in the  
18 Sacramento River near Rio Vista. Historically, rice fields along the Colusa Basin  
19 Drain are flooded in fall to decompose the rice stubble, and the water is released  
20 through the Knights Landing Outfall gates into the Sacramento River. In 2011  
21 and 2012, construction at the outfall gates required the water to be diverted into  
22 the Yolo Bypass, resulting in higher than normal flows. These events temporarily  
23 resulted in a fall pulse flow in the Yolo Bypass that increased the volume of flow  
24 by more than 300 to 900 percent (Frantzich 2014). Concurrently, a substantial  
25 increase in nutrients, phytoplankton, and zooplankton was observed in the Yolo  
26 Bypass and Cache Slough. In 2013, the fall pulse flow of rice drainage water did  
27 not occur in the Yolo Bypass, and nutrient concentrations did not increase. These  
28 nutrient inputs, when they occur, and corresponding increases in phytoplankton  
29 and zooplankton production, could contribute to improved foraging opportunities  
30 for Delta Smelt.

31 Results in prior years indicate that entrainment and salvage-related mortality of  
32 Delta Smelt associated with water pumping and CVP/SWP exports from the Delta  
33 occur primarily from December to July (Kimmerer 2008, Grimaldo et al. 2009,  
34 Baxter et al. 2010). Entrainment occurs when migrating and spawning adult Delta  
35 Smelt and their larvae overlap in time and space with reverse (southward, or  
36 upstream) flows in the Old and Middle river channels (Kimmerer 2008, Grimaldo  
37 et al. 2009, Baxter et al. 2010).

38 In January 2015, the IEP Management Analysis and Synthesis Team (MAST)  
39 published a report to provide an assessment and conceptual model of factors  
40 affecting Delta Smelt throughout its life cycle. One focus of the report was an  
41 evaluation of a notable increase in abundance of all Delta Smelt life stages in  
42 2011, which indicated that the Delta Smelt population could potentially rebound  
43 when conditions are favorable for spawning, growth, and survival.

1 The IEP MAST updated conceptual model described the habitat conditions and  
2 ecosystem drivers affecting each Delta Smelt life stage, across seasons and how  
3 the seasonal effects contributed to the annual success of the species. The  
4 conclusions of the report highlighted some key points about Delta Smelt and their  
5 habitat, using 2011 as the example year. In summary, the report concluded that  
6 Delta Smelt likely benefitted from the following favorable habitat conditions  
7 in 2011:

- 8 1) Adults and larvae benefitted from high winter 2010 and spring 2011 outflows,  
9 which reduced entrainment risk and possibly improved other habitat  
10 conditions, prolonged cool spring water temperatures, and possibly good food  
11 availability in late spring.
- 12 2) Juvenile Delta Smelt benefitted from cool water temperatures in late spring  
13 and early summer as well as from relatively good food availability and low  
14 levels of harmful *Microcystis*.
- 15 3) Subadults benefitted from good food availability and from favorable habitat  
16 conditions in the large low salinity zone, located more toward Suisun Bay in  
17 2010.

#### 18 *Longfin Smelt*

19 Longfin Smelt populations occur along the Pacific Coast of North America, and  
20 the San Francisco Estuary represents the southernmost population. Longfin Smelt  
21 generally occur in the Delta; Suisun, San Pablo, and San Francisco bays; and the  
22 Gulf of the Farallones, just outside San Francisco Bay. Longfin Smelt are not a  
23 focus of any specific RPA actions. However, RPA actions that benefit Delta  
24 Smelt, salmonids, and sturgeon, including increasing Delta outflow, have the  
25 potential to benefit other fish, including Longfin Smelt, given their similar habitat  
26 requirements and trophic feeding levels.

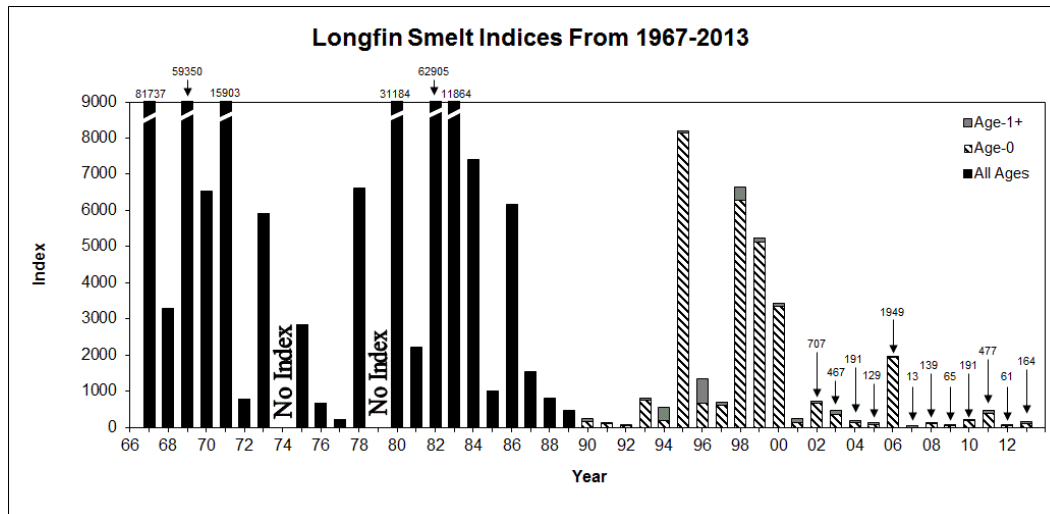
27 Longfin Smelt are anadromous and spawn in fresh water in the Delta, generally at  
28 2 years of age (Moyle 2002). They migrate upstream to spawn during late fall  
29 through winter, with most spawning from November through April (DFG 2009a).  
30 Spawning in the Sacramento River is believed to occur from just downstream of  
31 the confluence of the Sacramento and San Joaquin rivers upstream to about Rio  
32 Vista. Spawning on the San Joaquin River extends from the confluence upstream  
33 to about Medford Island (Moyle 2002). Spawning likely also occurs in Suisun  
34 Marsh and the Napa River (DFG 2009a).

35 Longfin Smelt larvae are most abundant in the water column usually from January  
36 through April (Reclamation 2008a). The geographic distribution of Longfin  
37 Smelt larvae is closely associated with the position of X2; the center of  
38 distribution varies with outflow conditions, but not with respect to X2 (Dege and  
39 Brown 2004). This pattern is consistent with juveniles migrating downstream to  
40 low salinity, brackish habitats for growth and rearing. Larger Longfin Smelt feed  
41 primarily on opossum shrimps and other invertebrates (Feyrer et al. 2003).  
42 Copepods and other crustaceans also can be important food items, especially for  
43 smaller fish (Reclamation 2008a).

1 Longfin Smelt in the San Francisco Estuary are broadly distributed in both time  
2 and space, and interannual distribution patterns are relatively consistent  
3 (Rosenfield and Baxter 2007). Seasonal patterns in abundance indicate that the  
4 population is at least partially anadromous (Rosenfield and Baxter 2007), and the  
5 detection of Longfin Smelt within the estuary throughout the year suggests that,  
6 similar to Striped Bass, anadromy is one of several life history strategies or  
7 contingents in this population.

8 The relative population size of Longfin Smelt in the San Francisco Estuary is  
9 measured by indices of abundance generated from different sampling programs.  
10 The abundance of age 0 and older fish is best indexed by the Fall Midwater Trawl  
11 and Bay Study, while the abundance of larvae and young juveniles is best indexed  
12 by the 20-mm survey. The relationship between these indices and actual  
13 population sizes is unknown. Although the Fall Midwater Trawl data suggest a  
14 sharp decline in Longfin Smelt abundance during the last decade, some of that  
15 decline might be attributable to a downstream movement in the longfin  
16 distribution into regions better covered by the Bay Study fish survey. The Bay  
17 Study uses two types of trawls, an otter trawl and a midwater Trawl. The Longfin  
18 Smelt abundance index created from the Fall Midwater Trawl is consistent with  
19 the trend in the Bay Study midwater trawl but not the Bay Study otter Trawl. In  
20 addition, there have been an increasing proportion of false zeros in the survey data  
21 where the Bay Study midwater trawl failed to detect any Longfin Smelt when  
22 they were detected in the otter trawl.

23 The abundance of Longfin Smelt in the estuary has fluctuated over time but has  
24 exhibited statistically significant step-declines around 1989 to 1991 and in 2004  
25 (Thomson et al. 2010). A synthesis of prior studies conducted by USFWS in its  
26 12-Month Finding on a Petition to List the San Francisco Bay-Delta Population of  
27 the Longfin Smelt as Endangered or Threatened (USFWS 2012) reported that  
28 increased Delta outflow in winter and spring is the largest factor possibly  
29 affecting Longfin Smelt abundance. The trend in Longfin Smelt abundance from  
30 1967 through 2013 is presented on Figure 9.2.



1

2 **Figure 9.2 Fall Midwater Trawl Abundance Indices for Longfin Smelt from 1967 to**  
 3 **2013**

4 Source: California Department of Fish and Wildlife, Trends in Abundance of Selected  
 5 Species, January 15, 2014. <http://www.dfg.ca.gov/delta/data/fmwt/Indices/>

6 Habitat for Longfin Smelt is open water, largely away from shorelines and  
 7 vegetated inshore areas except perhaps during spawning. This includes all of the  
 8 large embayments in the estuary and the deeper areas of many of the larger  
 9 channels in the western Delta; habitat suitability in these areas for Longfin Smelt  
 10 can be strongly influenced by variation in freshwater flow (Jassby et al. 1995,  
 11 Bennett and Moyle 1996, Kimmerer 2004, Kimmerer et al. 2009).

12 Water exports and inadvertent entrainment at the SWP and CVP export facilities  
 13 are anthropogenic sources of mortality for Longfin Smelt. The export facilities  
 14 are known to entrain most species of fish in the Delta (Brown et al. 1996).  
 15 Longfin Smelt entrainment mainly occurs from December to May, with peak  
 16 adult entrainment from December to February (Grimaldo et al. 2009). In water  
 17 year 2011, Aasen (2012) reported four adult Longfin Smelt were salvaged at the  
 18 project export facilities, compared with much higher numbers in the early 2000s  
 19 and late 1980s. The entrainment of Longfin Smelt in recent years has been  
 20 reduced likely because of changes in export operations and a decline in  
 21 abundance.

22 *Sacramento Splittail*

23 Sacramento Splittail are found primarily in marshes, turbid sloughs, and slow-  
 24 moving river reaches throughout the Delta subregion (Sommer et al. 1997, 2008).  
 25 Sacramento Splittail are most abundant in moderately shallow, brackish tidal  
 26 sloughs and adjacent open-water areas, but they also can be found in freshwater  
 27 areas with tidal or riverine flow (Moyle et al. 2004).

28 Adult Sacramento Splittail typically migrate upstream from brackish areas in  
 29 January and February and spawn in fresh water, particularly on inundated  
 30 floodplains when they are available, in March and April (Sommer et al. 1997,  
 31 Moyle et al. 2004, Sommer et al. 2008). A substantial amount of splittail

1 spawning occurs in the Yolo and Sutter bypasses and the Cosumnes River area of  
2 the Delta (Moyle et al. 2004). Spawning also can occur in the San Joaquin River  
3 during high-flow events (Sommer et al. 1997, 2008). However, not all adults  
4 migrate significant distances to spawn as evidenced by spawning in the Napa and  
5 Petaluma rivers (Feyrer et al. 2005).

6 Although juvenile Sacramento Splittail are known to rear in upstream areas for a  
7 year or more (Baxter 1999), most move to the Delta after only a few weeks or  
8 months of rearing in floodplain habitats along the rivers (Feyrer et al. 2006).  
9 Juveniles move downstream into the Delta from April to August (Meng and  
10 Moyle 1995, Feyrer et al. 2005). Sacramento Splittail recruitment is largely  
11 limited by extent and period of inundation of floodplain spawning habitats, with  
12 abundance observed to spike following wet years and dip after dry years  
13 (Moyle et al. 2004). However, the 5- to 7-year life span buffers the adult  
14 population abundance (Sommer et al. 1997, Moyle et al. 2004). Other factors that  
15 may adversely affect the splittail population in the Delta include entrainment,  
16 predation, changed estuarine hydraulics, nonnative species (Moyle et al. 2004),  
17 pollutants (Greenfield et al. 2008), and limited food.

#### 18 *American Shad*

19 American Shad is a recreationally important anadromous species introduced into  
20 the Sacramento-San Joaquin River Basin in the 1870s (Moyle 2002). American  
21 Shad spend most of their adult life at sea and may make extensive migrations  
22 along the coast. American Shad become sexually mature while in the ocean and  
23 migrate through the Delta to spawning areas in the Sacramento, Feather,  
24 American, and Yuba rivers. Some spawning also takes place in the lower San  
25 Joaquin, Mokelumne, and Stanislaus rivers (USFWS 1995). The spawning  
26 migration may begin as early as February, but most adults migrate into the Delta  
27 in March and early April (Skinner 1962). Migrating adults generally take 2 to  
28 3 months to pass through the Sacramento-San Joaquin estuary (Painter et al.  
29 1979).

30 Fertilized eggs are slightly negative buoyant, are not adhesive, and drift in the  
31 current. Newly hatched larvae are found downstream of spawning areas and can  
32 be rapidly transported downstream by river currents because of their small size.  
33 Juvenile shad rear in the Sacramento River below Knights Landing, the Feather  
34 River below Yuba City, and the Delta; rearing also takes place in the Mokelumne  
35 River near the DCC to the San Joaquin River. No rearing occurs in the American  
36 and Yuba rivers (Painter et al. 1979). Some juvenile shad may rear in the Delta  
37 for up to a year before outmigrating to the ocean (USFWS 1995). Outmigration  
38 from the Delta begins in late June and continues through November  
39 (Painter et al. 1979).

40 Juvenile American Shad are frequently encountered in the Delta during the  
41 FMWT Survey and in fish salvage monitoring at the south Delta SWP and CVP  
42 fish facilities (DWR et al. 2013). American Shad use of the Delta has been  
43 observed to vary with salinity (e.g., X2 position) and outflows (Kimmerer 2002).



1 American Shad are entrained at the Tracy Fish Collection Facility (Bowen et al.  
2 1998) and in the Clifton Court Forebay, mostly during May through December  
3 when young American Shad migrate downstream. The American Shad  
4 population in the Sacramento-San Joaquin River Basin has declined since the late  
5 1970s, most likely because of increased diversion of water from rivers and the  
6 Delta, combined with changing ocean conditions, and possibly pesticides  
7 (Moyle 2002). Salvage of American Shad at project export facilities in water year  
8 2011 represented nearly 659,000 fish (Aasen 2012), with similar but slightly  
9 lower salvage in 2010 (545,125 fish) (Aasen 2011).

10 *Striped Bass*

11 Striped Bass is a recreationally important anadromous species introduced into the  
12 Sacramento-San Joaquin River Basin between 1879 and 1882 (Moyle 2002).  
13 Despite their nonnative status and piscivorous feeding habits, Striped Bass are  
14 considered important because they are a major game fish in the Delta. Striped  
15 Bass use the Delta as a migratory route and for rearing and seasonal foraging.  
16 Striped Bass spend the majority of their lives in salt water, returning to fresh  
17 water to spawn. When not migrating for spawning, adult Striped Bass in the San  
18 Francisco Bay-Delta are found in San Pablo Bay, San Francisco Bay, and the  
19 Pacific Ocean (Moyle 2002). Adult Striped Bass spend about 6 to 9 months of the  
20 year in San Francisco and San Pablo bays (Hassler 1988). Striped Bass also use  
21 deeper areas of many of the larger channels in the Delta, in addition to large  
22 embayments such as Suisun Bay.

23 Spawning occurs in spring, primarily in the Sacramento River between  
24 Sacramento and Colusa and in the San Joaquin River between Antioch and  
25 Venice Island (Farley 1966). Eggs are free-floating and negatively buoyant and  
26 hatch as they drift downstream, with larvae occurring in shallow and open waters  
27 of the lower reaches of the Sacramento-San Joaquin rivers, the Delta, Suisun Bay,  
28 Montezuma Slough, and Carquinez Strait. According to Hassler (1988), the  
29 distribution of larvae in the estuary depends on river flow. In low-flow years, all  
30 Striped Bass eggs and larvae are found in the Delta, while in high-flow years, the  
31 majority of eggs and larvae are transported downstream into Suisun Bay.

32 YOY Striped Bass distribute themselves in accordance with the estuarine salinity  
33 gradient (Kimmerer 2002, Feyrer et al. 2007), indicating that salinity is a major  
34 factor affecting their habitat use and geographic distributions. Kimmerer (2002)  
35 found that distributions of fish species, including Striped Bass, substantially  
36 overlapped with the low salinity zone. Older Striped Bass are increasingly  
37 flexible about their distribution relative to salinity (Moyle 2002).

38 The entrainment of Striped Bass has been observed at the project export facilities,  
39 including Clifton Court Forebay (Stevens et al. 1985, Bowen et al. 1998,  
40 Aasen 2012). In water year 2011, salvage of Striped Bass at export facilities  
41 (approximately 550,000 fish) continued a generally low trend observed since the  
42 mid-1990s. Prior to 1995, annual Striped Bass salvage was generally above  
43 1 million fish (Aasen 2012). DWR et al. (2013) reported that Striped Bass longer  
44 than 24 mm were effectively screened at Tracy Fish Collection Facility and

1 bypassed the pumps. However, planktonic eggs, larvae, and juveniles smaller  
2 than 24 mm in length received no protection from entrainment.

3 Striped Bass, primarily YOY, are one of the pelagic fish of the upper estuary that  
4 have shown substantial variability in their populations, with evidence of long-  
5 term declines (Kimmerer et al. 2000, Sommer et al. 2007a). As discussed earlier  
6 for Delta Smelt, a substantial portion of the abundance patterns has been  
7 associated with variation of outflow in the estuary (Jassby et al. 1995, Kimmerer  
8 et al. 2001, Loboschefskey et al. 2012), although this is disputed by some  
9 stakeholders (Bourez 2011). However, surveys showed that population levels for  
10 YOY Striped Bass began to decline sharply around 1987 and 2002  
11 (Thomson et al. 2010), despite relatively moderate hydrology, which typically  
12 supports at least modest fish production (Sommer et al. 2007a). Moyle (2002)  
13 cites causes of decline in Striped Bass to include climatic factors, entrainment at  
14 project export facilities in the south Delta, other diversions, pollutants, reduced  
15 estuarine productivity, invasions by alien species, and human exploitation.  
16 Kimmerer et al. (2000, 2001) attribute the decline in juvenile YOY Striped Bass  
17 to declining carrying capacity, likely related to food limitation. Loboschefskey  
18 et al. (2012) showed that there had been no long-term decline for age 1 and older  
19 Striped Bass as of 2004.

#### 20 *Pacific Lamprey*

21 The Pacific Lamprey is a widely distributed species that uses the Delta for  
22 upstream migration as adults, for downstream migration as juveniles, and for  
23 rearing as ammocoetes (larval form) (Hanni et al. 2006, Moyle et al. 2009).  
24 Pacific Lampreys are present in the north, central, and south Delta, and  
25 ammocoetes are present year-round in all of the regions (DWR et al. 2013).  
26 Limited information on status of Pacific Lamprey in the Delta exists, but the  
27 number of lampreys inhabiting the Delta is likely greatly suppressed compared  
28 with historical levels, as suggested by the loss of access to historical habitat and  
29 apparent population declines throughout California and the Sacramento-San  
30 Joaquin River Basin (Moyle et al. 2009).

31 Limited data indicate most adult Pacific Lamprey migrate through the Delta  
32 enroute to upstream holding and spawning grounds in the early spring through  
33 early summer (Hanni et al. 2006). As documented in other large river systems, it  
34 is likely that some adult migration through the Delta occurs from late fall and  
35 winter through summer and possibly over an even broader period (Robinson and  
36 Bayer 2005, Hanni et al. 2006, Moyle et al. 2009, Clemens et al. 2012, Lampman  
37 2011). Data from the FMWT Survey in the lower Sacramento and San Joaquin  
38 rivers and Suisun Bay suggest that peak outmigration of Pacific Lamprey through  
39 the Delta coincides with high-flow events from fall through spring (Hanni et al.  
40 2006). Some outmigration likely occurs year-round, as observed at sites farther  
41 upstream (Hanni et al. 2006), and in other river systems (Moyle 2002). Some  
42 Pacific Lamprey ammocoetes likely spend part of their extended (5 to 7 years)  
43 freshwater residence rearing in the Delta, particularly in the upstream, freshwater  
44 portions (DWR et al. 2013).

1 **9.3.4.12.2 Aquatic Habitat**

2 Flow management in the Delta has created stress on aquatic resources by  
3 (1) changing aspects of the historical flow regime (timing, magnitude, duration)  
4 that supported life history traits of native species; (2) limiting access to or quality  
5 of habitat; (3) contributing to conditions better suited to invasive, nonnative  
6 species (reduced spring flows, increased summer inflows and exports, and low  
7 and less-variable interior Delta salinity [Moyle and Bennett 2008]); and  
8 (4) causing reverse flows in channels leading to project export facilities that can  
9 entrain fish (Mount et al. 2012). Native species of the Delta are adapted to and  
10 depend on variable flow conditions at multiple scales as influenced by the  
11 region's dramatic seasonal and interannual climatic variation. In particular, most  
12 native fishes evolved reproductive or outmigration timing associated with  
13 historical peak flows during spring (Moyle 2002).

14 Water temperatures in the Delta follow a seasonal pattern of winter cold-water  
15 conditions and summer warm-water conditions, largely because of the region's  
16 Mediterranean climate, with alternating cool-wet and hot-dry seasons. Currently  
17 in the Delta, the most significant changes in water temperatures have been in the  
18 form of increased summer water temperatures over large areas of the Delta  
19 because of high summer ambient air temperatures, the increased temperature of  
20 river inflows, and to a lesser extent, reduced quantities of freshwater inflow and  
21 modified tidal and groundwater hydraulics (Kimmerer 2004, Mount et al. 2012,  
22 NRC 2012, Wagner et al. 2011). Water temperatures in summer now approach or  
23 exceed the upper thermal tolerances (e.g., 20 to 25° Centigrade [C]) for  
24 cold-water fish species such as salmonids and Delta-dependent species such as  
25 Delta Smelt. This is especially true in parts of the south Delta and San Joaquin  
26 River, potentially restricting the distribution of these species and precluding  
27 previously important rearing areas (NRC 2012).

28 Landscape-scale changes resulting from flood management infrastructure, along  
29 with flow modification, have eliminated most of the historical hydrologic  
30 connectivity of floodplains and aquatic ecosystems in the Delta and its tributaries,  
31 thereby degrading and diminishing Delta habitat for native plant and animal  
32 communities (Mount et al. 2012). The large reduction of hydrologic variability  
33 and landscape complexity, coupled with degradation of water quality, has  
34 supported invasive aquatic species that have further degraded conditions for  
35 native species. Due to the combination of these factors, the Delta appears to have  
36 undergone an ecological regime shift unfavorable to many native species (Moyle  
37 and Bennett 2008, Baxter et al. 2010). The major species influenced by current  
38 Delta hydrology include Delta Smelt, Longfin Smelt, Sacramento Splittail, White  
39 Sturgeon, juvenile Chinook Salmon, and Striped Bass (Jassby et al. 1995,  
40 Kimmerer 2002, Rosenfield and Baxter 2007, Kimmerer et al. 2009, Fish 2010,  
41 Perry et al. 2012, Thomson et al. 2010, Feyrer et al. 2010, Loboschefskey et al.  
42 2012, Mount et al. 2012).

43 Salinity is a critical factor influencing plant and animal communities in the Delta.  
44 Although estuarine fish species are generally tolerant of a range of salinity, this  
45 varies by species and lifestage. Some species can be highly sensitive to

1 excessively low or high salinity during physiologically vulnerable periods, such  
2 as reproductive and early life history stages. Although the Delta is tidally  
3 influenced, most of the Delta is fresh water year-round, due to inflows from  
4 rivers. The south Delta can have low salinity because of agricultural return water.  
5 The tidally influenced low salinity zone can move upstream into the central Delta.

6 An important measure of the spatial geography of salinity in the western Delta is  
7 X2. The X2 has also been correlated with the amount of suitable habitat for Delta  
8 Smelt in fall (Feyrer et al. 2007, 2010; USFWS 2008a). It is also helps define the  
9 extent of habitat available for oligohaline pelagic organisms and their prey. An  
10 analysis of historical monitoring data by Feyrer et al. (2007) revealed that the  
11 abiotic habitat of Delta Smelt can be defined as a specific envelope of salinity and  
12 turbidity that changes over the course of the species' life cycle. Project operations  
13 and other potential factors (e.g., lower outflows) have tended to shift the X2  
14 position in fall farther upstream out of the wide expanse of Suisun Bay into the  
15 much narrower channels near the confluence of the Sacramento and San Joaquin  
16 rivers (near Collinsville), reducing the spatial extent of low salinity habitat  
17 important for relevant species such as Delta Smelt (USFWS 2008a, 2011a;  
18 Kimmerer et al. 2009; Baxter et al. 2010). However, there is emerging  
19 information suggesting that a comparison of the Delta outflow during pre-project  
20 and post-project time periods do not support the conclusion that project operations  
21 have significantly moved X2 more easterly in September and October compared  
22 to pre-project conditions and project operations have only potentially impacted  
23 X2 location in November (Hutton et al. in press).

#### 24 **9.3.4.12.3 Nutrients and Food Web Support**

25 Nutrients are essential components of terrestrial and aquatic environments  
26 because they provide a resource base for primary producers. Typically in  
27 freshwater aquatic environments, phosphorous is the primary limiting  
28 macronutrient, whereas in marine aquatic environments, nitrogen tends to be  
29 limiting. A balanced range of abundant nutrients provides optimal conditions for  
30 maximum primary production, a robust food web, and productive fish  
31 populations. However, changes in nutrient loadings and forms, excessive  
32 amounts of nutrients, and altered nutrient ratios can lead to eutrophication and a  
33 suite of problems in aquatic ecosystems, such as low dissolved oxygen  
34 concentrations, un-ionized ammonia, excessive growth of toxic forms of  
35 cyanobacteria, and changes in components of the food web. Nutrient  
36 concentrations in the Delta have been well studied (Jassby et al. 2002;  
37 Kimmerer 2004; Van Nieuwenhuysse 2007; Glibert 2010; Glibert et al. 2011,  
38 2014).

39 Estuaries are commonly characterized as highly productive nursery areas for  
40 numerous aquatic organisms. Nixon (1988) noted that there is a broad continuum  
41 of primary productivity levels in different estuaries, which in turn affects fish  
42 production and abundance. Compared to other estuaries, pelagic primary  
43 productivity in the upper San Francisco Estuary is relatively poor, and a relatively  
44 low fish yield is expected (Wilkerson et al. 2006). In the Delta and Suisun Marsh,  
45 this appears to result from turbidity, clam grazing (Jassby et al. 2002), and

1 nitrogen and phosphorus dynamics (Wilkerson et al. 2006, Van Nieuwenhuysen  
2 2007, Glibert 2010, Glibert et al. 2014).

3 There has been a significant long-term decline in phytoplankton biomass  
4 (chlorophyll a) and primary productivity to low levels in the Suisun Bay region  
5 and the Delta (Jassby et al. 2002). Shifts in nutrient concentrations such as high  
6 levels of ammonium and nitrogen to phosphorus ratio may contribute to the  
7 phytoplankton reduction and to changes in algal species composition in the San  
8 Francisco Estuary (Wilkerson et al. 2006; Dugdale et al. 2007; Lehman et al.  
9 2005, 2008b, 2010; Glibert 2010; Glibert et al. 2014). Low and declining primary  
10 productivity in the estuary may be contributing to the long-term pattern of  
11 relatively low and declining biomass of pelagic fishes (Jassby et al. 2002).

12 The introductions of two clams from Asia have led to major alterations in the food  
13 web in the Delta. *Potamocorbula* is most abundant in the brackish and saline  
14 water of Suisun Bay and the western Delta, and *Corbicula* is most abundant in the  
15 fresh water of the central Delta. These filter feeders significantly reduce the  
16 phytoplankton and zooplankton concentrations in the water column, reducing  
17 food availability for native fishes, such as Delta Smelt and young Chinook  
18 Salmon (Feyrer et al. 2007, Kimmerer 2002).

19 Additionally, introduction of the clams led to the decline of higher-food-quality  
20 native copepods and the establishment of poorer quality nonnative copepods.  
21 More recently, the cyclopoid copepod, *Limnoithona*, has rapidly become the most  
22 abundant copepod in the Delta after its introduction in 1993 (Hennessy and  
23 Enderlein 2013). This species is hypothesized to be a low-quality food source and  
24 intraguild predator of native and nonnative calanoid copepods (CRA 2005). The  
25 clam *Potamocorbula* also has been implicated in the reduction of the native  
26 opossum shrimp, a preferred food of Delta native fishes such as Sacramento  
27 Splittail and Longfin Smelt (Feyrer et al. 2003). Reductions in food availability  
28 and food quality have led to lower fish foraging efficiency and reduced growth  
29 rates (Moyle 2002).

30 Studies on food quality have been relatively limited in the San Francisco Estuary,  
31 with even less information on long-term trends. Nonetheless, several studies have  
32 documented or suggested the food limitations for aquatic species in the estuary,  
33 including zooplankton (Mueller-Solger et al. 2002, Kimmerer et al. 2005), Delta  
34 Smelt (Bennett 2005, Bennett et al. 2008), Chinook Salmon (Sommer et al.  
35 2001a), Sacramento Splittail (Greenfield et al. 2008), Striped Bass  
36 (Loboschewsky et al. 2012), and Largemouth Bass (Nobriga 2009).

#### 37 **9.3.4.12.4 Turbidity**

38 Turbidity is an important water quality component in the Delta that affects  
39 physical habitat through sedimentation and food web dynamics through  
40 attenuation of light in the water column. Light attenuation, in turn, affects the  
41 extent of the photic zone where primary production can occur and the ability of  
42 predators to locate prey and for prey to escape predation.

1 Turbidity has been declining in the Delta, as indicated by sediment data collected  
2 by the U.S. Geological Survey since the 1950s (Wright and Schoellhamer 2004),  
3 with important implications for food web dynamics and predation. Higher water  
4 clarity is at least partially caused by increased water filtration and plankton  
5 grazing by highly abundant overbite clams (*Potamocorbula amurensis*) and other  
6 benthic organisms (Kimmerer 2004, Greene et al. 2011). High nutrient loads,  
7 coupled with reduced sediment loads and higher water clarity, could contribute to  
8 plankton and algal blooms and overall increased eutrophic conditions in some  
9 areas (Kimmerer 2004).

10 The first high-flow events of winter create turbid conditions in the Delta, which  
11 can be drawn into the south Delta during reverse flow conditions in the Old and  
12 Middle rivers. Delta Smelt may follow turbid waters into the southern Delta,  
13 increasing their proximity to project export facilities and, therefore, their  
14 entrainment risk (USFWS 2008a).

#### 15 **9.3.4.12.5 Contaminants**

16 Contaminants can change ecosystem functions and productivity through  
17 numerous pathways. Trends in contaminant loadings and their ecosystem effects  
18 are not well understood. Efforts are underway to evaluate direct and indirect toxic  
19 effects on the POD fishes of manmade contaminants and natural toxins associated  
20 with blooms of *Microcystis aeruginosa*, a cyanobacterium or blue-green alga that  
21 releases a potent toxin known as microcystin. Toxic microcystins cause food web  
22 impacts at multiple trophic levels, and histopathological studies of fish liver tissue  
23 suggest that fish exposed to elevated concentrations of microcystins have  
24 developed liver damage and tumors (Lehman et al. 2005, 2008b, 2010.)

25 There are longstanding concerns related to mercury and selenium in the  
26 Sacramento and San Joaquin watersheds, the Delta, and San Francisco Bay (see  
27 Chapter 6, Surface Water Quality, for additional detail on these constituents).  
28 Additional study is needed to avoid increases in mercury exposure resulting from  
29 tidal wetlands restoration; methylmercury is produced at a relatively high rate in  
30 wetlands and newly flooded aquatic habitats (Davis et al. 2003). Methylmercury  
31 increases in concentration at each level in the food chain and can cause concern  
32 for people and birds that eat piscivorous fish (bass) and sturgeon, as described in  
33 Chapter 6, Surface Water Quality. It has not been shown to be a direct problem  
34 for fish in the Delta, but studies of other fish summarized by Alpers et al. (2008)  
35 indicate that mercury in fish has been linked to hormonal and reproductive  
36 effects, liver necrosis, and altered behavior in fish. With regard to selenium,  
37 benthic foragers like diving ducks, sturgeon, and splittail have the greatest risk of  
38 selenium toxicity; the invasion of the nonnative bivalves (e.g., *P. amurensis*) has  
39 resulted in increased bioavailability of selenium to benthivores in San Francisco  
40 Bay (Linville et al. 2002).

41 Baxter et al. (2008) prepared a 2007 synthesis of results as part of a POD Progress  
42 Report, including a summary of prior studies of contaminants in the Delta. The  
43 summary included studies that suggested that phytoplankton growth rates may be  
44 inhibited by localized high concentrations of herbicides (Edmunds et al. 1999).

1 Toxicity to invertebrates has been noted in water and sediments from the Delta  
2 and associated watersheds (Kuivila and Foe 1995, Weston et al. 2004). The 2004  
3 Weston study of sediment toxicity recommended additional study of the effects of  
4 the pyrethroid insecticides on benthic organisms. Undiluted drainwater from  
5 agricultural drains in the San Joaquin River watershed can be acutely toxic  
6 (quickly lethal) to fish (Chinook Salmon and Striped Bass) and have chronic  
7 effects on growth, likely because of high concentrations of major ions  
8 (e.g., sodium and sulfates) and trace elements (e.g., chromium, mercury, and  
9 selenium) (Saiki et al. 1992).

#### 10 **9.3.4.12.6 Fish Passage and Entrainment**

11 The Delta presents a challenge for anadromous and resident fish during upstream  
12 and downstream migration, with its complex network of channels, low eastern  
13 and southern tributary inflows, and reverse currents created by pumping for water  
14 exports. These complex conditions can lead to straying, extended exposure to  
15 predators, and entrainment during outmigration. Tidal elevations, salinity,  
16 turbidity, in-flow, meteorological conditions, season, habitat conditions, and  
17 project exports all have the potential to influence fish movement, currents, and  
18 ultimately the level of entrainment and fish passage success and survival, which is  
19 the subject of extensive research and adaptive management efforts (IRP 2010,  
20 2011). Michel et al. (2010, 2015) used acoustic telemetry to examine survival of  
21 late fall-run Chinook Salmon smolts outmigrating from the Sacramento River  
22 through the Delta and San Francisco Estuary. Survival was lowest in the  
23 freshwater portion (Delta) and the brackish portion of the estuary relative to  
24 survival in the riverine portion of the migration route.

#### 25 *North Delta Fish Passage and Entrainment*

26 In the north Delta, migrating fish have multiple potential pathways as they move  
27 upstream into the Sacramento or Mokelumne river systems. Marston et al. (2012)  
28 studied stray rates for in-migrating San Joaquin River Basin adult salmon that  
29 stray into the Sacramento River Basin. Results indicated that it was unclear  
30 whether reduced San Joaquin River pulse flows or elevated exports caused  
31 increased stray rates. The DCC, when open, can divert fish as they outmigrate  
32 along this route. The opening of the DCC when salmon are returning to spawn to  
33 the Mokelumne and Cosumnes rivers is believed to lead to increased straying of  
34 these fish into the American and Sacramento rivers because of confusion over  
35 olfactory cues. In recent years, experimental DCC closures have been scheduled  
36 during the fall-run Chinook Salmon migration season for selected days, coupled  
37 with pulsed flow releases from reservoirs on the Mokelumne River, in an attempt  
38 to reduce straying rates of returning adults. These closures have corresponded  
39 with reduced recoveries of Mokelumne River hatchery fish in the American River  
40 system and increased returns to the Mokelumne River hatchery (EBMUD 2012).

41 Outmigrating juvenile fish moving down the mainstem Sacramento River also can  
42 enter the DCC when the gates are open and travel through the Delta via the  
43 Mokelumne and San Joaquin river channels. In the case of juvenile salmonids,  
44 this shifted route from the north Delta to the central Delta increases their mortality

1 rate (Kjelson and Brandes 1989, Brandes and McLain 2001, Newman and  
2 Brandes 2010, Perry et al. 2010, 2012). Steel et al. (2012) found that the best  
3 predictor of which route was selected was the ratio of mean water velocity  
4 between the two routes. Salmon migration studies show losses of approximately  
5 65 percent for groups of outmigrating fish that are diverted from the mainstem  
6 Sacramento River into the waterways of the central and southern Delta (Brandes  
7 and McLain 2001; Vogel 2004, 2008; Perry and Skalski 2008). Perry and Skalski  
8 (2008) found that, by closing the DCC gates, total through-Delta survival of  
9 marked fish to Chipps Island increased by nearly 50 percent for fish moving  
10 downstream in the Sacramento River system. Closing the DCC gates appears to  
11 redirect the migratory path of outmigrating fish into Sutter and Steamboat sloughs  
12 and away from Georgiana Slough, resulting in higher survival rates. Species that  
13 may be affected include juvenile Green Sturgeon, steelhead, and winter and  
14 spring-run Chinook Salmon (NMFS 2009a).

15 However, analysis by Perry et al. (2015) suggests that the mechanisms governing  
16 route selection are more complex. Their analysis revealed the strong influence of  
17 tidal forcing on the probability of fish entrainment into the interior Delta. The  
18 probability of entrainment into both Georgiana Slough and the Delta Cross  
19 Channel was highest during reverse-flow flood tides, and the probability of fish  
20 remaining in the Sacramento River was near zero during flow reversals (Perry  
21 et al. 2015). The magnitude and duration of reverse flows at this river junction  
22 decrease as inflow of the Sacramento River increases. Consequently, reduced  
23 Sacramento River inflow increases the frequency of reverse flows at this junction,  
24 thereby increasing the proportion of fish that are entrained into the interior Delta,  
25 where mortality is high (Perry 2010).

26 Fish passage in the north Delta also can be affected by water quality. Water  
27 quality in the mainstem Sacramento River and its distributary sloughs can be poor  
28 at times during summer, creating conditions that may stress migrating fish or even  
29 impede migration. These conditions include dissolved oxygen, water  
30 temperatures, and, for some species, salinity (e.g., Delta Smelt). For adult  
31 Chinook Salmon, dissolved oxygen concentration less than 3 to 5 milligrams per  
32 liter (mg/L) can impede migration (Hallock et al. 1970) as can mean daily water  
33 temperatures of 21 to 23°C, depending on whether water temperatures are rising  
34 or falling (Strange 2010). Dissolved oxygen levels are generally >5 mg/L  
35 throughout the Delta, but water temperatures can exceed these thresholds during  
36 summer and fall.

37 The SWP Barker Slough Pumping Plant, located on a tributary to Cache Slough,  
38 may cause larval fish entrainment. The intake is equipped with a positive barrier  
39 fish screen to prevent fish at least 25 mm in size from being entrained. CDFW  
40 has monitored entrainment of larval Delta Smelt less than 20 mm at Barker  
41 Slough since 1995. When the presence of Delta Smelt larvae is indicated,  
42 pumping rates from Barker Slough are reduced to a 5-day running average rate of  
43 65 cfs, not to exceed a 75-cfs daily average for any day, for a minimum of 5 days  
44 and until monitoring shows no Delta Smelt are present.



1 *Central and South Delta Fish Passage and Entrainment*

2 The south Delta intake facilities include the CVP and SWP export facilities; local  
3 agency intakes, including Contra Costa Water District intakes; and agricultural  
4 intakes. Contra Costa Water District intakes and the CVP Contra Costa Canal  
5 Pumping Plant include fish screens; however, most of the remaining intakes do  
6 not include fish screens. Water flow patterns in the south Delta are influenced by  
7 the water diversion actions and operations of the south Delta seasonal temporary  
8 barriers and tides and river inflows to the Delta (Kimmerer and Nobriga 2008).  
9 Delta diversions can create reverse flows, drawing fish toward project facilities  
10 (Arthur et al. 1996, Kimmerer 2008, Grimaldo et al. 2009). While swimming  
11 through southern Delta channels, fish can be subjected to stress from poor water  
12 quality (seasonally high temperatures, low dissolved oxygen, high water  
13 transparency, and *Microcystis* blooms) and slow water velocities in lake-like  
14 habitats. Any of these factors can cause elevated mortality rates by weakening or  
15 disorienting the fish and increasing their vulnerability to predators (Vogel 2011).

16 Cunningham et al. (2015) found a negative influence of the export/inflow ratio on  
17 the survival of fall-run Chinook populations and a negative influence of increased  
18 total Delta exports on the survival of spring-run Chinook populations. An  
19 increase in total exports of 1 standard deviation (SD) from the 1967 to 2010  
20 average was predicted to result in a 68.1 percent reduction in the survival of Deer,  
21 Mill, and Butte Creek spring-run Chinook. Similarly, an increase in the ratio of  
22 Delta water exports to Delta inflow of 1 SD was expected to reduce survival of  
23 the four fall-run populations by 57.8 percent (Cunningham et al. 2015). Although  
24 a mechanistic explanation for the reduction in survival remains elusive, "*direct*  
25 *entrainment mortality seems an unlikely mechanism given the success of*  
26 *reclamation and transport procedures, even given increased predation potential*  
27 *at the release site. Changes to water routing may provide a more reasonable*  
28 *explanation for the estimated survival influence of Delta water exports"*  
29 (Cunningham et al. 2015). Although not directly comparable, this contrasts with  
30 the results of Zeug and Cavallo (2012) that found there was little evidence that  
31 large-scale water exports or inflows influenced CWT recovery rates in the ocean  
32 from 1993 to 2003.

33 Delaney et al. (2014) reported on a mark-recapture experiment examining the  
34 survival and movement patterns of acoustically tagged juvenile steelhead  
35 emigrating through the central and southern Delta. Their results indicated that  
36 most tagged steelhead remained in the mainstem San Joaquin River  
37 (77.6 percent); however, approximately one quarter (22.4 percent) of them  
38 entered Turner Cut. Route-specific survival probability for tagged steelhead  
39 using the Turner Cut route was 27.0 percent. The survival probability for tagged  
40 steelhead using the Mainstem route was 56.7 percent (Delaney et al. 2014).  
41 Travel times for tagged steelhead also differed between these two routes with  
42 steelhead using the mainstem route reaching Chipps Island significantly sooner  
43 than those that used the Turner Cut route. Travel time was not significantly  
44 affected by the limited OMR flow treatments examined in their study. While not  
45 significant, there was some evidence that fish movement toward each export

1 facility could be influenced by relative flow entering the export facility (Delaney  
2 et al. 2014).

3 Water from the San Joaquin River mainly moves downstream through the Head of  
4 Old River and through the channels of Old and Middle rivers and Grant Line and  
5 Fabian-Bell canals toward the south Delta intake facilities. Conversely, when  
6 water to the north of the diversion points for the two facilities moves southward  
7 (upstream), the net flow is negative (toward) the pumps. When the temporary  
8 barriers are installed from April through November, internal reverse circulation is  
9 created within the channels isolated by the barriers from other portions of the  
10 south Delta. These conditions are most pronounced during late spring through  
11 fall when San Joaquin River inflows are low and water diversion rates are  
12 typically high. Drier hydrologic years also reduce the frequency of net  
13 downstream flows in the south Delta and mainstem San Joaquin River.

14 A portion of fish that enter the CVP Jones Pumping Plant approach channel and  
15 the SWP Clifton Court Forebay are salvaged at screening and fish salvage  
16 facilities, transported downstream by trucks, and released. NMFS (2009a)  
17 estimates that the direct loss of fish from the screening and salvage process is in  
18 the range of 65 to 83.5 percent for fish from the point they enter Clifton Court  
19 Forebay or encounter the trash racks at the CVP facilities. Additionally, mark-  
20 recapture experiments indicate that most fish are probably subject to predation  
21 prior to reaching the fish salvage facilities (e.g., in Clifton Court Forebay)  
22 (Gingras 1997, Clark et al. 2009, Castillo et al. 2012). Aquatic organisms  
23 (e.g., phytoplankton and zooplankton) that serve as food for fish also are  
24 entrained and removed from the Delta (Jassby et al. 2002, Kimmerer et al. 2008,  
25 Brown et al. 1996). Fish entrainment and salvage are particular concerns during  
26 dry years when the distributions of young Striped Bass, Delta Smelt, Longfin  
27 Smelt, and other migratory fish species shift closer to the project facilities  
28 (Stevens et al. 1985, Sommer et al. 1997).

29 Salvage estimates reflect the number of fish entrained by project exports, but  
30 these numbers alone do not account for other sources of mortality related to the  
31 export facilities. These numbers do not include prescreen losses that occur in the  
32 waterways leading to the diversion facilities, which may in some cases reduce the  
33 number of salvageable fish (Gingras 1997, Clark et al. 2009, Castillo et al. 2012).  
34 For Delta Smelt, prescreen losses appear to be where most mortality occurs  
35 (Castillo et al. 2012). In addition, actual salvage numbers do not include the  
36 entrainment of fish larvae, which cannot be collected by the fish screens. The  
37 number of fish salvaged also does not include losses of fish that pass through the  
38 louvers intended to guide fish into the fish collection facilities or the losses during  
39 collection, handling, transport, and release back into the Delta.

40 The life stage of the fish at which entrainment occurs may be important for  
41 population dynamics (IRP 2011). For example, winter entrainment of Delta  
42 Smelt, Longfin Smelt, and Threadfin Shad may correspond to migration and  
43 spawning of adult fish, and spring and summer exports may overlap with  
44 development of larvae and juveniles. The loss of prespawning adults and all their  
45 potential progeny may have greater consequences than entrainment of the same

1 number of larvae or juvenile fish. Entrainment risk for fish tends to increase with  
2 increased reverse flows in Old and Middle rivers (Kimmerer 2008, Grimaldo  
3 et al. 2009).

4 Research conducted during 2010 and 2011 showed that upriver movements of  
5 adult Delta Smelt are achieved through a form of tidal rectification or active tidal  
6 transport by using lateral movement to shallow edges of channels on ebb tides to  
7 maintain their position (IRP 2010, 2011). Turbidity gradients could be involved  
8 in the lateral positioning of Delta Smelt within the channels, but large-scale  
9 turbidity pulses through the system may not be necessary to trigger upriver  
10 migrations of Delta Smelt if they are already occupying sufficiently turbid water  
11 (IRP 2011). The new understanding of potential tidal and turbidity effects on  
12 Delta Smelt behavior may have important implications for the Delta Smelt  
13 monitoring programs that are the basis for biological triggers for RPA Actions  
14 1 and 2 by understanding the catch efficiency of mid-water trawl data in relation  
15 to the lateral positioning of Delta Smelt within channels.

16 There are more than 2,200 diversions in the Delta (Herren and Kawasaki 2001).  
17 These irrigation diversion pipes are shore-based, typically small (30 to  
18 60 centimeter pipe diameter), and operated via pumps or gravity flow, and most  
19 lack fish screens. These diversions increase total fish entrainment and losses and  
20 alter local fish movement patterns (Kimmerer and Nobriga 2008). Delta Smelt  
21 have been found in samples of Delta irrigation diversions, as well as larger  
22 wetland management diversions downstream. However, Nobriga et al. (2004)  
23 found that the low and inconsistent entrainment of Delta Smelt measured in the  
24 study reflected habitat use by Delta Smelt and relatively small hydrodynamic  
25 influence of the diversion.

#### 26 **9.3.4.12.7 Disease**

27 Preliminary results of several histopathological studies have found evidence of  
28 significant disease in Delta fish species (Reclamation 2008a). For example,  
29 massive intestinal infections with an unidentified myxosporean were found in  
30 yellowfin goby collected from Suisun Marsh (Baxa et al. 2013). Studies by  
31 Bennett (2005) and Bennett et al. (2008) show that exposure to toxic chemicals  
32 may cause liver abnormalities and cancerous cells in Delta Smelt, and stressful  
33 summer conditions, warm water, and lack of food may result in liver glycogen  
34 depletion and liver damage. Studies of Sacramento Splittail suggest that liver  
35 abnormalities in this species are more linked to health and nutritional status than  
36 to pollutant exposure (Greenfield et al. 2008).

37 Additionally, preliminary evidence suggests that contaminants and disease may  
38 impair Striped Bass. Studies by Lehman et al. (2010) suggest that the liver tissue  
39 and health of Striped Bass and Mississippi Silverside were adversely affected by  
40 tumors, particularly at sampling stations where concentrations of tumor-  
41 promoting microcystins were elevated. Exposure of Sacramento Splittail and  
42 Threadfin Shad to microcystins in experimental diets resulted in severe liver  
43 damage; shad also exhibited ovarian necrosis, indicating impairment of health and  
44 reproductive potential (Acuna et al. 2012).

1 In contrast, histopathological and viral evaluation of juvenile Longfin Smelt and  
2 Threadfin Shad collected in 2006 indicated no histological abnormalities and no  
3 evidence of viral infections or high parasite loads (Foott et al. 2006). Parasites  
4 were noted in Threadfin Shad gills at a high frequency, but the infections were not  
5 considered severe. Thus, both Longfin Smelt and Threadfin Shad were  
6 considered healthy in 2006 (a high-flow year). Adult Delta Smelt collected from  
7 the Delta during winter 2005 also were considered healthy, showing little  
8 histopathological evidence for starvation or disease (Reclamation 2008a).  
9 However, there was some evidence of low frequency endocrine disruption. In  
10 2005, 9 of 144 (6 percent) of adult Delta Smelt males were intersex, having  
11 immature oocytes in their testes (Reclamation 2008a).

#### 12 **9.3.4.12.8 Nonnative Invasive Species**

13 Nonnative invasive species influence the Delta ecosystem by increasing  
14 competition and predation on native species, reducing habitat quality (as result of  
15 invasive aquatic macrophyte growth), and reducing food supplies by altering the  
16 aquatic food web. Not all nonnative species are considered invasive<sup>2</sup>. Some  
17 introduced species have minimal ability to spread or increase in abundance.  
18 Others have commercial or recreational value (e.g., Striped Bass, American Shad,  
19 and Largemouth Bass).

20 Many nonnative fishes have been introduced into the Delta for sport fishing  
21 (game fish such as Striped Bass, Largemouth Bass, Smallmouth Bass, Bluegill,  
22 and other sunfish), as forage for game fish (Threadfin Shad, Golden Shiner, and  
23 Fathead Minnow), for vector control (Inland Silverside, Western Mosquitofish),  
24 for human food use (Common Carp, Brown Bullhead, and White Catfish), and  
25 from accidental releases (Yellowfin Goby, Shimofuri Goby, and Shokihaze Goby)  
26 (Moyle 2002). Introduced fish may compete with native fish for resources and, in  
27 some cases, prey on native species.

28 Because of invasive species and other environmental stressors, native fishes have  
29 declined in abundance throughout the region during the period of monitoring  
30 (Matern et al. 2002, Brown and Michniuk 2007, Sommer et al. 2007a,  
31 Mount et al. 2012). Habitat degradation, changes in hydrology and water quality,  
32 and stabilization of natural environmental variability are all factors that generally  
33 favor nonnative, invasive species (Mount et al. 2012, Moyle et al. 2012).

#### 34 **9.3.4.12.9 Predation**

35 Predation is an important factor that influences the behavior, distribution, and  
36 abundance of prey species in aquatic communities to varying degrees. Predation  
37 can have differing effects on a population of fish depending on the size or age  
38 selectivity, mode of capture, mortality rates, and other factors. Predation is a part  
39 of every food web, and native Delta fishes were part of the historical Delta food  
40 web. Because of the magnitude of change in the Delta from historical times and

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<sup>2</sup> DFG (2008) defines "invasive species" as "species that establish and reproduce rapidly outside of their native range and may threaten the diversity or abundance of native species through competition for resources, predation, parasitism, hybridization with native populations, introduction of pathogens, or physical or chemical alteration of the invaded habitat."

1 the introduction of nonnative predators, it is logical to conclude that predation  
2 may have increased in importance as a mortality factor for Delta fishes, with some  
3 observers suggesting that it is likely the primary source of mortality for juvenile  
4 salmonids in the Delta (Vogel 2011). Predation occurs by fish, birds, and  
5 mammals, including sea lions. The alternatives considered in this EIS are not  
6 anticipated to modify predatory actions of birds and mammals on the focal  
7 species. Therefore, the predation discussion is focused on fish predators.

8 A panel of experts recently convened to review data on predation in the Delta and  
9 draw preliminary conclusions on the effects of predation on salmonids. The panel  
10 acknowledged that the system supports large populations of fish predators that  
11 consume juvenile salmonids (Grossman et al. 2013). However, the panel  
12 concluded that because of extensive flow modification, altered habitat conditions,  
13 native and nonnative fish and avian predators, temperature and dissolved oxygen  
14 limitations, and the overall reduction in salmon population size, it was unclear  
15 what proportion of the juvenile salmonid mortality could be attributed to  
16 predation. The panel further indicated that predation, while the proximate cause  
17 of mortality, may be influenced by a combination of other stressors that make fish  
18 more vulnerable to predation.

19 Striped Bass, White Catfish, Largemouth Bass and other centrarchids, and  
20 silversides are among the introduced, nonnative species that are notable predators  
21 of smaller-bodied fish species and juveniles of larger species in the Delta. Along  
22 with Largemouth Bass, Striped Bass are believed to be major predators on larger-  
23 bodied fish in the Delta. In open-water habitats, Striped Bass are most likely the  
24 primary predator of juvenile and adult Delta Smelt (DWR et al. 2013) and can be  
25 an important open-water predator on juvenile salmonids (Johnston and Kumagai  
26 2012). Native Sacramento Pikeminnow may also prey on juvenile salmonids and  
27 other fishes. Limited sampling of smaller pikeminnows did not find evidence of  
28 salmonids in the foregut of Sacramento Pikeminnow (Nobriga and Feyrer 2007),  
29 but this does not mean that Sacramento Pikeminnow do not prey on salmonids in  
30 the Delta.

31 Largemouth Bass abundance has increased in the Delta over the past few decades  
32 (Brown and Michniuk 2007). Although Largemouth Bass are not pelagic, their  
33 presence at the boundary between the littoral and pelagic zones makes it probable  
34 that they opportunistically consume pelagic fishes. The increase in salvage of  
35 Largemouth Bass occurred during the time period when Brazilian waterweed was  
36 expanding its range in the Delta (Brown and Michniuk 2007). The beds of  
37 Brazilian waterweed provide good habitat for Largemouth Bass and other species  
38 of centrarchids. Largemouth Bass have a much more limited distribution in the  
39 estuary than Striped Bass, but a higher per-capita impact on small fishes (Nobriga  
40 and Feyrer 2007). Increases in Largemouth Bass may have had a particularly  
41 important effect on Threadfin Shad and Striped Bass, whose earlier life stages  
42 occur in littoral habitat (Grimaldo et al. 2004, Nobriga and Feyrer 2007).

43 Invasive Mississippi silversides are another potentially important predator of  
44 larval and pelagic fishes in the Delta. This introduced species was not believed to  
45 be an important predator on Delta Smelt, but recent studies using DNA techniques

1 detected the presence of Delta Smelt in the guts of 41 percent of Mississippi  
2 silversides sampled in mid-channel trawls (Baerwald et al. 2012). This finding  
3 may suggest that predation impacts could be significant, given the increasing  
4 numbers of Mississippi silversides in the Delta.

5 Predation of fish in the Delta is known to occur in specific areas, for example at  
6 channel junctions and areas that constrict flow or confuse migrating fish and  
7 provide cover for predatory fish (Vogel 2011). Sabal (2014) found similar results  
8 at Woodbridge Dam on the Mokelumne River where the dam was associated with  
9 increased Striped Bass per capita salmon consumption and attracted larger  
10 numbers of Striped Bass, decreasing migrating juvenile salmon survival by 10 to  
11 29 percent. DFG (1992) identified subadult Striped Bass as the major predatory  
12 fish in Clifton Court Forebay. In 1993, for example, Striped Bass made up  
13 96 percent of the predators removed (Vogel 2011). Cavallo et al. (2012) studied  
14 tagged salmon smolts to test the effects of predator removal on outmigrating  
15 juvenile Chinook Salmon in the south Delta. Their results suggested that predator  
16 abundance and migration rates strongly influenced survival of salmon smolts.  
17 Exposure time to predators has been found to be important for influencing  
18 survival of outmigrating salmon in other studies in the Delta (Perry et al. 2012).

#### 19 **9.3.4.12.10 Aquatic Macrophytes**

20 Aquatic macrophytes are an important component of the biotic community of  
21 Delta wetlands and can provide habitat for aquatic species, serve as food, produce  
22 detritus, and influence water quality through nutrient cycling and dissolved  
23 oxygen fluctuations. Whipple et al. (2012) described likely historical conditions  
24 in the Delta, which have been modified extensively, with major impacts on the  
25 aquatic macrophyte community composition and distribution. The primary  
26 change has been a shift from a high percentage of emergent aquatic macrophyte  
27 wetlands to open water and hardened channels.

28 The introduction of two nonnative invasive aquatic plants, water hyacinth and  
29 Brazilian waterweed, has reduced habitat quantity and value for many native  
30 fishes. Water hyacinth forms floating mats that greatly reduce light penetration  
31 into the water column, which can significantly reduce primary productivity and  
32 available food for fish in the underlying water column. Brazilian waterweed  
33 grows along the margins of channels in dense stands that prohibit access by native  
34 juvenile fish to shallow water habitat. Additionally, the thick cover of these two  
35 invasive plants provides excellent habitat for nonnative ambush predators, such as  
36 bass, which prey on native fish species. Studies indicate low abundance of native  
37 fish, such as Delta Smelt, Chinook Salmon, and Sacramento Splittail, in areas of  
38 the Delta where submerged aquatic vegetation infestations are thick (Grimaldo  
39 et al. 2004, 2012; Nobriga et al. 2005).

40 Invasive aquatic macrophytes are still equilibrating within the Delta and resulting  
41 habitat changes are ongoing, with negative impacts on habitats and food webs of  
42 native fish species (Toft et al. 2003, Grimaldo et al. 2009). Concerns about  
43 invasive aquatic macrophytes are centered on their ability to form large, dense

1 growth that can clog waterways, block fish passage, increase water clarity,  
2 provide cover for predatory fish, and cause high biological oxygen demand.

3 **9.3.4.13 Yolo Bypass**

4 The Yolo Bypass conveys flood flows from the Sacramento Valley, including the  
5 Sacramento River, Feather River, American River, Sutter Bypass, and west side  
6 streams

7 The Yolo Bypass provides habitat for a wide variety of fish and aquatic species,  
8 including temporary migration corridors and juvenile rearing habitat for  
9 anadromous salmonids and other native and anadromous fishes. Species captured  
10 as adults and subsequently collected as YOY suggest that the Yolo Bypass  
11 provides spawning habitat for these species, including splittail, American Shad,  
12 Striped Bass, Threadfin Shad, Largemouth Bass and carp (Harrell and Sommer  
13 2003, Sommer et al. 2014). The Yolo Bypass lacks suitable gravel substrate that  
14 would support salmon spawning.

15 **9.3.4.13.1 Aquatic Habitat**

16 Aquatic habitats in the Yolo Basin include stream and slough channels for fish  
17 migration, and when flooded, seasonal spawning habitat and productive rearing  
18 habitat (Sommer et al. 2001a; CALFED 2000a, 2000b). During years when the  
19 Yolo Bypass is flooded, it serves as an important migratory route for juvenile  
20 Chinook Salmon and other native migratory and anadromous fishes moving  
21 downstream. During these times, it provides juvenile anadromous salmonids an  
22 alternative migration corridor to the lower Sacramento River (Sommer et al.  
23 2003) and, sometimes, better rearing conditions than the adjacent Sacramento  
24 River channel (Sommer et al. 2001a, 2005). When the floodplain is activated,  
25 juvenile salmon can rear for weeks to months in the Yolo Bypass floodplain  
26 before migrating to the estuary (Sommer et al. 2001a). Research on the Yolo  
27 Bypass has found that juvenile salmon grow substantially faster in the Yolo  
28 Bypass floodplain than in the adjacent Sacramento River, primarily because of  
29 greater availability of invertebrate prey in the floodplain (Sommer et al. 2001a,  
30 2005). When not flooded, the lower Yolo Bypass provides tidal habitat for young  
31 fish that enter from the lower Sacramento River via Cache Slough Complex  
32 (McLain and Castillo; DWR, unpublished data).

33 Sommer et al. (1997) demonstrated that the Yolo Bypass is one of the single most  
34 important habitats for Sacramento Splittail. Because the Yolo Bypass is dry  
35 during summer and fall, nonnative species (e.g., predatory fishes) generally are  
36 not present year-round except in perennial water sources (Sommer et al. 2003). In  
37 addition to providing important fish habitat, seasonal inundation of the Yolo  
38 Bypass supplies phytoplankton and detritus that may benefit aquatic organisms  
39 downstream in the brackish portion of the San Francisco Estuary (Sommer et al.  
40 2004, Lehman et al. 2008a).

#### 1 **9.3.4.13.2 Fish Passage**

2 The Fremont Weir is a major impediment to fish passage and a source of  
3 migratory delay and loss of adult Chinook Salmon, steelhead, and sturgeon  
4 (NMFS 2009a, Sommer et al. 2014). The Fremont Weir creates a migration  
5 barrier for a variety of species, although fish with strong jumping capabilities  
6 such as salmonids may be able to pass the weir at higher flows. Although there is  
7 a fish ladder maintained by CDFW at the center of the weir, the ladder is small,  
8 outdated, and inefficient. Additionally, there are no facilities at the weir to pass  
9 upstream migrants at lower flows. Some adult winter-run, spring-run, and fall-run  
10 Chinook Salmon and White Sturgeon migrate into Yolo Bypass when there is no  
11 flow into the floodplain via the Fremont Weir. Therefore, these fish are often  
12 unable to reach upstream spawning habitat in the Sacramento River and its  
13 tributaries (Harrell and Sommer 2003, Sommer et al. 2014). Other structures in  
14 the Yolo Bypass, such as the Toe Drain, Lisbon Weir, and irrigation dams in the  
15 northern end of the Tule Canal, also may impede upstream passage of adult  
16 anadromous fish (NMFS 2009a).

17 Fish are also attracted into the bypass during periods when water is not flowing  
18 over the Fremont Weir. Fyke trap monitoring by DWR has shown that adult  
19 salmon and steelhead migrate up the Toe Drain in autumn and winter regardless  
20 of whether the Fremont Weir spills (Harrell and Sommer 2003, Sommer et al.  
21 2014). The Toe Drain does not extend to the Fremont Weir because the channel  
22 is blocked by roads or other higher ground at several locations. Sturgeon and  
23 salmonids attracted by high flows into the basin become concentrated behind the  
24 Fremont Weir, where they are subject to heavy legal and illegal fishing pressure.

25 Stranding of juvenile salmonids and sturgeon has been reported in the Yolo  
26 Bypass in scoured areas behind the weir and in other areas as floodwaters recede  
27 (NMFS 2009a, Sommer et al. 2005). However, Sommer et al. (2005) found most  
28 juvenile salmon outmigrated off the floodplain as it drained.

#### 29 **9.3.4.14 Suisun Marsh**

30 Suisun Bay and Marsh are ecologically linked with the central Delta, although  
31 with different tidal and salinity conditions than found upstream. Suisun Bay and  
32 Marsh are the largest expanse of remaining tidal marsh habitat within the greater  
33 San Francisco Bay-Delta ecosystem and include Honker, Suisun, and Grizzly  
34 bays; Montezuma and Suisun sloughs; and numerous other smaller channels  
35 and sloughs.

#### 36 **9.3.4.14.1 Aquatic Habitat**

37 Suisun Marsh is a brackish-water marsh bordering the northern edge of Suisun  
38 Bay. Most of its marsh area consists of diked wetlands managed for waterfowl,  
39 with the rest of the acreage consisting of tidally influenced sloughs (Suisun  
40 Ecological Workgroup 2001). The central latitudinal location of Suisun Marsh  
41 within the San Francisco Estuary makes it an important rearing area for  
42 euryhaline freshwater, estuarine, and marine fishes. Many fish species that  
43 migrate or use Delta habitats also are found in the waters of Suisun Bay.



1 Tides reach Suisun Bay and Marsh through the Carquinez Strait, and most  
2 freshwater flows enter at the southeast border of Suisun Marsh at the confluence  
3 of the Sacramento and San Joaquin rivers. The mixing of freshwater outflows  
4 from the Central Valley with saline tidal water in Suisun Bay and Suisun Marsh  
5 results in brackish water with strong salinity gradients, complex patterns of flow  
6 interactions, and generally the highest biomass productivity in the entire estuary  
7 (Siegel et al. 2010).

8 Although the fish assemblages in Suisun Bay and Marsh can differ substantially  
9 from the fish assemblages in the Delta, all the species that use the Delta also use  
10 Suisun Bay and Marsh.

11 Flow, turbidity, and salinity are important factors influencing the location and  
12 abundance of zooplankton and small prey organisms used by Delta species  
13 (Kimmerer et al. 1998). The location where net current flowing inland along the  
14 bottom reverses direction and sinking particles are trapped in suspension is  
15 associated with higher turbidity known as the estuarine turbidity maximum.  
16 Burau et al. (2000) reports that the estuarine turbidity maximum occurs near the  
17 Benicia Bridge and in Suisun Bay near Garnet Point on Ryer Island.  
18 Zooplanktonic organisms maintain position in this region of historically high  
19 productivity in the estuary through vertical movements (Kimmerer et al. 1998).

20 Salinity in the Suisun Bay and Marsh system is a major water quality  
21 characteristic that strongly influences physical and ecological processes. Fish  
22 species native to Suisun Marsh require low salinities during the spawning and  
23 rearing periods (Suisun Ecological Workgroup 2001; Kimmerer 2004;  
24 Feyrer et al. 2007, 2010; Nobriga et al. 2008). The Suisun Bay and Marsh usually  
25 contain both the maximum estuarine salinity gradient and the low salinity zone.  
26 The overall estuarine salinity gradient trends from west (higher) to east (lower) in  
27 Suisun Bay and Marsh. The location of the low salinity zone gradient and X2 can  
28 be influenced by outflow. Suisun Marsh also exhibits a persistent north-south  
29 salinity gradient. Despite low and seasonal flows, the surrounding watersheds  
30 have a significant water freshening effect because of the long residence times of  
31 freshwater discharges from the upper sloughs and wastewater effluent.

32 The Suisun Bay and Marsh system contains a wide variety of habitats such as  
33 marsh plains, tidal creeks, sloughs, channels, cuts, mudflats, and bays. These  
34 features and the complex hydrodynamics and water quality of the system have  
35 historically fostered significant biodiversity within Suisun tidal aquatic habitats,  
36 but, like the Delta, these habitats also have been significantly altered and  
37 degraded by human activities over the decades.

38 Categories of tidal aquatic habitat were identified as part of the Suisun Marsh  
39 Plan development process and were defined using physical boundaries; habitats  
40 include bays, major sloughs, minor sloughs, and the intertidal mudflats in those  
41 areas (Engle et al. 2010). These tidal habitats total approximately 26,000 acres,  
42 with the various embayments totaling about 22,350 acres. Tidal slough habitat is  
43 composed of major and minor sloughs, with major sloughs of Suisun Marsh  
44 having a combined acreage of about 2,200 acres consisting of both shallow and

1 deep channels. Minor sloughs are made up of shallow channel habitat and have a  
 2 combined acreage of about 1,100 acres. Habitats in Suisun Marsh bays and  
 3 sloughs support a diverse assemblage of aquatic species that typically use  
 4 open-water tidal areas for breeding, foraging, rearing, or migrating.

#### 5 **9.3.4.14.2 Fish Entrainment**

6 Several facilities have been constructed by DWR and Reclamation to provide  
 7 lower-salinity water to managed wetlands in the Suisun Marsh, including the  
 8 Roaring River Distribution System, Morrow Island Distribution System, and  
 9 Goodyear Slough Outfall. Other facilities constructed under the Suisun Marsh  
 10 Preservation Agreement that could entrain fish include the Lower Joice Island and  
 11 Cygnus Drain diversions.

12 The intake to the Roaring River Distribution System is screened to prevent  
 13 entrainment of fish larger than approximately 25 mm (approximately 1 inch).  
 14 DWR monitored fish entrainment from September 2004 to June 2006 at the  
 15 Morrow Island Distribution System to evaluate entrainment losses at the facility.  
 16 Monitoring took place over several months under various operational  
 17 configurations and focused on Delta Smelt and salmonids. Over 20 species were  
 18 identified during the sampling, but only 2 fall-run-sized Chinook Salmon (at the  
 19 South Intake in 2006) and no Delta Smelt from entrained water were caught  
 20 (Reclamation 2008a). The Goodyear Slough Outfall system is open for free fish  
 21 movement except near the outfall when flap gates are closed during flood tides  
 22 (Reclamation 2008a). Conical fish screen have been installed on the Lower Joice  
 23 Island diversion on Montezuma Slough.

#### 24 **9.3.4.15 San Joaquin River from Confluence of the Stanislaus River to** 25 **the Delta**

26 Since the construction of Friant Dam, significant changes in physical (fluvial  
 27 geomorphic) processes and substantial reductions in streamflows in the San  
 28 Joaquin River have occurred, resulting in large-scale alterations to the river  
 29 channel and associated aquatic, riparian, and floodplain habitats. Throughout the  
 30 area, there are physical barriers, reaches with poor water quality or no surface  
 31 flow, and false migration pathways that have reduced habitat connectivity for  
 32 anadromous and resident native fishes (Reclamation and DWR 2011). As a  
 33 result, there has been a general decline in both the abundance and distribution of  
 34 native fishes, with several species extirpated from the system (Moyle 2002).

35 Moyle (2002) reported that of the 21 native fish species historically present in the  
 36 San Joaquin River, at least 8 are now uncommon, rare, or extinct. The deep-  
 37 bodied fish assemblage (e.g., Sacramento Splittail, Sacramento Blackfish) has  
 38 been replaced by nonnative species like carp and catfish.

39 The San Joaquin River from the Stanislaus River to the Delta is dominated by  
 40 nonnative species such as Largemouth Bass, Inland Silverside, carp, and several  
 41 species of sunfish and catfish (Moyle 2002). Anadromous species include fall-run  
 42 Chinook Salmon, steelhead, Striped Bass, American Shad, White Sturgeon, and  
 43 several species of lamprey (Reclamation et al. 2003). The fall-run Chinook

1 Salmon population is supported in part by hatchery stock in the Merced River.  
2 Spawning by anadromous salmonids in the San Joaquin River Basin occurs only  
3 in the tributaries to the San Joaquin River, including the Merced, Tuolumne, and  
4 Stanislaus rivers (Brown and Moyle 1993). Spring-run Chinook Salmon no  
5 longer exist in the San Joaquin River, but are targeted for restoration in this  
6 system under Reclamation's San Joaquin River Restoration Program. In early  
7 2015, the program experimentally released juvenile spring-run Chinook Salmon  
8 into the San Joaquin River near the Merced River. Surviving adults may return to  
9 the San Joaquin River as early as spring 2017. Because of the uncertainty of  
10 future restoration success and the current lack of natural presence in the San  
11 Joaquin River, spring-run Chinook Salmon is not included in the analysis of San  
12 Joaquin River fish.

### 13 **9.3.4.15.1 Fish in the San Joaquin River**

14 The analysis is focused on the following species:

- 15 • Fall-run Chinook Salmon
- 16 • Steelhead
- 17 • White Sturgeon
- 18 • Sacramento Splittail
- 19 • Pacific Lamprey
- 20 • Striped Bass
- 21 • American Shad

#### 22 *Fall-run Chinook Salmon*

23 Fall-run Chinook Salmon are present in the San Joaquin River and its major  
24 tributaries upstream to and including the Merced River. Spawning and rearing  
25 occur in the major tributaries (Merced, Tuolumne, and Stanislaus rivers)  
26 downstream of the mainstem dams. Weir counts in the Stanislaus River suggest  
27 that adult fall-run Chinook Salmon in the San Joaquin River Basin typically  
28 migrate into the upper rivers between late September and mid-November and  
29 spawn shortly thereafter (Pyper et al. 2006; Anderson et al. 2007;  
30 FISHBIO 2010a, 2011).

31 The San Joaquin River downstream of the Stanislaus River primarily provides  
32 upstream passage for adult fall-run Chinook Salmon and downstream passage for  
33 juveniles and smolts as they outmigrate from the tributary spawning and rearing  
34 areas to the Delta to the Pacific Ocean. The juvenile fall-run Chinook Salmon  
35 outmigration in the San Joaquin River Basin typically occurs during winter and  
36 spring, extending primarily from January through May. The outmigration  
37 consists primarily of fry in winter and smolts in spring (FISHBIO 2007, 2013).  
38 Trawl sampling in the lower San Joaquin River from Mossdale to the Head of Old  
39 River (the Mossdale Trawl) captures Chinook Salmon from February into July,  
40 with peak catches generally during April and May (Speegle et al. 2013).

1 *Steelhead*

2 Steelhead were historically present in the San Joaquin River, though data on their  
3 population levels are lacking (McEwan 2001). The current steelhead population  
4 in the San Joaquin River is substantially reduced compared with historical levels,  
5 although resident Rainbow Trout occur throughout the major San Joaquin River  
6 tributaries. Additionally, small populations of steelhead persist in the lower San  
7 Joaquin River and tributaries (e.g., Stanislaus, Tuolumne, and possibly the  
8 Merced rivers) (Zimmerman et al. 2009, McEwan 2001). Steelhead/Rainbow  
9 Trout of anadromous parentage occur at low numbers in all three major San  
10 Joaquin River tributaries. These tributaries have a higher percentage of resident  
11 Rainbow Trout compared to the Sacramento River and its tributaries  
12 (Zimmerman et al. 2009).

13 Presence of steelhead smolts from the San Joaquin River Basin is estimated  
14 annually by CDFW based on the Mossdale Trawl (SJRGGA 2011). The sampling  
15 trawls capture steelhead smolts, although usually in small numbers. One  
16 steelhead smolt was captured and returned to the river during the 2009 sampling  
17 period (SJRGGA 2010), and three steelhead were captured and returned in both  
18 2010 and 2011 (Speegle et al. 2013).

19 *Sacramento Splittail*

20 Historically, Sacramento Splittail were widespread in the San Joaquin River and  
21 found upstream to Tulare and Buena Vista lakes, where they were harvested by  
22 native peoples (Moyle et al. 2004). Today, Sacramento Splittail likely ascend the  
23 San Joaquin River to Salt Slough during wet years (Baxter 1999). During dry  
24 years, Sacramento Splittail are uncommon in the San Joaquin River downstream  
25 of the Tuolumne River (Moyle et al. 2004). Most spawning takes place in the  
26 flood bypasses, along the lower reaches of the Sacramento and San Joaquin rivers  
27 and major tributaries, and lower Cosumnes River and similar areas in the  
28 western Delta.

29 Most juveniles apparently move downstream into the Delta from April to August  
30 (Meng and Moyle 1995). Factors influencing the Sacramento Splittail population  
31 are unclear, but the population is largely influenced by extent and period of  
32 inundation of floodplain spawning habitats, with abundance spiking following wet  
33 years and declining after dry years (Moyle et al. 2004). Other factors that may  
34 influence the San Joaquin River portion of the population include flood control,  
35 entrainment by diversion, recreational fishing, pollutants, and nonnative species  
36 (Moyle et al. 2004).

37 *Pacific Lamprey*

38 The Pacific Lamprey is a widely distributed anadromous species found in  
39 accessible reaches of the San Joaquin River and many of its tributaries.

40 Data from mid-water trawls in the lower San Joaquin River near Mossdale  
41 indicate that adults likely migrate into the San Joaquin River in spring and early  
42 summer (Hanni et al. 2006). In other large river systems, the initial adult  
43 migration from the ocean generally stops in summer, and Pacific Lampreys hold  
44 until the following winter or spring before undergoing a secondary migration to

1 spawning grounds (Robinson and Bayer 2005, Clemens et al. 2012). Midwater  
2 trawl surveys in the San Joaquin River suggest that peak ammocoete outmigration  
3 occurs in January and February (Hanni et al. 2006).

4 Little information is available on factors influencing Pacific Lamprey in the San  
5 Joaquin River, but they are likely affected by many of the same factors as salmon  
6 and steelhead because of parallels in their life cycles. Lack of access to historical  
7 spawning habitats because of the mainstem dams and other migration barriers,  
8 modification of spawning and rearing habitats, altered hydrology, entrainment by  
9 water diversions, and predation by nonnative invasive species such as Striped  
10 Bass all likely influence Pacific Lamprey in the San Joaquin River and tributaries.

#### 11 *Striped Bass*

12 Striped Bass are regularly found in San Joaquin River tributaries, including in  
13 lower mainstem deep pools of the Stanislaus and Tuolumne rivers (e.g., Anderson  
14 et al. 2007). Ainsley et al. (2013) reported that Striped Bass were collected at two  
15 locations between the Head of the Old River and the mouth of the Stanislaus  
16 River on the mainstem San Joaquin River in May.

#### 17 *American Shad*

18 Little is known about American Shad populations inhabiting the San Joaquin  
19 River. American Shad may spawn in the San Joaquin River system, but their  
20 abundance is unknown. Sport fishing for American Shad occurs seasonally in the  
21 San Joaquin River.

#### 22 *Sturgeon*

23 Little is known about White Sturgeon populations inhabiting the San Joaquin  
24 River. Spawning-stage adults generally move into the lower reaches of rivers  
25 during winter prior to spawning, then migrate upstream to spawn in response to  
26 higher flows (Schaffter 1997, McCabe and Tracy 1994). Based on tag returns  
27 from White Sturgeon tagged in the Sacramento-San Joaquin Estuary and  
28 recovered by anglers, Kohlhorst et al. (1991) estimated that over 10 times as  
29 many White Sturgeon spawn in the Sacramento River as in the San Joaquin River.

30 CDFW fisheries catch information for the San Joaquin River obtained from  
31 fishery report cards (DFG 2008b, 2009b, 2010, 2011, 2012b; CDFW 2013, 2014)  
32 documented that anglers upstream of Highway 140 caught between 8 and  
33 25 mature White Sturgeon annually between 2007 and 2013. Below Highway  
34 140 downstream to Stockton, anglers caught between 2 and 35 mature White  
35 Sturgeon annually over the same time period; most of the White Sturgeon caught  
36 were released.

37 White Sturgeon spawning in the San Joaquin River was documented for the first  
38 time in 2011 and confirmed in 2012. Viable White Sturgeon eggs were collected  
39 in 2011 at one sampling location downstream of Laird Park (Gruber et al. 2012)  
40 and in 2012 at four sampling locations generally between Laird Park and the  
41 Stanislaus River confluence (Jackson and Van Eenennaam 2013). Although the  
42 majority of sturgeon likely spawn in the Sacramento River, the results of these  
43 surveys confirm that White Sturgeon do spawn in the San Joaquin River in both

1 wet- and dry-year conditions and may be an important source of production for  
2 the White Sturgeon population in the Sacramento-San Joaquin river system.

3 Green Sturgeon are also present in the San Joaquin River, but at considerably  
4 lower numbers than White Sturgeon. Between 2007 and 2012, anglers reported  
5 catching six Green Sturgeon in the San Joaquin River (Jackson and Van  
6 Eenennaam 2013). Although the reported presence of Green Sturgeon in the  
7 San Joaquin River coincides with the spawning migration period of Green  
8 Sturgeon within the Sacramento River, no evidence of spawning has been  
9 detected (Jackson and Van Eenennaam 2013).

#### 10 **9.3.4.15.2 Aquatic Habitat**

11 Aquatic habitat conditions vary spatially and temporally throughout the lower San  
12 Joaquin River because of differences in habitat availability and connectivity,  
13 water quantity and quality (including water temperature), and channel  
14 morphology.

15 Downstream of the Stanislaus River confluence, the San Joaquin River is more  
16 sinuous than upstream reaches and contains oxbows, side channels, and remnant  
17 channels. It conveys the combined flows of the major tributaries, including the  
18 Merced, Tuolumne, Stanislaus, and Calaveras rivers. Flood control levees closely  
19 border much of the river but are set back in places, creating some off-channel  
20 aquatic habitat areas when inundated (Reclamation and DWR 2011). The channel  
21 gradient in this portion of the San Joaquin River is low, and the lack of gravel or  
22 coarser substrate precludes spawning by salmonids.

#### 23 **9.3.4.15.3 Fish Passage**

24 In the reach of the river downstream of the confluence of the Stanislaus River,  
25 fish encounter passage challenges associated with water diversions, and adult  
26 salmon migrating upstream from the Delta also may encounter prohibitively high  
27 stream temperatures that delay migration until temperatures decline (McBain and  
28 Trush 2002). Installation of seasonal barriers in the Delta also can impair fish  
29 passage.

#### 30 **9.3.4.15.4 Hatcheries**

31 No hatcheries in the San Joaquin River Basin are affected by CVP or SWP  
32 operations. The Merced River Hatchery, located on the Merced River, is operated  
33 by CDFW to supplement the fall-run Chinook Salmon population. It is not  
34 included in the CVP or SWP service areas. As part of the San Joaquin River  
35 Restoration Program, CDFW has begun operation of a conservation hatchery  
36 downstream of Friant Dam to produce spring-run Chinook Salmon (Reclamation  
37 and DWR 2010).

#### 38 **9.3.4.15.5 Predation**

39 Recent studies of predation in the San Joaquin River are limited to the major  
40 tributaries, where largemouth and Smallmouth Bass have been identified as the  
41 most important predators of juvenile Chinook Salmon (McBain and Trush and

1 Stillwater Sciences 2006). Striped Bass also have been identified as salmon  
2 predators, though recent evidence for the San Joaquin River is lacking.

3 **9.3.4.16 New Melones Reservoir, Tulloch Reservoir, and Goodwin Dam**

4 The north, middle, and south forks of the Stanislaus River converge upstream of  
5 the CVP New Melones Reservoir. Water from New Melones Reservoir flows  
6 into Tulloch Reservoir (Reclamation 2010b). Downstream of Tulloch Reservoir,  
7 the Stanislaus River flows through the reservoir formed by Goodwin Dam and  
8 then approximately 40 miles to the confluence with the San Joaquin River.

9 New Melones Reservoir is located approximately 60 miles upstream from the  
10 confluence of the Stanislaus and San Joaquin rivers and is operated by  
11 Reclamation. New Melones Reservoir is an artificial environment and does not  
12 support a naturally evolved aquatic community. Most of the species in the  
13 reservoir were introduced, although a few native species may still be present.  
14 From a fisheries perspective, recreational fishing is the most important use of  
15 New Melones Reservoir. Fish species in New Melones Reservoir include  
16 Rainbow Trout, Brown Trout, Largemouth Bass, sunfishes such as Black Crappie  
17 and Bluegill, and three species of catfish (Reclamation 2010b). Rainbow Trout,  
18 Brown Trout, and large Channel Catfish are generally restricted to colder, deeper  
19 water during summer, when New Melones Reservoir has two distinct thermal  
20 layers of water, although large Brown Trout and Channel Catfish are found in  
21 shallow water near steep banks at night when they ascend to feed.

22 Tulloch Reservoir is operated as an afterbay for the New Melones Reservoir and  
23 is subject to fluctuating water levels that occur on a daily and seasonal basis.  
24 Tulloch Reservoir stratifies weakly during summer and contains a reserve of  
25 relatively cold, well-oxygenated water that is released downstream. Tulloch  
26 Reservoir supports both warm and cold freshwater habitat. Goodwin Power  
27 (2013) reported that DFG captured 15 species in Tulloch Reservoir from  
28 1969 through 1998. Five dominant species made up almost 80 percent of the  
29 catch; White Catfish (31 percent of the total), Bluegill (20 percent), Sacramento  
30 Sucker (11 percent), Smallmouth Bass (10 percent), and Black Crappie  
31 (7 percent). Of these, only the Sacramento Sucker is native. Other native species  
32 in the catch were Sacramento Hitch, Hardhead, Sacramento Pikeminnow, and  
33 Rainbow Trout (now stocked). Other nonnative fish found in Tulloch reservoir  
34 include Largemouth Bass and Threadfin Shad (DFG 2002b).

35 Little information exists regarding aquatic resources in the reservoir formed by  
36 Goodwin Dam. It is assumed that fish assemblies are similar to those described  
37 for Tulloch Reservoir.

38 **9.3.4.17 Stanislaus River from Goodwin Dam to the San Joaquin River**

39 **9.3.4.17.1 Fish in the Stanislaus River**

40 Steelhead and fall-run Chinook Salmon currently occur in the lower Stanislaus  
41 River. Historically, spring-run Chinook Salmon were believed to be the primary  
42 salmon run in the Stanislaus River. Native spring-run Chinook salmon have been

1 extirpated from all tributaries in the San Joaquin River Basin, which represents a  
 2 large portion of their historic range and abundance (NMFS 2014b). Other  
 3 anadromous fish species that occur in the lower Stanislaus River include Striped  
 4 Bass, American Shad, and an unidentified species of lamprey (SRFG 2003). The  
 5 analysis is focused on the following species:

- 6 • Fall-run Chinook Salmon
- 7 • Steelhead
- 8 • Pacific Lamprey
- 9 • Striped Bass
- 10 • American Shad

#### 11 *Fall-run Chinook Salmon*

12 Data collected by private fishery consultants, nonprofit organizations, and DFG  
 13 demonstrate the majority of fall-run Chinook Salmon adults migrate upstream  
 14 from late September through December with peak migration from late October  
 15 through early November. Most Chinook Salmon spawning occurs between  
 16 Riverbank (River Mile 33) and Goodwin Dam (River Mile 58.4) (Reclamation  
 17 2012b). Based on redd surveys conducted by FISHBIO, peak spawning typically  
 18 occurs in November with roughly 7 percent of spawning occurring prior to  
 19 November 1, and 2 percent prior to October 15. The few redds created during late  
 20 September and early October are typically in the reach just below Goodwin Dam.  
 21 By late October, the amount of spawning in downstream locations increases as  
 22 water temperatures decrease, and the median redd location is typically around  
 23 Knights Ferry (SWRCB 2015).

24 In 2010, over 20 percent of the fall-run Chinook Salmon observed passing the  
 25 Stanislaus River weir had adipose fin clips, indicating the presence of a coded-  
 26 wire-tag (CWT) in their snout. Since there is no hatchery on the Stanislaus River  
 27 and no hatchery releases have been conducted into this tributary since 2006, it is  
 28 apparent that straying from other rivers is occurring (FISHBIO 2010b).

29 Rotary screw trap data indicate that about 99 percent of salmon juveniles migrate  
 30 out of the Stanislaus River from January through May (SRFG 2004). Fry  
 31 migration generally occurs from January through March, followed by smolt  
 32 migration from April through May (Reclamation 2012). Watry et al. (2012)  
 33 found that in both 2010 and 2011, peak passage during the pre-smolt period  
 34 generally corresponded with flow pulses. Zeug et al. (2014) examined 14 years of  
 35 rotary screw trap data on the lower Stanislaus River and found a strong positive  
 36 response in survival, the proportion of pre-smolt migrants and the size of smolts  
 37 when cumulative flow and flow variance were greater and concluded that the data  
 38 suggested that periods of high discharge in combination with high discharge  
 39 variance are important for successful emigration as well as migrant size and the  
 40 maintenance of diverse migration strategies.

41 Mesick (2001) surmised that when water exports are high relative to San Joaquin  
 42 River flows, little, if any, San Joaquin River water reaches San Francisco Bay  
 43 where it may be needed to help attract the salmon back to the Stanislaus River.  
 44 During mid-October from 1987 through 1989, when export rates exceeded



1 400 percent of Vernalis flows, Mesick (2001) found that straying rates ranged  
2 between 11 and 17 percent. In contrast, straying rates were estimated to be less  
3 than 3 percent when Delta export rates were less than about 300 percent of  
4 San Joaquin River flow at Vernalis during mid-October.

5 One of the limiting factors appears to be the high rates of mortality for juveniles  
6 migrating through dredged channels in the Stanislaus River and Delta, particularly  
7 the Stockton Deep Water Ship Channel (Newcomb and Pierce 2010). Pickard  
8 et al. (1982) reported that the survival of juvenile fish in the deep-water ship  
9 channel is highest during flood flows or when a barrier is placed at the head of the  
10 Old River that more than doubles the flow in the ship channel. The Stanislaus  
11 River Fish Group (SRFG) (2004) noted that escapement is also directly correlated  
12 with springtime flows when each brood migrates downstream as smolts.  
13 However, the cause of the mortality in the ship channel has not been studied. It is  
14 possible that mortality results from the combined effects of warm water  
15 temperatures, low dissolved oxygen concentrations, ammonia toxicity, and  
16 predation.

17 As discussed earlier, dredging for gravel and gold, regulated flows, and the diking  
18 of floodplains for agriculture have substantially limited the availability of  
19 spawning and rearing habitat for fall-run Chinook Salmon. Reclamation has  
20 conducted spawning gravel augmentation to improve spawning and rearing  
21 habitats in the reach between Goodwin Dam and Knights Ferry most years since  
22 1999. The dredged areas also contain an abundance of large predatory fish,  
23 although the SRFG concluded that there is uncertainty about whether predation is  
24 a substantial source of mortality for juvenile salmon.

25 The SRFG also concluded that water diversions for urban and agricultural use in  
26 all three San Joaquin River tributaries, which reduce flows and potentially result  
27 in unsuitably warm water temperatures during spring and fall, affect fall-run  
28 Chinook Salmon juvenile rearing and adult and juvenile migration in the lower  
29 San Joaquin River and Delta.

### 30 *Steelhead*

31 Steelhead were thought to be extirpated from the San Joaquin River system  
32 (NMFS 2009a). However, monitoring has detected small self-sustaining  
33 (i.e., non-hatchery origin) populations of steelhead in the Stanislaus River and  
34 other streams previously thought to be devoid of steelhead (SRFG 2003, McEwan  
35 2001). There is a catch-and-release steelhead fishery in the lower Stanislaus  
36 River between January 1 and October 15. Surveys of *O. mykiss* (resident trout  
37 and the anadromous steelhead) abundance and distribution conducted annually  
38 since 2009 have documented a relatively stable population. River-wide  
39 abundance estimates from 2009 to 2014 have averaged just over 20,220 (all life  
40 stages combined) and have never been estimated to be less than about 14,000  
41 (2009). The highest densities and abundances of *O. mykiss* are consistently found  
42 in Goodwin Canyon. Key factors that may contribute to higher-than average  
43 abundances in the Stanislaus River (relative to other San Joaquin River  
44 tributaries) include high gradient reaches that are typically associated with higher  
45 amount of fast-water habitats, particularly in Goodwin Canyon (SWRCB 2015).

1 Historically, the distribution of steelhead extended into the headwaters of the  
 2 Stanislaus River (Yoshiyama et al. 1996). Steelhead currently can migrate more  
 3 than 58 miles up the Stanislaus River to the base of Goodwin Dam. In the  
 4 Stanislaus River, there is little data regarding the migration patterns of adult  
 5 steelhead since adults generally migrate during periods when river flows and  
 6 turbidity are high making fish difficult to observe with standard adult monitoring  
 7 techniques. Stanislaus River weir data indicate that steelhead migrate upstream,  
 8 through the South Delta and lower San Joaquin river, between September and  
 9 March with numbers ranging from 6 to 85<sup>3</sup> between 2008-2011 and 2013  
 10 (Reclamation 2014e). High Delta export rates relative to San Joaquin River flows  
 11 at Vernalis, when adults are migrating through the Delta (presumably December  
 12 through May), may result in adults straying to the Sacramento River Basin.

13 It is believed that steelhead spawn primarily between December and March in the  
 14 Stanislaus River. Although steelhead few steelhead spawning surveys have been  
 15 conducted in the Stanislaus, spawning *O. mykiss* were documented between  
 16 Goodwin Dam and Horseshoe Bar in a 2014 spawning survey (Reclamation and  
 17 DWR 2015). The spawning adults require holding and feeding habitat with cover  
 18 adjacent to suitable spawning habitat. These habitat features are relatively rare in  
 19 the lower Stanislaus River because of in-river gravel mining and the scouring of  
 20 gravel from riffles in Goodwin Canyon.

21 Juvenile steelhead rear in the Stanislaus River for at least 1 year, and usually  
 22 2 years, before migrating to the ocean. As a result, flow, water temperature, and  
 23 dissolved oxygen concentration in the reach between Goodwin Dam and the  
 24 Orange Blossom Bridge (their primary rearing habitat) are critical during summer  
 25 (Reclamation 2012b).

26 Small numbers of steelhead smolts have been captured in rotary screw traps at  
 27 Caswell State Park and near Oakdale (FISHBIO 2007; Watry et al. 2007, 2012),  
 28 and data indicate that steelhead outmigrate primarily from February through May.  
 29 Rotary screw traps are generally not considered efficient at catching fish as large  
 30 as steelhead smolts, and the number captured is too small to estimate capture  
 31 efficiency, so no steelhead smolt outmigration population estimate has been  
 32 calculated. The capture of these fish in downstream migrant traps and the  
 33 advanced smolting characteristics exhibited by many of the fish indicate that  
 34 some steelhead/rainbow juveniles might migrate to the ocean in spring. However,  
 35 it is not known whether the parents of these fish were anadromous or fluvial (they  
 36 migrate within fresh water). Resident populations of steelhead/rainbow in large  
 37 streams are typically fluvial, and migratory juveniles look much like smolts.

### 38 *Pacific Lamprey*

39 The Pacific Lamprey is a widely distributed anadromous species that inhabits  
 40 accessible reaches of the Stanislaus River (SRFG 2003). Limited information on  
 41 Pacific Lamprey status in the Stanislaus River exists, but the species has

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<sup>3</sup> Numbers presented are for all *O. mykiss* passing upstream of the Stanislaus Weir and do not differentiate between adult steelhead and resident rainbow trout that are moving within the river; therefore, actual numbers of steelhead may be lower than those presented.

1 experienced loss of access to historical habitat and apparent population declines  
2 throughout California and the Sacramento and San Joaquin River basins  
3 (Moyle et al. 2009). Little information is available on factors influencing  
4 Pacific Lamprey populations in the Stanislaus River, but they are likely affected  
5 by many of the same factors as salmon and steelhead because of parallels in their  
6 life cycles.

7 Ocean stage adults likely migrate into the Stanislaus River in spring and early  
8 summer, where they hold for approximately 1 year before spawning (Hanni et al.  
9 2006). Hannon and Deason (2008) have documented Pacific Lampreys spawning  
10 in the American River from between early January and late May, with peak  
11 spawning typically in early April. Spawning time is presumably similar in the  
12 Stanislaus River. Pacific Lamprey ammocoetes are expected to rear in the  
13 Stanislaus River for all or part of their 5- to 7-year freshwater residence. Data  
14 from rotary screw trapping in the nearby Mokelumne and Tuolumne rivers  
15 suggest that outmigration of Pacific Lamprey generally occurs from early winter  
16 through early summer (Hanni et al. 2006). Catches of juvenile Pacific Lampreys  
17 in trawl surveys of the mainstem San Joaquin River, near the mouth of the  
18 Stanislaus River at Mossdale, occurred during winter and spring. Some  
19 outmigration likely occurs year-round, as observed at sites on the mainstem  
20 Sacramento River (Hanni et al. 2006). Significant numbers of lampreys of  
21 unknown species and unspecified life stage have been captured during rotary  
22 screw trapping on the Stanislaus River at Oakdale (FISHBIO 2007) and Caswell  
23 (Watry et al. 2007).

#### 24 *Striped Bass*

25 Striped Bass occur in the Stanislaus River, and they support a sport fishery when  
26 adult fish migrate upstream to spawn. Striped Bass have been observed at Lovers  
27 Leap and at Knights Ferry from May through the end of June. These adult fish  
28 were observed in all habitats (USFWS 2002, Kennedy and Cannon 2005). The  
29 distribution of Striped Bass in the Stanislaus River is thought to be limited to  
30 downstream of the historic Knights Ferry Bridge due to a set of falls about 3 feet  
31 tall in the area (USFWS 2002).

#### 32 *American Shad*

33 American Shad migrate up the Stanislaus River to spawn in the late spring and  
34 support a sport fishery during that period. American Shad have been observed on  
35 occasion from June through July at Lovers Leap (USFWS 2002, Kennedy and  
36 Cannon 2005). American Shad were found primarily in the faster habitats and  
37 were observed in schools of 20 or more (USFWS 2002).

#### 38 **9.3.4.17.2 Aquatic Habitat**

39 Schneider et al. (2003) conducted hydrologic analysis of the Stanislaus River and  
40 found that New Melones Dam (built in 1979) and more than 30 smaller dams  
41 cumulatively impound 240 percent of average annual unimpaired runoff.  
42 Schneider et al. (2003) concluded that this has reduced winter floods and spring  
43 snow melt runoff, and increased summer base flows to supply irrigation demand.  
44 As a result, the frequency and extent of overbank flooding has been reduced.

1 Based on historical data and field measurements, Schneider et al. (2003)  
2 suggested that the channel had incised approximately 1 to 3 feet since dam  
3 construction, and that the discharge needed for overbank flows has approximately  
4 doubled.

5 With respect to the related need for geomorphic flows, Kondolf et al. (2001)  
6 estimated bedload mobilization flows in the Stanislaus River to be around  
7 5,000 to 8,000 cfs to mobilize the median particle size of the channel bed  
8 material. Flows necessary to mobilize the bed material increased downstream  
9 from a minimal 280 cfs where gravel had been recently added near Goodwin Dam  
10 to about 5,800 cfs at Oakdale Recreation Area (Reclamation 2008a). Before  
11 construction of New Melones Dam, a bed-mobilizing flow of 5,000 to 8,000 cfs  
12 was equivalent to a 1.5- to 1.8-year return interval flow. Following construction  
13 of the dam, 5,000 cfs represents approximately a 5-year return interval flow, and  
14 8,000 cfs exceeds all flows within the 21-year study period, 1979 to 1999  
15 (maximum flow = 7,350 cfs on January 3, 1997). The probability of occurrence  
16 for a daily average flow exceeding 5,330 cfs (the pre-dam bankfull discharge) is  
17 0.01 per year.

18 Low dissolved oxygen (DO) levels have been measured in the San Joaquin River,  
19 in particular in the Deep Water Ship Channel (DWSC) from the Port of Stockton  
20 seven miles downstream to Turner Cut (Lee and Jones-Lee 2003). These  
21 conditions are the result of increased residence time of water combined with high  
22 oxygen demand in the anthropogenically modified channel, which leads to DO  
23 depletion, particularly near the sediment-water interface (SJTA 2012). Despite  
24 these conditions, adult salmon and steelhead migration does not appear to be  
25 adversely impacted (Pyper et. al 2006). However, during the 1960s, Hallock et al.  
26 (1970) found that adult radio-tagged Chinook Salmon delayed their upstream  
27 migration whenever dissolved oxygen concentrations were less than 5 mg/L at  
28 Stockton. SWRCB D-1422 requires water to be released from New Melones  
29 Reservoir to maintain dissolved oxygen standards in the Stanislaus River, as  
30 described in Chapter 6, Surface Water Quality. It has been shown that low DO  
31 conditions in the San Joaquin River can be ameliorated somewhat through  
32 installation of the Head of the Old River Barrier which increases San Joaquin  
33 River flows (SJTA 2012).

#### 34 *Spawning and Rearing Habitat*

35 Upstream dams have suppressed channel-forming flows that replenish spawning  
36 beds in the Stanislaus River (Kondolf et al. 1996). The physical presence of the  
37 dams impedes normal sediment transportation processes. Kondolf (et al. 2001)  
38 identified levels of sediment depletion at 20,000 cubic yards per year as a result of  
39 a variety of factors, including mining, and geomorphic processes associated with  
40 past and ongoing dam operations. In 2011, 5,000 tons of gravel were placed in  
41 Goodwin Canyon downstream of Goodwin Dam, of which around 70 percent was  
42 transported into nearby downstream areas during high flows (SOG 2012).

43 Extensive instream gravel mining removed large quantities of spawning habitat  
44 (Kondolf et al. 2001). Gravel mining also has resulted in instream mine pits that  
45 occur in the primary salmonid spawning areas, including a large, approximately

1 1-mile-long pit called the Oakdale Recreation Pond. Instream mine pits trap  
2 bedload sediment, store large volumes of sand and silt, and pass sediment-starved  
3 water downstream, where it typically erodes the channel bed and banks to regain  
4 its sediment load (Kondolf et al. 2001). Reclamation restores and replenishes  
5 spawning gravel and rearing habitat lost from the construction and operation of  
6 dams in the Stanislaus River to restore spawning habitat and remediate sediment  
7 related loss of geomorphic function, such as channel incision.

#### 8 *Floodplain Habitat*

9 Kondolf et al. (2001) identified that floodplain terraces and point bars inundated  
10 before operation of New Melones Reservoir have become fossilized with fine  
11 material and thick riparian vegetation that is never rejuvenated by scouring flows.  
12 Channel forming flows in the 8,000-cfs range have occurred only twice since  
13 New Melones Reservoir began operation 28 years ago.

14 Based on historical data and field measurements, Schneider et al. (2003)  
15 suggested that the channel incised approximately 1 to 3 feet since dam  
16 construction, and that the discharge needed for overbank flows has approximately  
17 doubled. Without inundation, the floodplains cannot provide terrestrial food for  
18 juvenile salmon or organic matter that helps produce more food within the river.  
19 Increased flows required for inundation also have had the effect of further  
20 isolating floodplains from the channel, leading to the loss of floodplain habitats.

21 In 2011, a habitat restoration project to increase spawning habitat also restored  
22 640 feet of remnant side channel habitat, allowing water to flow at the current  
23 1.5-year return interval (575 cfs), in addition to three cross channels designed to  
24 inundate at higher flows (SOG 2011).

#### 25 **9.3.4.17.3 Fish Passage and Entrainment**

26 Constructed in 1913, Goodwin Dam was probably the first permanent barrier to  
27 significantly affect anadromous fish access to upstream habitat in the Stanislaus  
28 River. Goodwin Dam had a fishway, but Chinook Salmon could seldom pass it,  
29 and other salmonids may have been similarly affected. Yoshiyama et al. (1996)  
30 estimated that historically Chinook Salmon and other salmonids had access to  
31 113 miles of habitat, compared with 58 miles under current conditions.

32 There are numerous small, unscreened diversions on the lower Stanislaus River  
33 (Herren and Kawasaki 2001). The effects of these diversions on fish is not clear;  
34 however, in tracking the fate of 49 radio tagged fish, S.P. Cramer and Associates  
35 (1998) did not detect any entrainment at several moderately sized unscreened  
36 pumps in the lower Stanislaus River.

#### 37 **9.3.4.17.4 Predation**

38 Areas of the Stanislaus River, including spawning riffles in the active channel,  
39 were mined for gravel and gold primarily between 1940 and 1970. The mined  
40 areas consist of long, deep ditches and large ponds that provide habitat for  
41 predators, such as Striped Bass, Sacramento Pikeminnow, Largemouth Bass, and  
42 Smallmouth Bass (Mesick 2002). Studies by S.P. Cramer and Associates (1998)

1 documented predation on juvenile salmonids by bass in the Tuolumne and  
2 Stanislaus rivers. However, in its review of information, the SRFG (2004)  
3 concluded that the available studies and observations suggest that fish predators in  
4 the Stanislaus River may be limited to adult pikeminnow and Riffle Sculpin  
5 feeding on newly emerged fry, whereas Smallmouth Bass, Largemouth Bass, and  
6 possibly American Shad probably feed on relatively few parr that remain in the  
7 river during late spring and summer when water temperatures are high.

8 It is possible that predation is high for juveniles rearing in the deep-water ship  
9 channel in the Delta as observed by Pickard et al. (1982). Predation rates on  
10 hatchery-reared juveniles and tagged juveniles may be higher than those for  
11 naturally produced fish. TID/MID (1992, 2013), and TRTAC et al. (2006), have  
12 documented predation on salmonids by nonnative predatory fishes in the  
13 Tuolumne River, primarily in run-of-river gravel mining ponds and dredged areas.  
14 Sonke and Fuller (2012) reported the number of juvenile Chinook Salmon passing  
15 the rotary screw traps at Waterford (2006 to 2012) and Grayson (1995 to 2012) on  
16 the Tuolumne River. FISHBIO (2013) calculated the potential consumption of  
17 juvenile Chinook Salmon by predators in the reach between the Waterford and  
18 Grayson rotary screw traps in 2012 and found that consumption of juvenile  
19 Chinook Salmon in this reach could equal or exceed the number passing the  
20 Waterford trap. Based on their consumption calculations and the difference in  
21 estimated numbers of juvenile Chinook Salmon passing the Waterford and  
22 Grayson rotary screw traps, FISHBIO (2013) concluded that it is plausible that  
23 the majority of juvenile Chinook Salmon losses in this reach are due to predation.  
24 NMFS (2009a) noted that losses on the Stanislaus River have not been similarly  
25 quantified, but predation on fall-run Chinook Salmon smolts and steelhead by  
26 Striped Bass and Largemouth Bass has been documented.

#### 27 **9.3.4.18 San Luis Reservoir**

28 San Luis Reservoir is located at the base of the foothills on the west side of the  
29 San Joaquin Valley in Merced County, as described in Chapter 5, Surface Water  
30 Resources and Water Supplies. Water from the Delta is delivered to San Luis  
31 Reservoir via the California Aqueduct and Delta-Mendota Canal for storage.

32 San Luis Reservoir and O'Neill Forebay support several species of fish that have  
33 become established within the system, either by direct introduction or from the  
34 Delta system via pumping from the California Aqueduct and Delta-Mendota  
35 Canal. Striped Bass are the predominant species in San Luis Reservoir  
36 (DWR 1987) and support a recreational fishery. Other species include  
37 Sacramento Blackfish, American Shad, Threadfin Shad, Largemouth Bass,  
38 Kokanee Salmon, Green Sunfish, Bluegill, White Sturgeon, and White Crappie.

39 There are no sensitive fish species in the San Luis Reservoir except, possibly,  
40 individuals entrained by the CVP and SWP projects in the Delta. These  
41 individuals have already been lost to their populations, as they cannot return to the  
42 Delta once entrained. Potentially occurring fish species with special status that  
43 may have been imported from the Delta include Chinook Salmon, Delta Smelt,  
44 Hardhead, and Sacramento Splittail (Reclamation and CSP 2013).

1 **9.3.5 San Francisco Bay Area Region**

2 Fish and aquatic habitat resources in the San Francisco Bay Area Region include  
3 habitat through San Francisco Bay and along the Pacific Ocean coast. The  
4 anadromous fish species discussed above use the Pacific Ocean as part of their  
5 life cycles. In addition, the Pacific Ocean supports the killer whale which relies  
6 upon Chinook Salmon (e.g., fall-run Chinook Salmon) for food.

7 The San Francisco Bay Area Region also includes fish habitat within reservoirs  
8 that store CVP and SWP water. CVP and SWP water supplies are stored in  
9 Contra Loma and San Justo reservoirs; the SWP Bethany Reservoir and Lake  
10 Del Valle; the Contra Costa Water District Los Vaqueros Reservoir; and the East  
11 Bay Municipal Utility District (EBMUD) Upper San Leandro, San Pablo,  
12 Briones, and Lafayette reservoirs and Lake Chabot. Many of these reservoirs also  
13 store water from local and regional water supplies. CVP and SWP water is  
14 generally not stored in reservoirs within Santa Clara County (SCVWD 2010).

15 **9.3.5.1 Pacific Ocean Habitat of the Killer Whale**

16 The Pacific Ocean along the coast of California is included in this description of  
17 the affected environment because of it provides habitat for the Southern Resident  
18 killer whale population. The effect of the action, however, is limited to changes  
19 in the number of Chinook Salmon produced in the Central Valley entering the  
20 Pacific Ocean, which contribute an important component of the killer whale diet.

21 Southern Resident killer whales are found primarily in the coastal waters offshore  
22 of British Columbia and Washington and Oregon in summer and fall (NMFS  
23 2008). During winter, killer whales are sometimes found off the coast of central  
24 California and more frequently off the Washington coast (Independent  
25 Hilborn et al. 2012).

26 The 2005 NMFS endangerment listing (70 FR 69903) for the Southern Resident  
27 killer whale distinct population segment lists several factors that may be limiting  
28 the recovery of killer whales, including the quantity and quality of prey,  
29 accumulation of toxic contaminants, and sound and vessel disturbance. In the  
30 Recovery Plan for Southern Resident Killer Whales (*Orcinus orca*), NMFS  
31 (2008) posits that reduced prey availability forces whales to spend more time  
32 foraging, which may lead to reduced reproductive rates and higher mortality rates.  
33 Reduced food availability may lead to mobilization of fat stores, which can  
34 release stored contaminants and adversely affect reproduction or immune function  
35 (NMFS 2008).

36 The Independent Science Panel reported that Southern Resident killer whales  
37 depend on Chinook Salmon as a critical food resource (Independent Science  
38 Panel and ESSA Technologies 2012). Hanson et al. (2010) analyzed tissues from  
39 predation events and feces to confirm that Chinook Salmon were the most  
40 frequent prey item for killer whales in two regions of the whale's summer range  
41 off the coast of British Columbia and Washington state, representing over  
42 90 percent of the diet in July and August. Samples indicated that when Southern  
43 Residents are in inland waters from May to September, they consume Chinook  
44 Salmon stocks that originate from regions including the Fraser River, Puget

1 Sound, the Central British Columbia Coast, West and East Vancouver Island, and  
2 Central Valley California (Hanson et al. 2010).

3 Significant changes in food availability for killer whales have occurred over the  
4 past 150 years, largely due to human impacts on prey species. Salmon abundance  
5 has been reduced over the entire range of the Southern Resident killer whales,  
6 from British Columbia to California. The Recovery Plan for Southern Resident  
7 Killer Whales (*Orcinus orca*) (NMFS 2008) indicates that wild salmon have  
8 declined primarily due to degraded aquatic ecosystems, overharvesting, and  
9 production of fish in hatcheries. The recovery plan supports restoration efforts to  
10 rebuild depleted salmon populations and other prey to ensure an adequate food  
11 base for Southern Resident killer whales.

12 Central Valley streams produce Chinook Salmon that contribute to the diet of  
13 Southern Resident killer whales. The number of Central Valley salmon that  
14 annually enter the ocean and survive to a size susceptible to predation by killer  
15 whales is not known. However, estimates of total Chinook Salmon production  
16 produced by the Comprehensive Assessment and Monitoring Program,  
17 administered by USFWS and Reclamation, provide an approximation of the size  
18 of the ocean population of Central Valley Chinook Salmon potentially available  
19 to killer whales. Since 1992, total production of fall-run Chinook Salmon ranged  
20 from 53,129 in 2009 to 1,436,928 in 2002 (Table 9.2). The term “total  
21 production” here represents the number of fish that returned from the ocean plus  
22 those that were taken as part of the commercial and sport fishery. It does not  
23 include natural mortality in the ocean, including salmon taken by killer whales.



1 **Table 9.2 Total Production (Number of Individuals) of Central Valley Fall-run**  
 2 **Chinook Salmon in the Pacific Ocean and Ocean Harvest 1992-2011**

Year	Total Production	Ocean Harvest
1992	333,087	203,318
1993	553,617	352,913
1994	711,654	449,060
1995	1,391,357	994,194
1996	891,739	471,865
1997	1,146,471	679,151
1998	557,433	263,935
1999	795,768	316,873
2000	1,156,596	571,829
2001	976,034	218,424
2002	1,436,928	418,785
2003	1,019,686	297,140
2004	977,463	500,929
2005	874,670	356,514
2006	453,274	110,540
2007	202,311	87,528
2008	71,870	0
2009	53,129	0
2010	208,050	13,851
2011	329,092	57,224

3 Source: DOI 2012

4 **9.3.5.2 Contra Loma Reservoir**

5 The Contra Loma Reservoir is a CVP facility in Contra Costa County that  
 6 provides offstream storage along the Contra Costa Canal. The 80-acre reservoir is  
 7 part of 661-acre Contra Loma Regional Park and Antioch Community Park  
 8 (Reclamation 2014b). There are currently 20 known fish species, including  
 9 8 species of game fish, in Contra Loma Reservoir. The East Bay Parks and  
 10 Recreation District (EBRPD) and CDFW stock Rainbow Trout and Channel  
 11 Catfish in the reservoir. The reservoir also supports self-sustaining populations of  
 12 Largemouth Bass, crappie, Redear Sunfish, and Bluegill, which are also popular  
 13 with anglers (Reclamation 2014b). Other species found include White Catfish,  
 14 Threadfin Shad, Bigscale Logperch, Common Carp, Sacramento Blackfish,  
 15 Warmouth, Green Sunfish, Goldfish, Prickly Sculpin, and Inland Silversides  
 16 (Reclamation 2014b).

1 Many of the fish species present have been unintentionally introduced from the  
 2 Delta via the Contra Costa Canal. Recently, the Rock Slough Fish Screen at the  
 3 head of Contra Costa Canal was constructed to prevent the entrainment of  
 4 federally protected species such as Delta Smelt at the Rock Slough Intake of the  
 5 Contra Costa Canal. The new screen also minimizes fish entrainment and  
 6 significantly reduces the potential for fish introductions into Contra Loma  
 7 Reservoir from the Contra Costa Canal (Reclamation 2014b).

#### 8 **9.3.5.3 San Justo Reservoir**

9 The San Justo Reservoir is a CVP facility in San Benito County that provides  
 10 offstream storage as part of the San Felipe Division, as described in Chapter 5,  
 11 Surface Water Resources and Water Supplies. Other than stocked Rainbow  
 12 Trout, all of the fish and other aquatic organisms that have been observed in  
 13 San Justo Reservoir are nonnative species (SBCWD 2012).

#### 14 **9.3.5.4 South Bay Aqueduct Reservoirs**

15 Bethany Reservoir, Patterson Reservoir, and Lake Del Valle are SWP facilities  
 16 associated with the South Bay Aqueduct in Alameda County, as described in  
 17 Chapter 5, Surface Water Resources and Water Supplies. At Bethany Reservoir,  
 18 anglers catch five types of bass (Spotted, White, Largemouth, Smallmouth, and  
 19 Striped), crappie, catfish, and trout (CSP 2013). Presumably, many of the same  
 20 species would be found in Patterson Reservoir. Lake Del Valle is stocked  
 21 regularly with trout and catfish. Largemouth and Smallmouth Bass, Striped Bass,  
 22 and panfish are also caught (EBPRD 2014).

#### 23 **9.3.5.5 Los Vaqueros Reservoir**

24 Los Vaqueros Reservoir is a Contra Costa Water District offstream storage  
 25 facility in Contra Costa County, as described in Chapter 5, Surface Water  
 26 Resources and Water Supplies. Aquatic habitat quality for fish is low to moderate  
 27 due to poorly developed cover vegetation along the shoreline. The reservoir has  
 28 been stocked with more than 300,000 game fish, primarily Rainbow Trout and  
 29 Kokanee Salmon. Other fish introduced to the reservoir include Striped Bass,  
 30 Largemouth Bass, sunfish, Brown Bullhead, and Channel Catfish (Reclamation  
 31 and CCWD 2011).

#### 32 **9.3.5.6 East Bay Municipal Utility District Reservoirs**

33 The EBMUD reservoirs in Alameda and Contra Costa County used to store water  
 34 within and near the EBMUD service area include Briones Reservoir, San Pablo  
 35 Reservoir, Lafayette Reservoir, Upper San Leandro Reservoir, and Lake Chabot.  
 36 Water stored in these reservoirs includes water from local watersheds, the  
 37 Mokelumne River watershed, and CVP water supplies, as described in Chapter 5,  
 38 Surface Water Resources and Water Supplies. San Pablo Reservoir is regularly  
 39 stocked with trout and catfish (EBMUD 2014). Other species caught in the  
 40 reservoir include crappie, Largemouth Bass, Smallmouth Bass, Spotted Bass, and  
 41 carp (OEHHA 2009).

1 CDFW annually stocks trout in Lafayette Reservoir. Other species found in the  
2 reservoir include Bluegill, black bass, Black Crappie, and several species of  
3 catfish (Lafayette Chamber of Commerce 2014).

4 Lake Chabot is stocked with hatchery-raised Rainbow Trout and Channel Catfish  
5 by EBRPD and CDFW for recreational fishing. The lake also supports a popular  
6 nonnative, warm-water recreational fishery for Largemouth Bass, Bluegill, and  
7 Black Crappie. Some native trout escape from the Upper San Leandro Reservoir  
8 during spill events and likely end up in Lake Chabot (EBMUD 2013).

### 9 **9.3.6 Central Coast Region**

10 The Central Coast Region includes portions of San Luis Obispo and Santa  
11 Barbara counties served by the SWP. SWP water is delivered to southern Santa  
12 Barbara County communities through Cachuma Lake.

#### 13 **9.3.6.1 Cachuma Lake**

14 Cachuma Lake is a facility owned and operated by Reclamation in Santa Barbara  
15 County. Cachuma Lake provides a variety of habitats for fish species, including  
16 deep-water areas, rocky drop-offs, shallow areas, and weed beds (wetland areas).  
17 Cachuma Lake and the upper Santa Ynez River are popular fishing areas that  
18 have been stocked with game fish by CDFW and the County of Santa Barbara.  
19 Native fish species in Cachuma Lake include steelhead/Rainbow Trout, Armored  
20 Three-Spine Stickleback, and Prickly Sculpin. Key game fish include  
21 Largemouth Bass, Smallmouth Bass, Bluegill, Green Sunfish, Redear Sunfish,  
22 Black Crappie, and White Crappie. Other species that have been identified in the  
23 lake include Channel Catfish, Black Bullhead, Threadfin Shad, goldfish, carp, and  
24 Mosquitofish (Reclamation 2010c).

### 25 **9.3.7 Southern California Region**

26 The Southern California Region includes portions of Ventura, Los Angeles,  
27 Orange, San Diego, Riverside, and San Bernardino counties served by the SWP.  
28 There are six SWP reservoirs along the main canal, West Branch, and East  
29 Branch of the California Aqueduct and many other reservoirs owned and operated  
30 by regional and local agencies. The Metropolitan Water District of Southern  
31 California's Diamond Valley Lake and Lake Skinner primarily store water from  
32 the SWP. Other reservoirs store SWP water, including United Water  
33 Conservation District's Lake Piru; City of Escondido's Dixon Lake; City of San  
34 Diego's San Vicente Reservoir and Lower Otay Reservoir; Helix Water District's  
35 Lake Jennings; and Sweetwater Authority's Sweetwater Reservoir.

#### 36 **9.3.7.1 State Water Project Reservoirs**

37 The SWP reservoirs include Quail Lake, Pyramid Lake, and Castaic Lake in Los  
38 Angeles County; Silverwood Lake and Crafton Hills Reservoir in San Bernardino  
39 County; and Lake Perris in Riverside County.

1 Although small compared to nearby Pyramid and Castaic lakes, Quail Lake's  
 2 290 acres and 3 miles of shoreline offer shoreline fishing. Striped Bass, Channel  
 3 Catfish, Blackfish, Tule Perch, Threadfin Shad, and Hitch have been found at  
 4 Quail Lake (DWR 1997).

5 Pyramid Lake is located in the Angeles and Los Padres National Forests, about  
 6 60 miles northwest of downtown Los Angeles. Largemouth Bass, Smallmouth  
 7 Bass, and Striped Bass as well as Bluegill, crappie, Brown Bullhead, Channel  
 8 Catfish, and trout are caught by anglers in Pyramid Lake (OEHHA 2013a).  
 9 Rainbow Trout, Bluegill, Green Sunfish, Largemouth Bass, catfish, and Prickly  
 10 Sculpin are found in Piru Creek below the dam (DWR 2004d).

11 Castaic Lake supports a warm-water fishery for Striped Bass and Largemouth  
 12 Bass. Bluegill and assorted minnows provide a forage base for the bass as well as  
 13 being caught by anglers. CDFW maintains a Rainbow Trout fishery in Castaic  
 14 Lake through stocking (DWR 2007).

15 Silverwood Lake is located in the San Bernardino National Forest and surrounded  
 16 by the Silverwood Lake State Recreation Area at the edge of the Mojave Desert  
 17 and at the base of the San Bernardino Mountains. Common sport fish caught in  
 18 Silverwood Lake include stocked Rainbow Trout, Largemouth Bass, Bluegill,  
 19 carp, crappie, catfish, and Striped Bass (CSP 2010, OEHHA 2013b). Other  
 20 species found in the lake include blackfish, Brown Bullhead, Tui Chub, and Tule  
 21 Perch (OEHHA 2013b).

22 The Crafton Hills Reservoir area includes 4.5 acres of open water and 1.9 acres of  
 23 open space. One fish species, Mosquitofish, was observed in the reservoir  
 24 (DWR 2009b).

25 Lake Perris is located within the Lake Perris State Recreation Area, which  
 26 provides extensive recreational opportunities, as described in Chapter 15,  
 27 Recreation Resources. Lake Perris is stocked with Rainbow Trout and managed  
 28 as a recreational fishery. Common fish species in the lake include Largemouth  
 29 Bass, Channel Catfish, Bluegill, Spotted Bass, Flathead Catfish, Green Sunfish,  
 30 Redear Sunfish, and Black Crappie (DWR 2010). Other species found in the lake  
 31 include Inland Silversides and Threadfin Shad (DWR 2007).

### 32 **9.3.7.2 Non-SWP Reservoirs in Riverside County**

33 Diamond Valley Lake and Lake Skinner in Riverside County are offstream  
 34 storage facilities owned and operated by Metropolitan Water District of Southern  
 35 California. These lakes are major reservoirs used to store SWP water. Diamond  
 36 Valley Lake supports Largemouth Bass, Striped Bass, catfish, Redear Sunfish,  
 37 Bluegill, and stocked Rainbow Trout (DVM 2014). Fish species found in Lake  
 38 Skinner include Striped Bass, Largemouth Bass, carp, and Bluegill. The  
 39 Metropolitan Water District also stocks catfish in summer and trout in winter  
 40 (Riverside County 2014).

1     **9.3.7.3     Non-SWP Reservoir in Ventura County**

2     Lake Piru, located in Ventura County, is used to store SWP water by United  
3     Water Conservation District. Like Pyramid Lake upstream on Piru Creek, sport  
4     fish species in Lake Piru include trout, Largemouth Bass, catfish, crappie,  
5     Bluegill, and Redear Sunfish (CA Lakes 2014). Other species found there include  
6     Bigscale Logperch, Black Bullhead, carp, goldfish, Golden Shiner, Green  
7     Sunfish, and Inland Silversides (CalFish 2014).

8     **9.3.7.4     Non-SWP Reservoirs in San Diego County**

9     Reservoirs in San Diego County that are used to store SWP water include the City  
10    of Escondido's Dixon Lake; City of San Diego's San Vicente, El Capitan, and  
11    Lower Otay reservoirs; Helix Water District's Lake Jennings; and Sweetwater  
12    Authority's Sweetwater Reservoir.

13    Dixon Lake is located in the hills above the City of Escondido within the  
14    Escondido Multiple Habitat Conservation Plan area (City of Escondido 2012).  
15    Fish species found in Dixon Lake include Rainbow Trout, Channel Catfish,  
16    Bluegill, Largemouth Bass, Striped Bass, and Black Crappie (SDFish 2014).

17    San Vicente Reservoir has been stocked with various sport fish including sunfish,  
18    Largemouth Bass, Black Crappie, catfish, and Rainbow Trout. Other species  
19    found in the reservoir include Threadfin Shad and Prickly Sculpin (SDCWA and  
20    USACE 2008). El Capitan reservoir is stocked with Largemouth Bass, crappie,  
21    Bluegill, Channel Catfish, Blue Catfish, Green Sunfish, and Common Carp (City  
22    of San Diego 2014a). Fish species in Lower Otay Reservoir include Largemouth  
23    Bass, Bluegill, Black Crappie, White Crappie, Channel Catfish, Blue Catfish,  
24    White Catfish, and bullheads (City of San Diego 2014b).

25    Lake Jennings is regularly stocked with trout and Channel Catfish. Other species  
26    found in the lake are Bluegill, Largemouth Bass and Blue Catfish (SDFish 2015).

27    Eleven fish species were observed in Sweetwater Reservoir during biological  
28    surveys for the wetlands habitat recovery project, all of which were nonnative and  
29    typical of southern California warm-water lakes. Species observed include  
30    Channel Catfish, Threadfin Shad, Bluegill, and Largemouth Bass (Sweetwater  
31    Authority 2013).

32    **9.3.7.5     Non-SWP Reservoir in San Bernardino County**

33    Lake Arrowhead, in San Bernardino County, is used to store SWP water by the  
34    Lake Arrowhead Community Services District (County of San Bernardino 2011;  
35    LACSD 2014a, 2014b). Lake Arrowhead is a private lake, and its use is restricted  
36    to homeowners in a tract of land roughly 1 mile around the perimeter of the lake,  
37    known as Arrowhead Woods. Fish species found in the lake include trout,  
38    Kokanee Salmon, bass, catfish, crappie, sunfish, and carp.

39    **9.3.7.6     Fish and Aquatic Resources During Drought**

40    California is contending with its fourth consecutive year of drought where  
41    significant shortages in water supplies have profoundly influenced water use in  
42    the state, including environmental uses. The reduced water availability has

1 depleted reservoir storage and the ability for operations to provide flow levels  
2 needed to support fish habitat within the river systems. In addition, the limited  
3 cold water held in CVP and SWP reservoirs has impaired the ability to manage  
4 water temperatures downstream. Similarly, the reduced flows in the Delta have  
5 resulted in shifts in salinity and water quality that influence the availability and  
6 quality of habitat for pelagic fishes as well as the factors that influence  
7 entrainment. As a consequence, the reduction in runoff and available water has  
8 likely compromised an already stressed aquatic ecosystem and may have further  
9 imperiled species that are threatened with or in danger of extinction.

10 As described in the sections above, many fish populations have been in decline  
11 over the last several years. There are undoubtedly multiple factors influencing  
12 this decline; however, the recent drought and actions taken to address the drought  
13 are clearly contributors. In the recent conditional approval by the SWRCB of  
14 Reclamation's Temporary Urgency Change Petition (SWRCB 2015), the SWRCB  
15 summarized the effects of the recent drought conditions on aquatic resources  
16 based on a biological review conducted for the purposes of consultation with  
17 NMFS and USFWS. The summaries from that document (SWRCB 2015) for  
18 several key species are paraphrased below.

19 The population of winter-run Chinook salmon is currently at extreme risk. In  
20 2014, due to a lack of ability to regulate water temperatures in September and  
21 October, high water temperatures in the Sacramento River reduced early life stage  
22 survival from Keswick to Red Bluff from a recent average of approximately  
23 27 percent down to 5 percent in 2014. Consequently, 95 percent of the year class  
24 of wild winter-run Chinook was lost last year (Reclamation and DWR 2015).  
25 Temperature management was difficult again in 2015, which reduces this  
26 population's ability to withstand environmental perturbations, especially during a  
27 prolonged drought when each of the existing brood years has been already  
28 negatively affected by drought conditions.

29 The 2014 spawning run of spring-run Chinook Salmon returning to the upper  
30 Sacramento River system also experienced significant impacts due to drought  
31 conditions as well as elevated temperatures on the Sacramento River and other  
32 tributaries. Similar to winter-run, spring-run Chinook Salmon eggs in the  
33 Sacramento River experienced significant and potentially complete mortality  
34 starting in early September 2014 due to high water temperatures downstream of  
35 Keswick. Extremely few juvenile spring-run Chinook Salmon were observed  
36 migrating downstream of the Sacramento River during high winter flows in 2015,  
37 when spring-run originating from the upper Sacramento River, Clear Creek, and  
38 other northern tributaries are typically observed, indicating that the population  
39 was significantly impacted. Similar concerns for spring-run Chinook Salmon exist  
40 this year as for winter-run. While spring-run have greater distribution and inhabit  
41 locations in addition to the Sacramento River, conditions on those streams are  
42 also expected to be poor due to the drought.

43 Steelhead have also likely been affected by the drought, but given the difficulty in  
44 sampling for these fish it is difficult to determine exactly how the species have  
45 been affected. Adult steelhead abundance is not estimated in the mainstem

1 Sacramento River or any waterways of the Central Valley. The drought conditions  
2 are causing increased stress to steelhead populations (with or without water  
3 project operations) from low flows causing reduced rearing and migratory habitat,  
4 increased water temperatures affecting survival, and likely higher than normal  
5 juvenile predation.

6 The effects of the drought are also reflected in Delta species. For example, recent  
7 population indices for Delta Smelt are at record low numbers. This is of  
8 particular concern given that most Delta Smelt do not survive to spawn more than  
9 one season and are thus for the most part an annual species. The fifth Spring  
10 Kodiak Trawl survey conducted the week of May 4, 2015, identified 4 adults in  
11 the Sacramento Deep Water Ship Channel, and one in Cache Slough. The fourth  
12 Spring Kodiak Trawl survey, conducted during the week of April 6, 2015,  
13 identified one adult, which was a record low for that survey (Smelt Working  
14 Group (SWG); 4 May 13 notes). According to the SWG, it appears fish density  
15 has become so low that the Spring Kodiak Trawl has reached or gone below its  
16 minimum effective detection ability (SWG; April 13 Notes). Additionally, in the  
17 final week (March 30) of supplemental USFWS sampling in the lower San  
18 Joaquin River, catch of adult Delta Smelt declined precipitously to zero in the  
19 final month of sampling.

20 In response to the drought and its adverse effects on aquatic resources,  
21 Reclamation is currently conditionally operating under the terms of a temporary  
22 urgency change petition that allows temporary changes to license and permit  
23 requirements imposed pursuant to SWRCB D-1641 to meet flow-dependent and  
24 water quality objectives to protect fish and wildlife beneficial uses. In  
25 compliance with the provisions of the BOs, Reclamation and the SWRCB have  
26 received concurrence on the changes from USFWS and NMFS (USFWS 2015,  
27 NMFS 2015).<sup>4</sup>

## 28 **9.4 Impact Analysis**

29 This section describes the potential mechanisms and analytical methods; results of  
30 the impact analyses; potential mitigation measures; and cumulative effects.

### 31 **9.4.1 Potential Mechanisms and Analytical Methods**

32 The impact analysis considers changes in the ecological attributes that affect fish  
33 and aquatic resources related to changes in CVP and SWP operations under the  
34 alternatives as compared to the No Action Alternative and the Second Basis of  
35 Comparison.

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<sup>4</sup> Additional information regarding CVP and SWP operations under a TUC Order issued on July 3, 2015, by the State Water Resources Control Board is provided at: [http://www.waterboards.ca.gov/waterrights/water\\_issues/programs/drought/docs/tucp/2015/tucp\\_order070315.pdf](http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/docs/tucp/2015/tucp_order070315.pdf).

#### 1 **9.4.1.1 CVP and SWP Reservoirs**

2 Changes in CVP and SWP operations under the alternatives could result in  
3 changes in reservoir storage volumes, elevations, and water temperatures in the  
4 primary water supply reservoirs (i.e., Trinity Lake, Shasta Lake, Lake Oroville,  
5 Folsom Lake, New Melones Lake, and San Luis Reservoir). Variation in  
6 reservoir storage, elevation, and temperature is a function of water demand, water  
7 quality requirements, and inflow; these attributes also change based on the  
8 water-year type.

9 The downstream reservoirs (i.e., Lewiston Lake, Keswick Reservoir, Thermalito  
10 Forebay and Afterbay, Lake Natoma, and Tulloch Reservoir) are operated to  
11 maintain relatively stable water elevations. These types of operations would  
12 result in similar conditions in the No Action Alternative, Alternatives 1 through 5,  
13 and the Second Basis of Comparison. Therefore, changes at these reservoirs are  
14 not evaluated in this EIS.

##### 15 **9.4.1.1.1 Changes in CVP and SWP Reservoir Storage Volume**

16 To evaluate changes in operation, changes in reservoir storage and elevation were  
17 estimated based upon modeled monthly average storage and reservoir elevation  
18 output from CalSim II for the entire 82-year period under the operations defined  
19 for each alternative, as described in Appendix 5A, CalSim II and DSM2  
20 Modeling. The output of CalSim II served as input to the quantitative procedures  
21 described below for evaluation of changes in fish habitat and bass nesting success  
22 in CVP and SWP reservoirs.

23 The effects analysis in Chapter 5, Surface Water Resources and Water Supplies,  
24 includes a summary of the monthly storage in each major upstream reservoir in  
25 combination with a frequency of exceedance analysis for each month. Reservoir  
26 storage values are characterized based on results of CalSim II hydrologic  
27 modeling and presented as average monthly storage by water year type. Although  
28 aquatic habitat within the CVP and SWP water supply reservoirs is not thought to  
29 be limiting, storage volume is used as an indicator of how much habitat is  
30 available to fish species inhabiting these reservoirs.

##### 31 **9.4.1.1.2 Changes in CVP and SWP Reservoir Elevation**

32 Seasonal temperature stratification is a dominant feature of these reservoirs.  
33 There are relatively distinct fish assemblages within the upper (warm water) and  
34 lower (cold water) habitat zones, with different feeding and reproductive  
35 behaviors. Flood control, water storage, and water delivery operations typically  
36 result in declining water elevations during the summer through the fall months,  
37 rising or stable elevations during the winter months, and rising elevations during  
38 the spring months, while storing precipitation and snowmelt runoff. During  
39 summer months, the relatively warm surface layer favors warm water fishes such  
40 as bass and catfish. Deeper layers are cooler and are suitable for cold water  
41 species. Drawdown of reservoir storage from June through October can diminish  
42 the volume of cold water, thereby reducing the amount of habitat for cold water  
43 fish species within these reservoirs during these months.



1 Reservoir storage and surface water elevations in the reservoirs from the  
2 CalSim II model were used to analyze potential effects on reservoir fishes. Water  
3 surface elevation in each reservoir was calculated from storage values and is  
4 presented as average end-of-month elevation by water year type.

5 Warm water fish species that inhabit the upper layer of these reservoirs may be  
6 affected by fluctuations in storage through changes in reservoir water surface  
7 elevations (WSELs). Stable or increasing WSEL during spring months (March  
8 through June) can contribute to increased reproductive success, young-of-the-year  
9 production, and juvenile growth rate of several warm water species, including the  
10 black basses. Conversely, reduced or variable WSEL due to reservoir drawdown  
11 during spring spawning months can cause reduced spawning success for warm  
12 water fishes through nest dewatering, egg desiccation, and physical disruption of  
13 spawning or nest guarding behaviors. Increases in WSEL are not thought to result  
14 in adverse effects on these species unless there is a corresponding decrease in  
15 water temperatures that can result in nest abandonment.

16 A conceptual approach was used to evaluate the effects of water surface elevation  
17 fluctuations on bass nests, based upon a relationship between black bass nest  
18 success and water surface elevation reductions developed by CDFW (Lee 1999)  
19 from research conducted on five California reservoirs. Lee (1999) examined the  
20 relationship between water surface elevation fluctuation rates and nesting success  
21 for black bass, and developed nest survival curves for Largemouth, Smallmouth,  
22 and Spotted bass. The equations corresponding to the curves are the following:

23           Largemouth Bass  $Y = -56.378 \cdot \ln(X) - 102.59$

24           Smallmouth Bass  $Y = -46.466 \cdot \ln(X) - 83.34$

25           Spotted Bass  $Y = -79.095 \cdot \ln(X) - 94.162$

26 Where: X is the fluctuation rate (m/day) and Y is the percentage of successful  
27 nests.

28 Based on the work by Lee (1999), the maximum receding water level rate  
29 providing 100 percent successful nesting varied among species, with receding  
30 water level rates of <0.02, <0.01, and <0.065 meters per day providing successful  
31 nesting of 100 percent of the Largemouth, Smallmouth, and Spotted bass nests,  
32 respectively. For this analysis, water surface elevations at the end of each month  
33 from the CalSim II model were used to calculate the monthly fluctuation rates,  
34 and derive the daily fluctuation rates used to compute the percentage of successful  
35 nests using the equations from Lee (1999).

36 CalSim II reports end-of-month (EOM) water surface elevations; therefore, water  
37 surface elevations from February to June were used in this analysis (i.e., March  
38 fluctuation rate = March EOM elevation – February EOM elevation). It was  
39 further assumed that the monthly change in elevation divided by the number of  
40 days in that month reflected the average daily fluctuation rate that was used as  
41 “X” in the above equations to compute the percentage of successful nests during  
42 that month. The percentages of successful bass nests were computed based on the

1 equations from Lee (1999) for each month of the potential spawning season for  
2 these species.

3 Review of the available literature suggests that bass nest failure is highly variable  
4 between water bodies and between years but it is not uncommon to have up to  
5 40 percent of bass nests fail (approximately 60 percent survival) (Scott and  
6 Crossman 1973). Many self-sustaining black bass populations in North America  
7 experience a nest success (i.e., the nest produces swim-up fry) rate of 21 to  
8 96 percent, with many reporting survival rates in the 40 to 60 percent range  
9 (Forbes 1981; Hunt and Annett 2002; Steinhart 2004). This would suggest that  
10 much less than 100 percent survival is required to have a self-sustaining  
11 population. Based on the literature review, bass nest survival probability in  
12 excess of 40 percent is assumed to be sufficient to provide for a self-sustaining  
13 bass fishery. For this analysis, differences between alternatives were evaluated  
14 using the exceedance probability corresponding to the 40 percent level of survival  
15 based on the probability of exceedance over the 82-year CalSim II modeling time  
16 period.

#### 17 **9.4.1.2 Rivers**

18 By altering reservoir storage and releases, changes in CVP and SWP operations  
19 under the alternatives would change flow and temperature regimes in downstream  
20 waterways. In turn, these alterations could affect fishery resources and important  
21 ecological processes on which the fish community depends.

##### 22 **9.4.1.2.1 Changes in Flows**

23 Changes in flows, in and of themselves, do not constitute an effect on aquatic  
24 resources. However, changes in flow can affect the quantity and quality of  
25 aquatic habitats in rivers and have direct effects on fish species through stranding  
26 or dewatering events that occur when flows are reduced. In addition, changes in  
27 flows can result in a reduction in ecologically important geomorphic processes  
28 resulting from reduced frequency and magnitude of intermediate to high flows.

29 Changes in flow also can influence the frequency and duration of inundated  
30 floodplains (e.g., Yolo Bypass) that support salmonid rearing and conditions for  
31 other native fish species. With implementation of the physical actions under  
32 NMFS RPA Action I.6.1, the inundation regime in the Yolo Bypass will be  
33 modified and managed to better coincide with the presence of juvenile salmonids  
34 and with a greater frequency. While this action is included in every alternative,  
35 changes in flows in the Sacramento River at the Freemont Weir associated with  
36 the various alternatives could result in slight differences in the flows entering the  
37 bypass and changes in the amount of habitat available to rearing salmonids and  
38 other native fish species.

39 The effects analysis in Chapter 5, Surface Water Resources and Water Supplies,  
40 includes a summary of the monthly flows at various points downstream of the  
41 reservoirs in each major stream affected by project operations. Instream flows are  
42 characterized based on results of CalSim II hydrologic modeling and presented as  
43 both average monthly flows by month and water year type and monthly frequency

1 of exceedance plots to allow examination of the entire range of simulation results  
2 for each of the alternatives as a means of evaluating differences among  
3 alternatives. Because the CalSim II model uses a monthly time step, it was  
4 determined that incremental changes of 5 percent or less were related to the  
5 uncertainties in the model processing. Therefore, flow changes of 5 percent or  
6 less are considered to be not substantially different, or “similar” in this  
7 comparative analysis.

8 To compare the operational flow regime and evaluate the potential effects on  
9 habitat for anadromous species inhabiting streams, it was necessary to determine  
10 the relationships between streamflow and habitat availability for each life stage of  
11 these species in the rivers in which flows may be altered by CVP and SWP  
12 operations.

13 A number of studies have been conducted using the models and techniques  
14 contained within the Instream Flow Incremental Methodology (IFIM) to establish  
15 these relationships in streams within the study area. The analytic variable  
16 provided by the IFIM is total habitat, in units of Weighted Useable Area (WUA),  
17 for each life stage (fry, juvenile and spawning) of each evaluation species (or race  
18 as applied to Chinook Salmon). Habitat (WUA) incorporates both macro- and  
19 microhabitat features. Macrohabitat features include changes in flow, and  
20 microhabitat features include the hydraulic and structural conditions (depth,  
21 velocity, substrate or cover) affected by flow which define the actual living space  
22 of the organisms. The total habitat available to a species/life stage at any  
23 streamflow is the area of overlap between available microhabitat and  
24 macrohabitat conditions. Because the combination of depths, velocities, and  
25 substrates preferred by species and life stages varies, WUA values at a given flow  
26 differ substantially for the species and life stages evaluated.

27 WUA-flow relationships were available only for some rivers for which simulated  
28 flows were available. Therefore, flow dependent habitat availability was  
29 evaluated quantitatively only for Clear Creek and the Sacramento, Feather, and  
30 American rivers, and was not reported for other rivers evaluated in this Draft EIS.  
31 Tables of the spawning habitat-discharge relationships used in the calculations of  
32 spawning WUA for these rivers are provided in Appendix 9E, Weighted Useable  
33 Area Analysis. Because the WUA-flow relationships developed by the most  
34 recent IFIM studies present WUA values within particular flow ranges at  
35 particular variable steps, it was often the case that the monthly flow for a  
36 particular reach fell between two flows for which there were WUA values. In  
37 these cases, the value was determined by linear interpolation between the  
38 available WUA values for the flows immediately below and above the target  
39 flow. When the target flow was lower than the lowermost flow for which a WUA  
40 value exists, the corresponding WUA value was determined by linear  
41 interpolation between a flow of zero and the lowermost flow for which a WUA  
42 value exists. When the target flow was higher than the highest flow for which a  
43 WUA value exists, the corresponding WUA value was determined by assuming  
44 the WUA value for the highest flow.

1 WUA values are calculated and presented only on a monthly time-step, and not as  
2 seasonal or annual values. WUA values based on the monthly CalSim II flows  
3 were prepared for detailed evaluation of the alternatives. Monthly WUA values  
4 are presented as the average total WUA in each river segment, for the entire  
5 82-year simulation period and the average total WUA in each of five water year  
6 types for each alternative. Differences between the alternatives and the two bases  
7 of comparison (No Action Alternative and Second Basis of Comparison) are used  
8 to identify the effects of each alternative on habitat availability (WUA) for each  
9 species and life stage in each river. These comparisons were made only for the  
10 months in which the species and life stage are anticipated to be present in each  
11 river/reach based on the life history timing presented in Appendix 9B.

12 The ability to estimate sub-monthly WUA values is limited due to the monthly  
13 time-step of the CalSim II results. The monthly time-step is most limiting during  
14 the fall through spring seasons in areas downstream of tributaries, when flows can  
15 vary significantly on a daily basis due to hydrologic conditions. Hydrologic  
16 variability in the runoff and tributary flows cause significant variability of flows  
17 in the areas of interest for the WUA computations. During the periods of low  
18 flows, regulated flows from reservoir releases dampen the impact of daily  
19 variability of flows on WUA estimates. Because the WUA analysis uses output  
20 from the monthly time step CalSim II model, it was determined that incremental  
21 changes of 5 percent or less were related to the uncertainties in the model  
22 processing. Therefore, changes in WUA values of 5 percent or less are  
23 considered to be not substantially different, or “similar” in this comparative  
24 analysis.

#### 25 **9.4.1.2.2 Changes in Water Temperatures**

26 Water temperatures in the rivers and streams downstream of the CVP and SWP  
27 reservoirs are influenced by factors such as reservoir cold water pool, elevation of  
28 reservoir release outlets, and seasonal atmospheric conditions. The level of water  
29 storage in a reservoir has a strong effect on the volume of cold water (cold water  
30 pool) in the reservoir and, in combination with the elevation of reservoir release  
31 outlets, the temperature of water released downstream. Storage levels are often  
32 lowest in the late summer and early fall, resulting in warmer waters released from  
33 the reservoir. During this time of year, ambient air temperatures contribute  
34 substantially to warming instream flows downstream of reservoirs. The summer  
35 and early fall are the times of year when river temperatures are most likely to rise  
36 above tolerance thresholds for steelhead and salmon.

37 The analysis of the effects of water temperature changes on fish was conducted  
38 using two approaches: 1) a comparison of average monthly water temperatures  
39 between the alternatives and the two bases of comparison (No Action  
40 Alternative and Second Basis), and 2) a comparison of average monthly water  
41 temperatures to established temperature objectives intended to be protective of  
42 fish. In addition, Reclamation’s salmon mortality model was applied in certain  
43 water bodies to examine the effects of temperature on salmon spawning and  
44 incubation. These approaches are described below.

1 *Comparison of Average Monthly Water Temperatures between Alternatives*

2 The analysis uses average water monthly temperatures to provide a comparison of  
3 the ability of operations considered under alternatives to meet water temperature  
4 objectives for various species. As described in Appendix 5A, Section 5A.A.3.6,  
5 water temperature modeling is subsequent to CalSim II modeling that simulates  
6 operations on a monthly basis; there are certain components in the temperature  
7 models that are downscaled to a daily time step (simulated or approximated  
8 hydrology). The results of those daily conditions are averaged to a monthly  
9 time step.

10 The effects analysis in Chapter 6, Surface Water Quality, includes a summary of  
11 the average monthly water temperature in each major stream downstream of CVP  
12 and SWP reservoirs in combination with a frequency of temperature exceedance  
13 analysis (see below) for each month. Water temperatures at various locations in  
14 each river were compared to determine whether mean monthly temperatures by  
15 water-year type were different between the alternatives and the two bases of  
16 comparison (No Action Alternative and Second Basis). Because the temperature  
17 models use inputs from the monthly-time-step CalSim II model, effects of real-  
18 time daily temperature management cannot be captured, even though the  
19 temperature models are capable of simulating on a sub-monthly timestep.  
20 Therefore, the analysis is based on monthly average temperature results. For this  
21 monthly analysis that uses two cascading models, it was determined that  
22 incremental changes of 0.5°F or less in mean monthly water temperatures would  
23 be within the model uncertainty. Therefore, changes of 0.5°F or less are  
24 considered to be not substantially different, or “similar” in this comparative  
25 analysis.

26 *Comparison to Established Water Temperature Thresholds*

27 The average monthly water temperature output from CalSim II does not allow a  
28 direct comparison to the temperature objectives identified in Table 9.3, and the  
29 effects of daily (or hourly) temperature swings are likely masked by the averaging  
30 process. Nonetheless, the average monthly water temperatures provide the basis  
31 for a coarse evaluation of the likelihood that temperature objectives (Table 9.3)  
32 would be exceeded. These objectives are used as thresholds in the temperature  
33 exceedance analysis where the frequency of exceedance (percent of years) is  
34 calculated over the 82-year CalSim II modeling period (Appendix 9N). Because  
35 average monthly water temperatures likely mask daily temperatures that could  
36 exceed important thresholds, any difference in the frequency of threshold  
37 exceedance was considered important and could be indicative of a biological  
38 effect on the species/life stage for which the objective was established. While  
39 likely effects from temperature on early life stages occur at a shorter temporal  
40 scale than can be captured in these models, comparative analyses are useful for  
41 looking at long term impacts over numerous water years and types.

1 **Table 9.3 Water Temperature Objectives**

Compliance Location	Year Types	Dates	Temperature Objective (°F)	Purpose
<b>Trinity River</b>				
Lewiston Dam Release	All Year Types	July–Sep	< 60	Spring-run Chinook Salmon holding
		Sep	< 56	Spring-run Chinook Salmon spawning
Lewiston Dam Release	All Year Types	Oct–Dec	< 56	Chinook Salmon, Coho Salmon, and steelhead spawning
<b>Clear Creek</b>				
Igo W	All Year Types	June–Sep 15	60	Spring-run Chinook Salmon holding and rearing
		Sep 15-Oct	56	Spring-run and fall-run Chinook Salmon spawning and egg incubation
<b>Sacramento River</b>				
Keswick Release	All Year Types	May–Sep	56	Winter- and spring-run Chinook Salmon spawning and egg incubation
Balls Ferry	All Year Types	May–Sep	56	Winter- and spring-run Chinook Salmon spawning and egg incubation
Bend Bridge	All Year Types	May–Sep	56	Winter- and spring-run Chinook Salmon spawning and egg incubation
			63	Green sturgeon spawning, incubation, and rearing
Red Bluff	All Year Types	Oct–Apr	56	Spring-, fall-, and late fall–run Chinook Salmon spawning and egg incubation
Hamilton City	All Year Types	Mar–Jun	61 (optimal), 68 (lethal)	White Sturgeon spawning and egg incubation
<b>Feather River</b>				
Robinson Riffle	All Year Types	Sep–Apr	56	Spring-run Chinook Salmon and steelhead spawning and incubation
		May–Aug	63	Spring-run Chinook Salmon and steelhead rearing

Compliance Location	Year Types	Dates	Temperature Objective (°F)	Purpose
Gridley Bridge	All Year Types	Oct–Apr	56	Fall- and late fall–run Chinook Salmon spawning and steelhead rearing
		May–Sep	64	Green sturgeon spawning, incubation, and rearing
<b>American River</b>				
Watt Avenue Bridge	All Year Types	May–Oct	65	Juvenile steelhead rearing
<b>Stanislaus River</b>				
Orange Blossom Bridge	All Year Types	Oct–Dec	56	Adult steelhead migration
		Jan– May	57	Steelhead smoltification
		Jan-May	55	Steelhead spawning and incubation
		Jun-Sep	65	Juvenile steelhead rearing
Knights Ferry	All Year Types	Jan-May	52	Steelhead smoltification

1 *Changes in Egg Mortality*

2 Water temperatures also affect the survival of various life stages of the focal  
3 species. Reclamation’s salmon mortality model (Appendix 9C, Reclamation  
4 Salmon Mortality Model Analysis Documentation) was used to estimate water  
5 temperature induced mortality in the early life stages (pre-spawned eggs,  
6 fertilized eggs, and pre-emergent fry) of salmonids in five rivers: Trinity,  
7 Sacramento, Feather, American, and Stanislaus, based on output from the  
8 temperature models. The salmon mortality model is limited to temperature effects  
9 on early life stages of Chinook Salmon. It does not evaluate potential direct or  
10 indirect temperature impacts on later life stages, such as emergent fry, smolts,  
11 juvenile out-migrants, or adults. Also, it does not consider other factors that may  
12 affect salmon mortality, such as in-stream flows, gravel sedimentation, diversion  
13 structures, predation, and ocean harvest. Differences between alternatives are  
14 assessed based on changes in the percent egg mortality by river over the entire  
15 82-year CalSim II simulation period and by water year type (based on 40-30-30  
16 indexing). Because the salmon mortality model uses output from the temperature  
17 models that are downscaled from the monthly time step CalSim II model, it was  
18 determined that incremental changes in egg mortality of 5 percent or less were  
19 related to the uncertainties in the model processing. Therefore, changes in egg

1 mortality of 5 percent or less are considered to be not substantially different, or  
2 “similar” in this comparative analysis.

### 3 **9.4.1.3 Delta**

4 Changes in CVP and SWP operations under the alternatives would affect Delta  
5 conditions primarily through changes in volume and timing of upstream storage  
6 releases and diversions, Delta exports and diversions, and DCC operations.  
7 Environmental conditions such as water temperature, predation, food production  
8 and availability, competition with introduced exotic fish and invertebrate species,  
9 and pollutant concentrations all contribute to interactive, cumulative conditions  
10 that have substantial effects on aquatic resources in the Delta.

#### 11 **9.4.1.3.1 Changes in Volume and Timing of Flows through the Delta**

12 Operations of the CVP DCC and intake facilities owned by the CVP, SWP, local  
13 agencies, and private parties affect Delta hydrologic flow regimes. The largest  
14 effects of flow management in the Delta related to aquatic resources are the  
15 modification of winter and spring inflows and outflows of the Delta, and the  
16 introduction of net cross-Delta and net reverse flows in some Delta channels that  
17 can alter fish movement patterns. Seasonal flows play an especially important  
18 role in determining the reproductive success and survival of many estuarine  
19 species including salmon, Striped Bass, American Shad, Delta Smelt, Longfin  
20 Smelt, and Sacramento Splittail. In addition, changes in Delta outflow influence  
21 the abundance and distribution of fish and invertebrates in the bay through  
22 changes in salinity, currents, nutrient levels, and pollutant concentrations. Altered  
23 flows through the Delta as a result of changes in CVP and SWP operations affect  
24 water residence time, an important physical property that can influence the ability  
25 of phytoplankton biomass to build up over time, with implications for higher  
26 trophic level consumers such as fish.

#### 27 **9.4.1.3.2 Changes in Water Quality**

28 Changes in water quality due to CVP and SWP operations under the alternatives  
29 would affect aquatic resources in the Delta primarily through changes in water  
30 temperatures, salinity, nutrient levels, pollutant concentrations and turbidity.  
31 Changes in CVP and SWP operations can increase Delta water temperatures by  
32 warmer reservoir releases and to a lesser extent, by reducing quantities of  
33 freshwater inflow and by modifying tidal and ground water hydraulics. Changes  
34 in CVP and SWP operations also can affect the location of the low salinity zone  
35 (position of X2), especially during periods of low inflows and high water exports  
36 (i.e., low outflow conditions) in drier water years. Nutrients, essential  
37 components of terrestrial and aquatic environments because they provide a  
38 resource base for primary producers, and pollutants such as selenium and mercury  
39 could be affected by changes in CVP and SWP operations. Turbidity is an  
40 important water quality component in the Delta that could be affected by changes  
41 in operation. Changes in turbidity affect food web dynamics through attenuation  
42 of light in the water column and altering predation success.



1 The DSM2, a one-dimensional hydrodynamic and water quality simulation  
2 model, is used to evaluate changes in salinity (as represented by EC) in the Delta  
3 and at the CVP/SWP export locations. CalSim II outputs are used to evaluate  
4 changes in location of X2 in the Delta. A more detailed overview of the DSM2  
5 model and input assumptions is presented in Appendix 5A, CalSim II and DSM2  
6 Modeling.

7 The Delta boundary flows and exports from CalSim II are used as input to the  
8 DSM2 Delta hydrodynamic and water quality models to estimate tidally-based  
9 flows, stage, velocity, and salt transport within the estuary. Because CalSim II  
10 operations are simulated on a monthly basis, the DSM2 model would not be able  
11 to capture daily operations and therefore the DSM2 outputs are presented on a  
12 monthly basis, as described in Appendix 5A, CalSim II and DSM2 Modeling.

13 DSM2 HYDRO outputs are used to predict changes in flow rates and depths. The  
14 QUAL module of DSM2 simulates fate and transport of conservative and non-  
15 conservative water quality constituents, including salts, given a flow field  
16 simulated by HYDRO. Chloride and bromide concentrations are estimated using  
17 relationships based on DSM2 EC results, as described in Appendix 6E, Analysis  
18 of Delta Salinity Indicators.

19 The CalSim II outputs described above that estimate the position X2 were used  
20 along with temperature to generally assess effects on Striped Bass and American  
21 Shad. Kimmerer (2002) noted that Striped Bass survival is negatively correlated  
22 with April – June X2 values, although the analysis was inconclusive on the  
23 mechanisms contributing to this relationship. Kimmerer (2009) noted that Delta  
24 Smelt and Striped Bass had more negative slopes in the habitat-X2 relationship  
25 for surveys conducted in spring to early summer months than other surveys. They  
26 also noted that the slopes for abundance-X2 and habitat-X2 were similar for  
27 American Shad and for Striped Bass, and that the habitat relationships to X2  
28 appeared consistent with their relationships of abundance (or survival) to X2.  
29 Thus, Kimmerer et al. (2009) contended that this similarity provides some support  
30 for the notion that increasing habitat quantity as defined by salinity could be one  
31 mechanism to explain the X2 relationship for these species. Based on this  
32 relationship, the position of X2 was used as general indicator of habitat for  
33 Striped Bass and American Shad. Alternatives that resulted in a more westerly  
34 position of X2 relative to the bases of comparison were considered to have less  
35 potential for adverse effect, whereas those with a more easterly position would  
36 have a greater potential for adverse effect.

### 37 **9.4.1.3.3 Changes in Fish Entrainment**

38 Changes in CVP and SWP operations can affect through-Delta survival of  
39 migratory (e.g., salmonids) and resident (e.g., Delta and Longfin smelt) fish  
40 species through changes in the level of entrainment at CVP and SWP export  
41 pumping facilities. The south Delta CVP and SWP facilities are the largest water  
42 diversions in the Delta and in the past, have entrained large numbers of Delta fish  
43 species. Tides, salinity, turbidity, in-flow, meteorological conditions, season,  
44 habitat conditions, and project exports all have the potential to influence fish

1 movement, currents, and ultimately the level of entrainment and fish passage  
2 success and survival. Entrainment risk for fish also tends to increase with  
3 increased reverse flows in Old and Middle rivers.

4 The potential for entrainment of salmonids migrating through the Delta was  
5 analyzed using predicted monthly salvage of salmonids from January through  
6 June using statistical relationships reported in Zeug and Cavallo (2014). In that  
7 analysis, salvage at the State Water Project and Central Valley Project was  
8 modeled as a function of physical, biological and hydrologic variables (see  
9 Appendix 9M for additional detail).

10 Results of the analysis are presented in box-whisker plots showing the median,  
11 central 50 percent probability, and range of simulated data. The comparison  
12 between alternatives relied on interpretation of these plots to distinguish  
13 differences in the median values as follows: (1) when the medians are nearly  
14 identical or the central 50 percent probabilities (i.e., the boxes) overlap  
15 completely, the medians were considered “similar;” (2) when the medians and  
16 box were offset, but the median values were within the range represented by the  
17 contrasting alternative’s box, the medians were considered “slightly” different;  
18 (3) when the median of one alternative was outside of the contrasting alternative’s  
19 box, but the boxes overlapped, the alternatives were considered “moderately”  
20 different; and (4) when the median of one alternative was outside of the  
21 contrasting alternative’s box, and the boxes did not overlap, the medians were  
22 considered “substantially” different.

23 In evaluating the potential for entrainment of Delta Smelt, as influenced by OMR  
24 flows under the alternatives, the USFWS (2008) regression model based on  
25 Kimmerer (2008) was used to estimate potential entrainment of Delta Smelt. The  
26 equation developed by Kimmerer (2008) is based on the average December  
27 through March OMR flow (in units of cfs) as predicted by the CalSim II model,  
28 and yields the percentage of adult Delta Smelt that may become entrained in the  
29 pumps. Further review by Kimmerer (2011) determined that the above equation  
30 has an upward bias, such that the results were reduced by 24 percent to correct  
31 this bias. In the event that a negative entrainment percentage was calculated, the  
32 result was changed to zero.

33 Changes in CVP and SWP operations under the alternatives could also change  
34 entrainment of larvae and early juvenile Delta Smelt. Larvae and early juvenile  
35 Delta Smelt are most prevalent in the Delta in the spring months of March  
36 through June. The USFWS (2008) regression model based on Kimmerer (2008)  
37 was used to calculate the percentage entrainment of larval and early juvenile Delta  
38 Smelt in Banks and Jones Pumping Plants. This regression is dependent on two  
39 variables: March through June average OMR flow (in cfs) and March through  
40 June average X2 position (in km). OMR and X2 values predicted by the  
41 CalSim II model for each alternative were used in estimating the entrainment loss.  
42 In the event that a negative entrainment percentage was calculated, the result was  
43 changed to zero.

1 In this study, the percent entrainment values estimated for Delta Smelt are used as  
2 a tool to compare the alternatives, as one of the factors that would indicate  
3 conditions that might benefit or contribute to adverse effects on Delta Smelt.  
4 Because the regression analysis uses flow output from the monthly time step  
5 CalSim II model and the confidence intervals on the regression parameters are  
6 somewhat broad, it was determined that incremental changes in entrainment  
7 estimates of 5 percent or less were within the model uncertainty. Therefore,  
8 changes in entrainment of less than 5 percent are considered to be not  
9 substantially different, or “similar” in this comparative analysis. One limitation  
10 of this approach is that it does not reflect the benefit that some of the alternatives  
11 might realize through adaptive management of OMR flows to further reduce  
12 potential entrainment, based on input from the Smelt Working Group.

#### 13 **9.4.1.3.4 Changes in Fish Passage and Routing**

14 Changes in CVP and SWP operations can affect through-Delta survival of  
15 migratory (e.g., salmonids) and resident (e.g., Delta and Longfin smelt) fish  
16 species through changes in passage conditions and routing. For example, changes  
17 in operation of the DCC affects the volume of water diverted into the Mokelumne  
18 River distributary channels toward the central and south Delta. Operation of the  
19 south Delta intake facilities, including facilities owned by the CVP and SWP and  
20 Contra Costa Water District, contribute to reverse flow conditions in Old and  
21 Middle rivers.

22 Changes in salmonid passage and routing were evaluated using the Delta Passage  
23 Model (DPM) and an analysis of Delta hydrodynamics and junction entrainment,  
24 as described below. The DPM is based on a detailed accounting of migratory  
25 pathways and reach-specific mortality as Chinook salmon smolts travel through a  
26 simplified network of reaches and junctions (see Appendix 9J for additional  
27 detail). Model output is expressed as through Delta survival of salmon smolts.

28 The key assumption in the Delta Hydrodynamic analysis is that the proportion of  
29 positive velocities in a channel, measured at a monthly time step, is an indicator  
30 of the likelihood that juvenile anadromous fish will successfully migrate through  
31 that channel towards the ocean (see Appendix 9K for additional detail). The  
32 analysis of junction entrainment used a regression based on predicted entrainment  
33 into a distributary and the proportion of flow into the distributary to predict the  
34 daily probability of fish entrainment (see Appendix 9L for additional detail).

35 Results of the Delta hydrodynamics and junction entrainment analysis are  
36 presented in box-whisker plots showing the median, central 50 percent  
37 probability, and range of simulated data. The comparison between alternatives  
38 relied on interpretation of these plots to distinguish differences in the median  
39 values as described above for changes in fish entrainment.

#### 40 **9.4.1.3.5 Changes in Delta Smelt Habitat (X2 Location)**

41 Changes in CVP and SWP operations under the alternatives could change the  
42 location of Fall X2 position (in September through December) as an indicator of  
43 available habitat for Delta Smelt. Feyrer et al. (2010) used X2 location as an

1 indicator of the extent of habitat available with suitable salinity and water  
 2 transparency for the rearing of older juvenile Delta Smelt. Feyrer et al. (2010)  
 3 concluded that when X2 is located downstream (west) of the confluence of the  
 4 Sacramento and San Joaquin Rivers, at a distance of 70 to 80 km from the Golden  
 5 Gate Bridge, there is a larger area of suitable habitat. The overlap of the low  
 6 salinity zone (or X2) with the Suisun Bay/Marsh results in a two-fold increase in  
 7 the habitat index (Feyrer et al 2010); however others (see Manly et al. 2015) have  
 8 questioned the use of outflow and X2 location as an indicator of Delta Smelt  
 9 habitat because other factors may be influencing survival.

10 To evaluate fall abiotic habitat availability for Delta Smelt under the alternatives,  
 11 X2 values (in km) simulated in the CalSim II model for each alternative were  
 12 averaged over September to December, and compared for differences. There are  
 13 uncertainties and limitations associated with this approach, e.g., it does not  
 14 evaluate other factors that influence the quality or quantity of habitat available for  
 15 Delta Smelt (e.g., turbidity, temperature, food availability), nor does it take into  
 16 account the relative abundance of Delta Smelt that might benefit from the  
 17 available habitat in the simulated X2 areas, in any given year. Other scientists  
 18 have developed and described life cycle models to evaluate Delta Smelt  
 19 population responses to changes in flow-related variables (e.g., Maunder and  
 20 Deriso 2011; Rose et al. 2013 a, b), but these life cycle modeling approaches were  
 21 not selected for use in the current study. The life cycle model developed by Rose  
 22 et al. (2013a, b) could not be used in this analysis because it uses a wide array of  
 23 daily data, many of the assumptions and parameter values were based on  
 24 judgment, and the model was not designed for forecasting future Delta Smelt  
 25 population abundances. The model was designed mostly for exploring hypothesis  
 26 about factors affecting Delta smelt populations dynamics, which is not suitable for  
 27 a comparative analysis of operational scenarios under the alternatives. Moreover,  
 28 Reed et al. (2014) noted that *“To date, these models have not been fully vetted and*  
 29 *evaluated sufficiently to be used for direct management applications.”* In this  
 30 study, simulated fall X2 values are used as a tool to compare the alternatives, as  
 31 one of the factors that would indicate available suitable habitat to benefit  
 32 Delta Smelt.

#### 33 **9.4.1.3.6 Changes in Salmonid Production**

34 Collectively, factors such as flow, temperature, and habitat availability affect the  
 35 population dynamics of anadromous fish species during their freshwater life  
 36 stages. Three different models were used to assess changes in salmonid  
 37 production potential: 1) SALMOD; 2) the Interactive Object-Oriented Simulation  
 38 (IOS) model for winter-run Chinook Salmon; and 3) the Oncorhynchus Bayesian  
 39 Analysis (OBAN) model for winter-run Chinook Salmon.

#### 40 *Comparison of Annual Production Using SALMOD*

41 The SALMOD model (Appendix 9D, SALMOD Analysis Documentation) was  
 42 used to assess changes in the annual production potential of four races of Chinook  
 43 Salmon in the Sacramento River. The primary assumption of the model is that  
 44 egg and fish mortality is directly proportional to spatially and temporally variable

1 habitat limitations, such as water temperatures, which themselves are functions of  
2 operational variables (timing and quantity of flow) and meteorological variables,  
3 such as air temperature. SALMOD is a spatially explicit model that characterizes  
4 habitat value and carrying capacity using the hydraulic and thermal properties of  
5 individual habitat units. Inputs to SALMOD include flow, water temperature,  
6 spawning distributions, spawn timing by salmon race, and the number of  
7 spawners provided by the user (e.g., recent average escapement).

8 Annual production potential or the number of outmigrants, annual mortality,  
9 length, and weight of the smolts are some of the reporting metrics available from  
10 SALMOD. The production numbers obtained from SALMOD are best used as an  
11 index in comparing to a specified baseline condition rather than absolute values.  
12 Differences between alternatives are assessed based on changes in the annual  
13 production potential for each species by river by water year type. Because  
14 SALMOD uses flows and output from the water temperature models that are  
15 downscaled from the monthly time step CalSim II model, it was determined that  
16 incremental changes in production of 5 percent or less were related to the  
17 uncertainties in the model processing. Therefore, changes in production of  
18 5 percent or less are considered to be not substantially different, or “similar” in  
19 this comparative analysis.

#### 20 *Comparison of Annual Winter-run Chinook Salmon Escapement Using IOS*

21 IOS is a stochastic life cycle simulation model for winter run Chinook Salmon in  
22 the Sacramento River. The IOS model is composed of six model stages that are  
23 arranged sequentially to account for the entire life cycle of winter run, from eggs  
24 to returning spawners. The primary output from the IOS model is escapement,  
25 the total number of winter-run Chinook Salmon that leave the ocean and return to  
26 the Sacramento River to spawn. Differences between alternatives are assessed  
27 based on changes in the median annual escapement and the range of escapement  
28 values encompassed in the first and second quartiles (25 to 75 percent of years)  
29 over the 82-year CalSim II simulation period. The IOS model uses scenario-  
30 specific daily DSM2, CalSim II, and Sacramento River Basin Water Temperature  
31 Model (HEC-5Q) data as model input. Because IOS uses output from the  
32 monthly time step CalSim II model, or other models downscaled from CalSim II,  
33 as input, it was determined that incremental changes in escapement estimates of  
34 5 percent or less in were related to the uncertainties in the model processing.  
35 Therefore, changes in escapement of 5 percent or less are considered to be not  
36 substantially different, or “similar” in this comparative analysis.

#### 37 *Comparison of Annual Winter-run Chinook Salmon Escapement Using OBAN*

38 The Oncorhynchus Bayesian Analysis (OBAN) is a model that uses statistical  
39 relationships between historical patterns in winter-run Chinook salmon abundance  
40 and a number of other parameters that covary with abundance to predict future  
41 population abundance. The model determines the effects of water temperature,  
42 harvest, exports, striped bass abundance, and offshore upwelling using historical  
43 abundance data. The set of parameters, called covariates, that provided the best  
44 model fit was retained for the full model. The model then uses predicted future  
45 values of these parameters, primarily from CalSim II and temperature model

1 outputs, to predict future patterns in Chinook salmon population abundance  
2 (escapement). Because OBAN uses output from the monthly time step CalSim II  
3 model, or other models downscaled from CalSim II, as input, it was determined  
4 that incremental changes in escapement estimates of 5 percent or less were related  
5 to the uncertainties in the model processing. Therefore, changes in escapement of  
6 5 percent or less are considered to be not substantially different, or “similar” in  
7 this comparative analysis.

#### 8 **9.4.1.3.7 Changes in Sturgeon Year Class Strength**

9 Changes in CVP and SWP operations can affect sturgeon species through changes  
10 in flows through the Delta that, in turn, affect the year class strength of both  
11 Green Sturgeon and White Sturgeon. Estimated Delta outflow from the CalSim II  
12 model was used to analyze the potential effects on sturgeon using the  
13 hypothesized relationship between Delta outflow and the age-0 Year Class Index  
14 (YCI) from the Bay Study in the presentation by Gingras et al. (2014). For this  
15 analysis, the mean Delta outflow during the March to July period for each year  
16 was calculated from the CalSim II output and used as an indicator of potential  
17 year class strength. Because the sturgeon analysis uses flow output from the  
18 monthly time step CalSim II model, it was determined that incremental changes in  
19 mean (March to July) Delta outflow of 5 percent or less were related to the  
20 uncertainties in the model processing. Therefore, changes in Delta outflow of less  
21 than 5 percent are considered to be not substantially different, or “similar” in this  
22 comparative analysis.

23 Mean (March to July) Delta outflow was also used as an indicator of the  
24 likelihood of producing a strong year class of sturgeon by examining the number  
25 of years (over the 82-year CalSim II simulation) that mean (March-July) Delta  
26 outflow would exceed a threshold of 50,000 cfs. Changes in the number of years  
27 exceeding the threshold was considered to have a potential effect on sturgeon.

#### 28 **9.4.1.4 Constructed Water Supply Facilities that Convey and Store CVP 29 and SWP Water**

30 The distribution system for water exported by CVP and SWP includes hundreds  
31 of miles of canals and numerous reservoirs designed to help regulate the flow of  
32 water to the areas where the water is used. Many of these canals and reservoirs  
33 support fish that were entrained into the system or intentionally stocked for  
34 recreational purposes, and changes in export deliveries could influence the quality  
35 of the aquatic habitat in these constructed water bodies. These constructed water  
36 bodies do not support important populations of native fish species and the  
37 management of flows is under the control of the entities that receive the water.  
38 Because many of the reservoirs also store water from non-CVP and SWP water  
39 supplies; it is difficult to predict changes in the aquatic habitat related to changes  
40 in CVP and SWP water supplies. Therefore, the potential effects of operation of  
41 these facilities on fish and aquatic resources are not addressed further in this EIS.

1     **9.4.1.5     Analysis of Provision of Fish Passage**

2     As described previously in the Affected Environment section, Shasta, Folsom,  
3     and New Melones dams and their associated downstream re-regulating reservoirs  
4     permanently blocked salmonid access to upper watersheds and effectively  
5     removed many miles of suitable habitat. These barriers particularly influenced  
6     populations of winter-run and spring-run Chinook Salmon and steelhead because  
7     their life history strategies are adapted to accessing higher elevation river reaches  
8     and tributaries to successfully spawn and rear, as well as for oversummering.  
9     Improving passage would increase the amount of available habitat, including  
10    access to colder headwaters, which would be particularly important considering  
11    anticipated climate change scenarios. Improved fish passage is not included  
12    under the Second Basin of Comparison or Alternative 2.

13    **9.4.1.6     Analysis of Trap and Haul Program**

14    Poor survival of juvenile salmonids in the Sacramento-San Joaquin Delta has  
15    been hypothesized as a major contributor to declines in the number of returning  
16    adults and may be a significant impediment to the recovery of threatened or  
17    endangered populations (NOAA 2009). Alternative 3 and Alternative 4 contain a  
18    trap and haul program for juvenile salmonids entering the Delta from the San  
19    Joaquin River, similar to the program in place on the Columbia River in Oregon.  
20    This action would not be implemented under the No Action Alternative, Second  
21    Basis of Comparison, or other action alternatives, with the exception of  
22    Alternatives 3 and 4. Background information on the trap and haul program  
23    associated with Alternatives 3 and 4 is provided in Appendix 9O and was used in  
24    the qualitative assessment of the trap and haul program under Alternatives 3  
25    and 4.

26    **9.4.1.7     Analysis of Predator Control Programs**

27    As described in Chapter 3, Description of Alternatives, Alternatives 3 and 4  
28    include predator control actions designed to reduce predation on salmonids and  
29    Delta Smelt, primarily within the Delta. Predator control measures are included  
30    in Alternatives 3 and 4, including an increased bag limit and minimum size limit  
31    for Striped Bass and black bass. The proposed bag and size limits are intended  
32    and expected to encourage more fishing effort for and greater harvest of Striped  
33    Bass and black bass, resulting in a reduction in the Striped Bass and black bass  
34    populations throughout the Delta. In addition, a sport reward program for  
35    Sacramento Pikeminnow would be implemented to encourage fishing for and  
36    removal of this predatory species. These two actions would not be implemented  
37    under the No Action Alternative, Second Basis of Comparison, or other action  
38    alternatives, with the exception of Alternatives 3 and 4.

39    **9.4.1.8     Analysis of Ocean Salmon Harvest Restrictions**

40    As described in Chapter 3, Description of Alternatives, Alternatives 3 and 4  
41    include restrictions on the annual ocean Chinook Salmon harvest, which is  
42    intended to minimize harvest mortality of natural origin Central Valley Chinook  
43    Salmon, including fall-run Chinook Salmon, by evaluating and modifying ocean

1 harvest for consistency with Viable Salmonid Population<sup>5</sup> standards. This would  
 2 include working with the Pacific Fisheries Management Council (PFMC),  
 3 CDFW, and NMFS to impose salmon harvest restrictions to reduce by-catch of  
 4 winter-run and spring-run Chinook Salmon to less than 10 percent of age-3 cohort  
 5 in all years.

6 The salmon ocean fishery off the coast of California is regulated by the PFMC,  
 7 which establishes the annual catch limit to optimize overall benefits, particularly  
 8 with regard to food production, recreation, and ecosystem protection. An annual  
 9 catch limit generally is based on achieving the maximum sustained yield from the  
 10 fishery, but also takes into account the effects of uncertainty; management  
 11 imprecision; the need to rebuild stocks; and other relevant economic, social, and  
 12 ecological factors. Compliance with the ESA, other laws, and treaties also may  
 13 affect the annual catch limit. Each year, the maximum allowable harvest  
 14 (i.e., maximum number of fish caught) is determined based on the abundance of  
 15 fish spawning in the previous year. Depending on the number of spawning fish,  
 16 different formulas for calculating the maximum allowable harvest (i.e., control  
 17 rules) are used. These rules calculate the maximum allowable harvest as  
 18 a percentage of the number of spawning fish, and are designed to maximize the  
 19 yield of fish from a stock while preventing overfishing. The annual catch limit  
 20 may be set at or below the maximum allowable harvest.

21 Reduction of the annual catch limit could directly influence the number of adult  
 22 salmon reaching their natal streams to spawn, which could affect the number of  
 23 salmon annually produced in Central Valley streams and the Trinity River.  
 24 Harvest restrictions would be implemented under Alternatives 3 and 4, but would  
 25 not be implemented under the No Action Alternative, Second Basis of  
 26 Comparison, or other action alternatives.

#### 27 **9.4.1.9 Approach to Analyzing the Effects of Alternatives on Fish**

28 The analysis of the effects of changes in operation of the CVP and SWP on fish  
 29 and aquatic resources in this EIS is influenced by numerous factors related to the  
 30 complexity of the ecosystem, changes within the system (e.g., climate change and  
 31 species population trends), and the imprecision of operational controls and  
 32 resolution in modeling tools. These factors are further complicated by the  
 33 scientific uncertainty about some fundamental aspects of aquatic species life  
 34 history and how these species respond to changes in the system, as well as  
 35 sometimes competing points of view on the interpretation of biological and  
 36 physical data within the scientific community. In light of these factors, the  
 37 analysis takes an approach that presents available information and model outputs,  
 38 synthesizes the results, and draws logical conclusions on likely effects of the  
 39 various alternatives. Where relevant and appropriate, the analysis attempts to

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<sup>5</sup> "A viable salmonid population (VSP)<sup>2</sup> is an independent population of any Pacific salmonid (genus *Oncorhynchus*) that has a negligible risk of extinction due to threats from demographic variation (random or directional), local environmental variation, and genetic diversity changes (random or directional) over a 100-year time frame" (McElhany et al. 2000, pg. 2).



1 identify the level of uncertainty and qualify effect conclusions where competing  
2 hypotheses may exist.

3 Many modeling tools have been developed to evaluate changes in CVP and SWP  
4 water management, and as a result, multiple sources of information are available  
5 to characterize conditions (e.g., water temperature, flows, reservoir storage).  
6 Most of these modeling tools explain or provide insight on one or two of the  
7 factors affecting the species, while some tools are more integrative  
8 (e.g., SALMOD) and capture multiple relationships among physical conditions  
9 and biological responses. Where integrative models were available, these were  
10 relied upon more than evaluation of the individual components. For species  
11 where these tools were not available, the analysis used a preponderance of  
12 evidence approach that drew conclusions based on trends indicated by the  
13 majority of the information. This approach assembled the full range of available  
14 information and model outputs and determined the direction (neutral, positive, or  
15 negative) of effect supported by the information.

16 For each focal species where sufficient information was available, the analysis  
17 includes an effects summary that presents the EIS authors' conclusions for that  
18 species and describes the rationale for the conclusion. It also presents a general  
19 indication of the level of uncertainty regarding the conclusion and presents  
20 qualifying information where disagreement in the scientific community may exist  
21 for more complete disclosure.

22 Because of the multiple model outputs, the body of the impact analysis contains a  
23 considerable amount of information, which is intended to summarize for the  
24 benefit of the reader, while leaving most of the detail in the appendices. The  
25 narrative contained in the body of the document and the model results in the  
26 appendices are intended to be used in concert in reviewing this EIS.

#### 27 **9.4.2 Conditions in Year 2030 without Implementation of** 28 **Alternatives 1 through 5**

29 This EIS includes two bases of comparison, as described in Chapter 3,  
30 Description of Alternatives: the No Action Alternative and the Second Basis of  
31 Comparison. Both of these bases are evaluated at 2030 conditions. Changes that  
32 would occur over the next 15 years without implementation of the alternatives are  
33 not analyzed in this EIS. However, the changes to aquatic resources that are  
34 assumed to occur by 2030 under the No Action Alternative and the Second Basis  
35 of Comparison are summarized in this section. Many of the changed conditions  
36 would occur in the same manner under both the No Action Alternative and the  
37 Second Basis of Comparison.

##### 38 **9.4.2.1 Common Changes in Conditions under the No Action** 39 **Alternative and Second Basis of Comparison**

40 Conditions in 2030 would be different than existing conditions due to:

- 41 • Climate change and sea level rise

- 1 • General plan development throughout California, including increased water  
2 demands in portions of Sacramento Valley
- 3 • Implementation of reasonable and foreseeable water resources management  
4 projects to provide water supplies

5 It is anticipated that climate change would result in more short-duration high-  
6 rainfall events and less snowpack in the winter and early spring months. The  
7 reservoirs would be full more frequently by the end of April or May by 2030 than  
8 in recent historical conditions. However, as the water is released in the spring,  
9 there would be less snowpack to refill the reservoirs. This condition would  
10 reduce reservoir storage and available water supplies to downstream uses in the  
11 summer. The reduced end of September storage also would reduce the ability to  
12 release stored water to downstream regional reservoirs. These conditions would  
13 occur for all reservoirs in the California foothills and mountains, including non-  
14 CVP and SWP reservoirs.

15 These changes would result in a decline of the long-term average CVP and SWP  
16 water supply deliveries by 2030 as compared to recent historical long-term  
17 average deliveries under the No Action Alternative and the Second Basis of  
18 Comparison. However, the CVP and SWP water deliveries would be less under  
19 the No Action Alternative as compared to the Second Basis of Comparison, as  
20 described in Chapter 5, Surface Water Resources and Water Supplies, which  
21 could result in more crop idling.

22 Under the No Action Alternative and the Second Basis of Comparison, land uses  
23 in 2030 would occur in accordance with adopted general plans. Development  
24 under the general plans would change aquatic resources, especially near  
25 municipal areas.

26 The No Action Alternative and the Second Basis of Comparison assumes  
27 completion of water resources management and environmental restoration  
28 projects that would have occurred without implementation of Alternatives  
29 1 through 5, including regional and local recycling projects, surface water and  
30 groundwater storage projects, conveyance improvement projects, and desalination  
31 projects, as described in Chapter 3, Description of Alternatives. The No Action  
32 Alternative and the Second Basis of Comparison also assumes implementation of  
33 actions included in the 2008 USFWS BO and 2009 NMFS BO that would have  
34 been implemented without the BOs by 2030, as described in Chapter 3,  
35 Description of Alternatives. These projects would include several projects that  
36 would affect aquatic resources, including:

- 37 • Habitat Restoration includes restoration of more than 10,000 acres of  
38 intertidal and associated subtidal wetlands in Suisun Marsh and Cache Slough;  
39 and at least 17,000 to 20,000 acres of seasonal floodplain restoration in Yolo  
40 Bypass.
- 41 – 2008 USFWS BO RPA Component 4 (Action 6). Habitat Restoration.
- 42 – 2009 NMFS BO RPA Action I.6.1. Restoration of Floodplain Habitat.

- 1       – 2009 NMFS BO RPA Action I.6.2. Near-Term Actions at Liberty  
2       Island/Lower Cache Slough and Lower Yolo Bypass.
- 3       – 2009 NMFS BO RPA Action I.6.3. Lower Putah Creek Enhancements.
- 4       – 2009 NMFS BO RPA Action I.6.4. Improvements to Lisbon Weir.
- 5       – 2009 NMFS BO RPA Action I.7. Reduce Migratory Delays and Loss of  
6       Salmon, Steelhead, and Sturgeon at Fremont Weir and Other Structures in  
7       the Yolo Bypass.
- 8       • 2009 NMFS BO RPA Action I.1.3. Clear Creek Spawning Gravel  
9       Augmentation.
- 10      • 2009 NMFS BO RPA Action I.1.4. Spring Creek Temperature Control  
11      Curtain Replacement.
- 12      • 2009 NMFS BO RPA Action I.2.6. Restore Battle Creek for Winter-Run,  
13      Spring-Run, and Central Valley Steelhead.
- 14      • 2009 NMFS BO RPA Action I.3.1. Operate Red Bluff Diversion Dam with  
15      Gates Out.
- 16      • 2009 NMFS BO RPA Action I.5. Funding for CVPIA Anadromous Fish  
17      Screen Program.
- 18      • 2009 NMFS BO RPA Action II.1. Lower American River Flow Management.
- 19      Implementation of these common actions are described in more detail in this  
20      section under the No Action Alternative and referred under the discussion of the  
21      Second Basis of Comparison.

#### 22      **9.4.2.2    No Action Alternative**

23      As described in Chapter 3, Description of Alternatives, the No Action  
24      Alternative includes implementation of the 2008 USFWS BO and the 2009  
25      NMFS BO Reasonable and Prudent Alternative (RPA) actions. It also includes  
26      changes not related to the coordinated long-term operation of the CVP and SWP,  
27      specifically changes in CVP and SWP operations caused by climate change and  
28      sea level rise, increased CVP and water rights water demand in portions of the  
29      Sacramento Valley, and implementation of reasonable and foreseeable non-CVP  
30      or SWP water resources management projects to provide water supplies. The  
31      resulting changes in ecological attributes and subsequent effects on fish and  
32      aquatic resources would vary geographically, as described below.

33      As described in Chapter 5, Surface Water Resources and Water Supplies, it is  
34      anticipated that climate change would result in more short-duration, high-rainfall  
35      events and less snowpack in the winter and early spring months. By 2030, the  
36      reservoirs would be full more frequently by the end of April or May than in recent  
37      historical conditions. However, as the water is released in the spring, there would  
38      be less snowpack to refill the reservoirs. This condition would reduce reservoir  
39      storage and available water supplies to downstream uses in the summer. The  
40      reduced storage in fall (end of September storage) would reduce the ability to

1 release stored water to downstream regional reservoirs. These conditions would  
 2 occur for all reservoirs in the California foothills and mountains, including non-  
 3 CVP and SWP reservoirs. Sea level rise also would result in reduced CVP and  
 4 SWP reservoir storage because the CVP and SWP must continue to meet the  
 5 salinity criteria to protect Delta water users and Delta aquatic resources, including  
 6 the SWRCB D-1641 and other salinity criteria to protect Delta water users. To  
 7 meet these criteria, the amount of water released from CVP and SWP reservoirs  
 8 must be increased as compared to recent historical conditions.

#### 9 **9.4.2.2.1 Trinity River Region**

##### 10 *Aquatic Habitat Conditions in CVP and SWP Reservoirs*

11 As described in Chapter 5, Surface Water Resources and Water Supplies, end of  
 12 September reservoir storage in Trinity Lake would be lower by 2030 as compared  
 13 to recent historical conditions due to climate change and related lower snowfall.  
 14 Lewiston Reservoir, a regulating reservoir, would be operated with daily changes  
 15 similar to historical conditions. These changes are not anticipated to substantially  
 16 affect aquatic resources in Trinity Lake or Lewiston Reservoir relative to recent  
 17 historical conditions.

##### 18 *Aquatic Habitat Conditions in Trinity and Lower Klamath Rivers*

19 Under the No Action Alternative, flow, water temperature, and aquatic habitat  
 20 conditions in the Trinity River would continue to be influenced by CVP and SWP  
 21 operations as described in the Affected Environment. Due to the increased  
 22 potential for reduced Trinity Lake surface water storage (see above), there could  
 23 be an increased potential for reduced Trinity River flows during the summer and  
 24 fall months under the No Action Alternative as compared to recent historical  
 25 conditions. The influence of climate change could result in higher water  
 26 temperatures in Trinity Lake that could translate to higher release temperatures in  
 27 the flow releases from Lewiston Dam and a reduction in habitat quality within the  
 28 Trinity River for salmonids and other native species.

29 By 2030, implementation of 2009 NMFS BO RPA Action II.6, Preparation of  
 30 Hatchery Genetic Management Plans for spring- and fall-run Chinook Salmon at  
 31 the Trinity River Fish Hatchery, which is not currently being implemented, could  
 32 reduce the adverse influence of recent hatchery operations on naturally produced  
 33 fall-run and spring-run Chinook Salmon, and increase genetic diversity and  
 34 diversity of run timing for these stocks.

##### 35 *Effects Related to Water Transfers*

36 It is not anticipated that water would be transferred to or from the Trinity River  
 37 Region. It also not anticipated that water transfers would result in changes to  
 38 Trinity Lake operations. Therefore, there would be no change in aquatic habitat  
 39 conditions as a result of water transfers.

1 **9.4.2.2.2 Central Valley Region**

2 *Aquatic Habitat Conditions in CVP and SWP Reservoirs*

3 Seasonal changes in reservoir surface elevations, storage volumes, and the volume  
4 of cold water held within the reservoirs would continue under the No Action  
5 Alternative. Conditions for reservoir fishes would continue to change seasonally  
6 in response to inflow and downstream flow releases to meet demand. Recent  
7 historical averages for reservoir storage and surface elevations in Shasta Lake,  
8 Lake Oroville, and Folsom Lake generally show increases in March and April,  
9 with a reduction in storage occurring in many years during May and June in  
10 response to releases to meet downstream demands. Water surface elevations in  
11 New Melones Reservoir generally decline throughout the spring period in many  
12 years, with reductions typically occurring from April through June.

13 As described in Chapter 5, Surface Water Resources and Water Supplies, end of  
14 September reservoir storage would be lower by 2030 as compared to recent  
15 historical conditions in Shasta Lake, Lake Oroville, Folsom Lake, New Melones  
16 Lake, and San Luis Reservoir due to climate change and related lower snowfall.  
17 Whiskeytown Lake, Keswick Reservoir, Thermalito Forebay and Afterbay, and  
18 Lake Natoma are regulating reservoirs and would be operated with daily changes  
19 similar to historical conditions.

20 Under the No Action Alternative, the magnitude of changes in seasonal surface  
21 elevation and reservoir storage could be more pronounced because of changes in  
22 the timing and intensity of storm events due to climate change and an overall  
23 reduction in snow pack. A smaller snowpack could result in less water entering  
24 the reservoirs during the spring months and an increased frequency of reservoir  
25 elevation declines during the spring months. By 2030, fish in these reservoirs that  
26 spawn in shallow water (e.g., various species of black bass) could be subject to a  
27 hydrologic regime that increases the frequency of reductions in surface elevation  
28 during the spring spawning period, reducing spawning success. In addition,  
29 reduced storage volumes and reduction of the cold water pools could reduce the  
30 amount and suitability of habitat for cold water fishes (e.g., trout) within the  
31 reservoirs relative to recent historical conditions.

32 *Aquatic Habitat Conditions in Rivers Downstream of CVP and SWP Facilities*

33 As described in Chapter 5, Surface Water Resources and Water Supplies, surface  
34 water flows are anticipated to increase during the winter months as a result of an  
35 increase in rainfall and decrease in snowfall, and to decrease in other months  
36 because of the diminished snowmelt flows in the spring and early summer  
37 months. In wetter years, fall flows may be increased relative to recent conditions  
38 to meet downstream targets for Fall X2, which would lead to reduced reservoir  
39 storage in the following months and less carryover storage in May of the  
40 following year.

41 As described in Chapter 6, Surface Water Quality, climate change is anticipated to  
42 result in higher water temperatures during portions of the year, with a  
43 corresponding reduction in habitat quality for salmonids and other cold water  
44 fishes. Increased downstream water demands and climate change are anticipated

1 to contribute to an inability to maintain an adequate cold water pool in critical dry  
2 years and extended dry periods in the future.

3 Implementation of the 2008 USFWS BO and the 2009 NMFS BO Reasonable and  
4 Prudent Alternative (RPA) actions under the No Action Alternative are  
5 anticipated to benefit aquatic species. The resulting changes in ecological  
6 attributes and subsequent effects on fish and aquatic resources would vary from  
7 river to river, as described below.

8 *Aquatic Habitat Conditions in the Clear Creek from Whiskeytown Dam to*  
9 *Sacramento River*

10 Under the No Action Alternative, flow, water temperature, and aquatic habitat  
11 conditions in Clear Creek would continue to be influenced by CVP and SWP  
12 operations as described in the Affected Environment. Whiskeytown Reservoir  
13 would continue to be operated to convey water from the Trinity River to the  
14 Sacramento River via the Spring Creek tunnel and to release flows to Clear Creek  
15 to support anadromous fish.

16 The No Action Alternative includes a suite of six 2009 NMFS BO RPA actions,  
17 intended to improve conditions for salmonids. These actions individually or in  
18 combination could influence conditions in Clear Creek by 2030. These include:

- 19 • 2009 NMFS BO RPA Action I.1. Spring Attraction Flows
- 20 • 2009 NMFS BO RPA Action I.2. Channel Maintenance Flows
- 21 • 2009 NMFS BO RPA Action I.3. Spawning Gravel Augmentation
- 22 • 2009 NMFS BO RPA Action I.4. Spring Creek Temperature Control Curtain
- 23 • 2009 NMFS BO RPA Action I.5. Thermal Stress Reduction
- 24 • 2009 NMFS BO RPA Action I.6. Adaptively Manage to Habitat  
25 Suitability/IFIM Study Results

26 Two of the actions involve additional flow releases to Clear Creek. 2009 NMFS  
27 BO RPA Action I.1, requires at least two pulse flows in May and June to attract  
28 adult spring-run Chinook Salmon holding in the Sacramento River. The pulse  
29 flows would be continued annually, and are expected to improve conditions for  
30 spring-run Chinook Salmon into the future. In addition, 2009 NMFS BO RPA  
31 Action I.1.2, requires the release of channel maintenance flows of a minimum of  
32 3,250 cfs into Clear Creek seven times in a ten-year period. These channel  
33 maintenance flows are intended to provide the higher flows necessary to move  
34 spawning gravels downstream from injection sites (locations where gravel  
35 augmentation is implemented) for the purpose of increasing the amount of  
36 spawning habitat available to spring-run Chinook Salmon and steelhead.  
37 However, as described in Chapter 5, Surface Water Resources and Water  
38 Supplies, the feasibility of releasing these flows is influenced by dam safety  
39 considerations and operational constraints, and the delivery of flows of this  
40 frequency may not be possible, thus the movement of gravel through mechanical  
41 means may be required to achieve this objective.

1 2009 NMFS BO RPA Action I.1.3 addresses the limited availability of spawning  
2 habitat in Clear Creek through the placement of gravel in selected sites in the  
3 creek. This program is expected to continue under the No Action Alternative,  
4 with ongoing improvements to spawning habitat for steelhead, and spring-run and  
5 fall-run Chinook Salmon.

6 Water temperatures in Clear Creek are influenced by the temperature of water in  
7 the Whiskeytown Reservoir and, to some extent, the magnitude of the release  
8 flows. As described in the Affected Environment, Reclamation has managed  
9 releases since 2002 to meet a daily average water temperature target of 56°F at the  
10 Igo Gauge (4 miles downstream of Whiskeytown Dam) from September 15  
11 through October 30 to support spring-run Chinook Salmon spawning. Beginning  
12 in 2004, an additional daily average temperature target of 60°F was implemented  
13 from June 1 to September 15 to protect over-summering juvenile steelhead and  
14 holding adult spring-run Chinook Salmon. 2009 NMFS BO RPA Action I.1.5  
15 continues these temperature targets; however, recent real time operations have  
16 experienced difficulty in meeting the temperature objectives, and by 2030, it may  
17 not be possible to meet the temperature targets as often. The Spring Creek  
18 Temperature Control Curtain in Whiskeytown Lake repaired in 2011 (and also  
19 included in the 2009 NMFS BO RPA) improves this condition by retaining cold  
20 water that is released to reduce water temperatures during the summer for over-  
21 summering juvenile steelhead and holding adult spring-run Chinook Salmon and  
22 during the fall for spring- and winter-run Chinook Salmon spawning and  
23 incubation.

24 2009 NMFS BO RPA Action I.1.6 requires adaptive management of flows in  
25 Clear Creek based on results of habitat suitability/IFIM studies. If warranted by  
26 the studies and if sufficient water is available, this action could result in modified  
27 minimum flows in Clear Creek during the fall and winter to improve conditions  
28 for spawning and incubating salmonids. Whether flow requirements would be  
29 modified by 2030 and the extent of any changes are currently unknown.

30 *Aquatic Habitat Conditions in the Sacramento River from Keswick to*  
31 *Freepoint*

32 Under the No Action Alternative, flow, water temperature, and aquatic habitat  
33 conditions in the Sacramento River downstream of Keswick Dam would continue  
34 to be influenced by CVP and SWP operations as described in the Affected  
35 Environment. Shasta Lake would continue to be operated to convey water from  
36 the Sacramento River to the Delta and release flows to the Sacramento River to  
37 support anadromous fish.

38 The No Action Alternative includes a variety of 2009 NMFS BO RPA actions or  
39 action suites intended to improve conditions for salmonids. These actions  
40 individually or in combination could influence conditions in the Sacramento River  
41 (and Battle Creek) by 2030. These include:

- 42 • 2009 NMFS BO RPA Action Suite I.2.1. Shasta Operations
- 43 – 2009 NMFS BO RPA Action Suite I.2.1. Performance Measures

- 1       – 2009 NMFS BO RPA Action I.2.2 (including I.2.2.A–I.2.2.C). November  
2       through February Keswick Release Schedule (Fall Actions)
- 3       – 2009 NMFS BO RPA Action I.2.3 (including I.2.3.A–I.2.3.C). February  
4       Forecast; March – May 14 Keswick Release Schedule (Spring Actions)
- 5       – 2009 NMFS BO RPA Action I.2.4. May 15 Through October Keswick  
6       Release Schedule (Summer Action)
- 7       – 2009 NMFS BO RPA Action I.2.5. Winter-Run Chinook Salmon Passage  
8       and Reintroduction Program at Shasta Dam – See “Conditions for Fish  
9       Passage”
- 10      – 2009 NMFS BO RPA Action I.2.6. Restore Battle Creek for Winter-Run,  
11      Spring-Run, and CV Steelhead
- 12      • 2009 NMFS BO RPA Action Suite I.3. Red Bluff Diversion Dam (RBDD)  
13      Operations
- 14      • 2009 NMFS BO RPA Action I.4. Wilkins Slough Operations
- 15      • 2009 NMFS BO RPA Action I.5. Funding for CVPIA Anadromous Fish  
16      Screen Program

17      Action Suite I.2 (Shasta Operations) was aimed at maintaining suitable  
18      temperatures for egg incubation, fry emergence, and juvenile rearing in the  
19      Sacramento River for the survival and recovery of the winter-run Chinook  
20      Salmon ESU. Spring-run Chinook Salmon and steelhead are also affected by  
21      temperature management actions from Shasta Lake. This suite of actions is  
22      designed to ensure that Reclamation uses maximum discretion to reduce adverse  
23      impacts of the projects to Chinook Salmon and steelhead in the Sacramento River  
24      by maintaining sufficient carryover storage and optimizing use of the cold water  
25      pool. Because Reclamation already operates Shasta Lake to optimize use of the  
26      cold water pool and maintain carryover storage for temperature control in the  
27      Sacramento River downstream of Shasta and Keswick dams, implementation of  
28      this suite of actions would have little effect on habitat conditions for winter-run  
29      Chinook Salmon and other fish species in the Sacramento River under the No  
30      Action Alternative.

31      A temperature control device has been in operation at Shasta Dam since 1998,  
32      with operations capable of maintaining a water temperature of 56°F downstream  
33      to Balls Ferry Bridge in most years through the summer spawning period for  
34      winter-run. Under the No Action Alternative, the ability to control water  
35      temperatures depends on a number of factors and management flexibility usually  
36      ends in October when the cold water pool in Shasta Lake is depleted. With  
37      climate change, cold water storage at the end of May in Shasta Lake is expected  
38      to be reduced under the No Action Alternative for all water year types. This  
39      would further reduce the already limited cold water pool in late summer. With  
40      the anticipated increase in demands for water by 2030 and less water being  
41      diverted from the Trinity River, it is expected that it would become increasingly



1 difficult to meet water temperature targets at the various temperature compliance  
2 points.

3 It is likely that severe temperature-related effects will be unavoidable in some  
4 years under the No Action Alternative. Due to these unavoidable adverse effects,  
5 RPA Action Suite I.2 also specifies other actions that Reclamation must take,  
6 within its existing authority and discretion, to compensate for these periods of  
7 unavoidably high temperatures. These actions include restoration of habitat at  
8 Battle Creek (see below) which may support a second population of winter-run  
9 Chinook Salmon, and a fish passage program at Keswick and Shasta dams to  
10 partially restore winter-run Chinook Salmon to their historical cold water habitat.

11 2009 NMFS BO RPA Action Suite I.3 addresses mortality and delay of adult and  
12 juvenile migration of winter-run, spring-run, steelhead, and green sturgeon caused  
13 by the presence of the RBDD and the configuration of the operable gates. As  
14 described in the Affected Environment, the Red Bluff Pumping Plant and fish  
15 screen, which diverts water to the Tehama Colusa Canal and Corning Canal, was  
16 constructed to allow year-round opening of the gates at the RBDD, and is  
17 included in the 2009 NMFS BO as Action Suite I.3. Allowing the dam gates at  
18 RBDD to remain open allows salmonids, sturgeon, and other fish species to pass  
19 unimpeded all year. These passage improvements are completed and are  
20 anticipated to benefit fish species that migrate upstream of the RBDD location  
21 through improved access to spawning and rearing areas and a reduction in  
22 predation due to dispersal of predator species like Striped Bass and Sacramento  
23 Pikeminnow.

24 Implementation of 2009 NMFS BO RPA Action I.4 is anticipated to enhance the  
25 ability to manage temperatures for anadromous fish downstream of Shasta Dam  
26 through adjusting Wilkins Slough flow criteria in a manner that best conserves the  
27 cold water pool for summer releases. In years other than critical dry years, the  
28 need for a variance from the 5,000 cfs navigation criterion will be considered  
29 during the process of developing the Keswick release schedules (Action I.2.2-4).  
30 Reclamation has stated that it is no longer necessary to maintain 5,000 cfs at  
31 Wilkins Slough for navigation (CVP/SWP operations BA, page 2-39), however,  
32 the 5,000 cfs flow criterion is now used to support long-time water diversions that  
33 have set their intake pumps just below this level. Under the No Action  
34 Alternative, operating to a minimal flow level at Wilkins Slough based on fish  
35 needs, rather than on outdated navigational requirements, could enhance the  
36 ability to use cold water releases to maintain cooler summer temperatures in the  
37 Sacramento River.

38 The No Action Alternative includes implementation of the CVPIA AFSP to  
39 reduce entrainment of juvenile anadromous fish from unscreened diversions. This  
40 program is also addressed in the 2009 NMFS BO RPA Action I.5. By providing  
41 funding to screen priority diversions as identified in the CVPIA AFSP, the loss of  
42 listed fish in water diversion channels by 2030 could be reduced. In addition, if  
43 new fish screens can be constructed so that diversions can occur at low water  
44 surface elevations to allow diversions below a flow of 5,000 cfs at Wilkins  
45 Slough, then cold water at Shasta Lake could be conserved during critical dry

1 years for release to support winter-run and spring-run Chinook Salmon needs  
2 downstream.

3 As described in the Affected Environment, implementation of the Battle Creek  
4 Restoration Program is underway in accordance with implementation of the  
5 CVPIA. This action, also included in the 2009 NMFS BO RPA Action I.2.6, is  
6 being implemented to partially compensate for unavoidable adverse effects of  
7 project operations by restoring winter-run and spring-run Chinook Salmon to the  
8 Battle Creek watershed. Full implementation of the Battle Creek Restoration  
9 Program under the No Action Alternative would substantially improve passage  
10 conditions for adult Chinook Salmon and steelhead by 2030 and would result in  
11 newly accessible anadromous fish habitat and improved water quality for the  
12 Coleman National Fish Hatchery (Reclamation and SWRCB 2003).  
13 Implementation of the RPA helps ensure that the Battle Creek experimental  
14 winter-run Chinook Salmon re-introduction program will proceed in a timely  
15 fashion. The Battle Creek Restoration Program is critical in creating a second  
16 population of winter-run Chinook Salmon. A second population of winter-run  
17 Chinook Salmon would reduce the risk that lost resiliency and increased  
18 vulnerability to catastrophic events might result in extinction of the species.

19 *Aquatic Habitat Conditions in the Feather River from Oroville Dam to*  
20 *Sacramento River*

21 As described in Chapter 5, Surface Water Resources and Water Supplies, and  
22 Chapter 6, Surface Water Quality, the NMFS and 2008 USFWS BO RPAs did not  
23 specifically recommend actions for Feather River operations. However,  
24 Reclamation and DWR operate the Shasta-Oroville-Folsom coordinated releases  
25 pursuant to 2009 NMFS BO RPA Actions 1.2.2C and 1.2.3B. The following two  
26 RPA actions for operations in the Sacramento River influence Feather River  
27 operations required to meet Delta outflow, X2, or other legal requirements:

- 28 • Action I.2.2. (including I.2.2.A–I.2.2.C) November through February  
29 Keswick Release Schedule (Fall Actions)
- 30 • Action I.2.3. (including I.2.3.A–I.2.3.C) February Forecast; March – May 14  
31 Keswick Release Schedule (Spring Actions).

32 Under the No Action Alternative, Feather River flows in the high flow channel  
33 downstream of Thermalito Dam would be influenced by releases for Fall X2  
34 Delta outflow requirements, regulation to meet water temperature criteria, and to  
35 time Lake Oroville releases and Delta export operations as described for the  
36 Affected Environment. Flows in the low flow channel downstream of Lake  
37 Oroville would remain similar to recent conditions. As part of the ongoing FERC  
38 relicensing process for the Oroville facilities, DWR has entered into a Settlement  
39 Agreement (DWR 2006) that includes actions to be implemented and included as  
40 terms of the anticipated FERC license. Depending on the progress of the  
41 relicensing process, these actions could be implemented by 2030 and would  
42 change fish habitat conditions in the Feather River relative to recent conditions.

1 Under the terms of the Settlement Agreement, DWR will develop a  
2 comprehensive Lower Feather River Habitat Improvement Plan. The Plan will  
3 provide an overall strategy for managing the various environmental measures  
4 developed for implementation in the plan area. The following programs and plans  
5 will be included in the comprehensive Lower Feather River Habitat Improvement  
6 Plan:

- 7 1) Gravel Supplementation and Improvement Program
- 8 2) Channel Improvement Program
- 9 3) Structural Habitat Supplementation and Improvement Program
- 10 4) Fish Weir Program
- 11 5) Riparian and Floodplain Improvement Program including the evaluation of  
12 pulse/flood flows
- 13 6) Feather River Fish Hatchery Improvement Program
- 14 7) Comprehensive Water Quality Monitoring Program
- 15 8) Oroville Wildlife Area Management Plan
- 16 9) Instream Flow and Temperature Improvement for Anadromous Fish.

17 Implementation of these programs and plans under the terms of the Settlement  
18 Agreement as incorporated into the new license are anticipated to improve habitat  
19 conditions and water quality for salmonids and other fishes using the channels of  
20 the Feather River above the confluence with the Sacramento River.

21 *Aquatic Habitat Conditions in the American River from Nimbus Dam to*  
22 *Sacramento River*

23 As described in the Affected Environment section, Reclamation releases water to  
24 the lower American River consistent with flood control requirements; existing  
25 water rights; CVP operations; the Lower American River Flow Management  
26 Standard flow recommendations developed by Reclamation, the Sacramento Area  
27 Water Forum, USFWS, NMFS, DFW, and other interested parties; SWRCB  
28 Decision 893 (D-893); and requirements of the 2009 NMFS BO RPA. The  
29 following two RPA actions for operations in the Sacramento River influence  
30 American River operations required to meet Delta outflow, X2, or other legal  
31 requirements:

- 32 • Action I.2.2. (including I.2.2.A–I.2.2.C) November through February  
33 Keswick Release Schedule (Fall Actions)
- 34 • Action I.2.3. (including I.2.3.A–I.2.3.C) February Forecast; March – May 14  
35 Keswick Release Schedule (Spring Actions).

36 The No Action Alternative includes a variety of 2009 NMFS BO RPA actions or  
37 action suites intended to improve conditions for salmonids in the lower American  
38 River. These actions individually or in combination could influence conditions in  
39 the American River by 2030. These include:

- 1 • 2009 NMFS BO RPA Action II.2.1. Lower American River Flow  
2 Management
- 3 • 2009 NMFS BO RPA Action II.2. Lower American River Temperature  
4 Management
- 5 • 2009 NMFS BO RPA Action II.3. Structural Improvements
- 6 • 2009 NMFS BO RPA Action II.4. Minimize Flow Fluctuation Effects
- 7 • 2009 NMFS BO RPA Action II.5. Fish Passage at Nimbus and Folsom dams
- 8 • 2009 NMFS BO RPA Action II.6.1. Preparation of Hatchery Genetic  
9 Management Plan (HGMP) for Steelhead
- 10 • 2009 NMFS BO RPA Action II.6.2. Interim Actions Prior to Submittal of  
11 Draft HGMP for Steelhead.

12 Under the No Action Alternative, American River flows would be influenced by  
13 releases for Fall X2 Delta outflow requirements, regulation to meet water  
14 temperature criteria, and to time Folsom Dam releases and Delta exports.  
15 However, by 2030, increasing water demands and the influence of climate change  
16 could worsen conditions for fish in the lower American River, particularly for  
17 salmonids.

18 Reclamation releases water from Folsom Lake to implement the flow schedule  
19 specified in the American River Flow Management Standard. The flow schedule  
20 was developed and implemented prior to issuance of the 2009 NMFS BO  
21 (Action II.1) to establish required minimum flows for anadromous salmonids in  
22 the lower American River. The flow schedule specifies minimum flows and does  
23 not preclude Reclamation from making higher releases at Nimbus Dam. The flow  
24 schedule was developed to require more protective minimum flows in the lower  
25 American River in consideration of the river's aquatic resources, particularly  
26 steelhead and fall-run.

27 Reclamation manages the Folsom/Nimbus Dam complex and the water  
28 temperature control shutters at Folsom Dam to maintain a daily average water  
29 temperature of 65°F or lower at Watt Avenue Bridge from May 15 through  
30 October 31, to provide suitable conditions for juvenile steelhead rearing in the  
31 lower American River. Water temperature is the physical factor with the greatest  
32 influence on salmonids in the American River. The inability to maintain suitable  
33 water temperatures for all life history stages of steelhead in the American River is  
34 a chronic issue because of operational (e.g., Folsom Lake operations to meet  
35 Delta water quality objectives and demands and deliveries to M&I users in Placer,  
36 El Dorado, and Sacramento County) and structural (e.g., limited reservoir water  
37 storage and cold water pool) factors. Under the No Action Alternative, increased  
38 water demand and climate change are expected to lead to further reductions in  
39 suitable habitat conditions and increased water temperatures.

40 2009 NMFS BO RPA Action II.3 requires Reclamation to evaluate physical and  
41 structural modifications that may improve temperature management capability in  
42 the lower American River. Structural improvements to be further evaluated and

1 potentially implemented include: improvements to the Folsom Dam TCD, cold  
2 water transport through Lake Natoma, installation of a TCD at El Dorado  
3 Irrigation District's intake or its functional equivalent, and improved temperature  
4 management decision-support tools. If one or more of these actions are  
5 implemented by 2030, they could increase the likelihood that water temperatures  
6 would be suitable for steelhead more frequently.

7 2009 NMFS BO RPA Action II.4 addresses stranding and isolation of juvenile  
8 steelhead through implementation of flow ramping protocols. Implementation of  
9 this action, including the continued monitoring for stranding and isolation of  
10 salmonids in conjunction with flow fluctuations under the No Action Alternative,  
11 could help to better predict the potential for steelhead redd dewatering and  
12 isolation, fry stranding, and fry and juvenile isolation and to potentially avoid  
13 adverse effects to salmonids.

14 As described above, temperature-related effects are likely during some years  
15 under the No Action Alternative. Because of these unavoidable effects, RPA  
16 Action II.5 requires Reclamation to evaluate options for providing steelhead  
17 access their historic cold water habitat above Nimbus and Folsom dams and to  
18 provide access if feasible.

19 Under the No Action Alternative, 2009 NMFS BO RPA Action Suite II.6, which  
20 addresses project effects related to the Nimbus Fish Hatchery related to  
21 introgression of out-of-basin hatchery stock with wild steelhead populations in the  
22 Central Valley, would be implemented. Implementation of an HGMP prior to  
23 2030 should minimize the effects of the ongoing steelhead hatchery program on  
24 the Central Valley steelhead DPS.

25 Implementation of the HGMP also would reduce operational effects on Killer  
26 Whale prey over the long term by improving the genetic diversity and diversity of  
27 run timing of Central Valley fall-run Chinook Salmon, decreasing the potential  
28 for localized prey depletions and increasing the likelihood that fall-run Chinook  
29 Salmon could withstand stochastic events, such as poor ocean conditions. By  
30 2030, implementation of this action could begin to contribute to a more consistent  
31 food source for Killer Whales, even in years with overall poor Chinook Salmon  
32 productivity.

33 *Aquatic Habitat Conditions in the San Joaquin River from Friant Dam to the*  
34 *Stanislaus River*

35 Under the No Action Alternative, operations at Friant Dam would remain similar  
36 to those described under the Affected Environment. Therefore, fish and aquatic  
37 habitat conditions in the San Joaquin River downstream of Friant Dam would  
38 remain similar to those described under the Affected Environment, although water  
39 temperatures could increase as a result climate change.

1        *Aquatic Habitat Conditions in the Stanislaus River from Goodwin Dam to San*  
 2        *Joaquin River*

3        Under the No Action Alternative, flow, water temperature, and aquatic habitat  
 4        conditions in the Stanislaus River downstream of Goodwin Dam would continue  
 5        to be influenced by CVP operations as described in Chapter 5, Surface Water  
 6        Resources and Water Supplies. Flows in the lower Stanislaus River are primarily  
 7        controlled by releases from New Melones Lake. Water released from New  
 8        Melones Dam and Powerplant is re-regulated at Tulloch Reservoir and is either  
 9        diverted at Goodwin Dam or released from Goodwin Dam to the lower  
 10       Stanislaus River.

11       The No Action Alternative includes a variety of 2009 NMFS BO RPA actions or  
 12       action suites intended to improve conditions for salmonids in the Stanislaus River.  
 13       These actions individually or in combination could influence conditions in the  
 14       Stanislaus River by 2030. These include:

- 15       • 2009 NMFS BO RPA Action III.1.1. Establish Stanislaus Operations Group  
 16       (SOG) for real-time operational decision-making
- 17       • 2009 NMFS BO RPA Action III.1.2. Provide cold water releases to maintain  
 18       suitable steelhead temperatures
- 19       • 2009 NMFS BO RPA Action III.1.3. Operate the East Side Division dams to  
 20       meet minimum flows
- 21       • 2009 NMFS BO RPA Action Suite III.2. Stanislaus River CV Steelhead  
 22       Habitat Restoration
  - 23       – 2009 NMFS BO RPA Action III.2.1. Increase and improve quality of  
 24       spawning habitat with addition of gravel
  - 25       – 2009 NMFS BO RPA Action III.2.2. Conduct floodplain restoration and  
 26       inundation flows in winter or spring to inundate steelhead juvenile rearing  
 27       habitat
  - 28       – 2009 NMFS BO RPA Action III.2.3. Restore freshwater migratory habitat  
 29       for juvenile steelhead
  - 30       – 2009 NMFS BO RPA Action III.2.4. Evaluate Fish Passage at New  
 31       Melones, Tulloch, and Goodwin dams

32       Under the No Action Alternative, Stanislaus River flows would be influenced by  
 33       regulations to meet water quality and flow criteria. However, by 2030, conditions  
 34       for fish, particularly salmonids, in the Stanislaus River fish are expected to  
 35       worsen because of increased temperatures due to the influence of climate change.

36       In accordance with 2009 NMFS BO RPA Action III.1.1, Reclamation has  
 37       convened a Stanislaus Operations Group (SOG) to provide a forum for real-time  
 38       operational flexibility implementation of the actions defined in the 2009 NMFS  
 39       BO RPA. This group includes representatives from Reclamation, NMFS,  
 40       USFWS, DWR, CDFW, SWRCB, and outside expertise at the discretion of  
 41       NMFS and Reclamation. The SOG provides direction and oversight to ensure

1 that the East Side Division actions are implemented, monitored for effectiveness  
2 and evaluated.

3 Under the No Action Alternative, Reclamation will continue, where feasible, to  
4 manage the cold water supply within New Melones Reservoir as described in  
5 2009 NMFS BO RPA Action III.1.2. The objective of these temperature criteria  
6 is to provide suitable temperatures for Central Valley steelhead rearing, spawning,  
7 egg incubation, smoltification, and adult migration in the Stanislaus River  
8 downstream of Goodwin Dam. There are no temperature control devices at New  
9 Melones, Goodwin, or Tulloch dams; thus, temperature management flexibility is  
10 limited to storage and flow management under certain conditions. Access to  
11 resources to offset operational temperature effects on steelhead in the Stanislaus  
12 River will continue to be limited, particularly in Conference Years and in drier  
13 Mid-Allocation Years. Under the No Action Alternative, steelhead would  
14 continue to be vulnerable to elevated temperatures in dry and critical dry years,  
15 even if actions are taken to improve temperature management. The frequency of  
16 these occurrences is expected to increase with climate change-related temperature  
17 increases.

18 Under the No Action Alternative, Reclamation would continue to meet the  
19 minimum flow schedule, to the best of their ability, as described in 2009 NMFS  
20 BO RPA Action III.1.3. The objective of the minimum flow schedule is to  
21 maintain minimum base flows to provide habitat for all life history stages of  
22 steelhead and to incorporate habitat maintaining geomorphic flows in a flow  
23 pattern that would provide migratory cues to smolts and facilitate out-migrant  
24 smolt movement. The flow schedule specifies minimum flows and does not  
25 preclude higher releases for other operational criteria. However, due to limited  
26 availability of water under the CVP water rights, it would be difficult to fully  
27 implement this action. Therefore, habitat conditions for steelhead and other fish  
28 species in the Stanislaus River would be similar or reduced relative to recent  
29 conditions in the near term. The value of this habitat also may be adversely  
30 influenced by higher temperatures associated with climate change.

31 Ongoing implementation of 2009 NMFS BO RPA Action Suite III.2 through  
32 2030 is anticipated to improve the physical habitat conditions for steelhead,  
33 although climate change may affect the types and cover rates of vegetation  
34 upslope of the river, and potentially increase the rate of fine sediment transport to  
35 the river and to spawning areas.

36 RPA Action III.2.4 requires Reclamation to evaluate options for providing  
37 steelhead access to their historic cold water habitat upstream of New Melones,  
38 Tulloch, and Goodwin dams and to provide access if feasible. As described  
39 above, temperature-related effects will be unavoidable in some years under the No  
40 Action Alternative. Lindley et al. (2007) identified the need for upstream habitat  
41 for salmonids, given predicted climate change in the next century. This may be  
42 particularly relevant for steelhead and salmon in the Stanislaus River where  
43 Goodwin Dam blocks all access to historical spawning and rearing habitat and  
44 where the remaining population survives as a result of dam operations in  
45 downstream reaches that were historically unsuitable habitat because of high

1 summertime temperatures. To the extent that preliminary fish passage efforts are  
2 underway by 2030, this could improve conditions for Stanislaus River salmonids.

3 *Aquatic Habitat Conditions in the Yolo Bypass (including Cache Slough,*  
4 *Lower Putah Creek, and Fremont Weir)*

5 As described in Chapter 5, Surface Water Resources and Water Supplies, climate  
6 change would increase the frequency of high flow events that would result in  
7 flows into the Yolo Bypass by 2030 as compared to recent historical conditions.  
8 Implementation of the operable gates at the Fremont Weir also would increase the  
9 frequency of flows into the Yolo Bypass.

10 Under the No Action Alternative, it is assumed that aquatic habitat conditions in  
11 the Yolo Bypass would improve by 2030 as a result of the following 2009 NMFS  
12 BO RPA actions:

- 13 • 2009 NMFS BO RPA Action I.6.1. Restoration of Floodplain Rearing  
14 Habitat.
- 15 • 2009 NMFS BO RPA Action I.6.2. Near-Term Actions at Liberty  
16 Island/Lower Cache Slough and Lower Yolo Bypass.
- 17 • 2009 NMFS BO RPA Action I.6.3. Lower Putah Creek Enhancements.
- 18 • 2009 NMFS BO RPA Action I.6.4. Improvements to Lisbon Weir.
- 19 • 2009 NMFS BO RPA Action I.7. Reduce Migratory Delays and Loss of  
20 Salmon, Steelhead, and Sturgeon at Fremont Weir and Other Structures in the  
21 Yolo Bypass

22 Under the No Action Alternative, it is assumed that the elements of 2009 NMFS  
23 BO RPA Action Suite I.6.1 would be implemented in the Yolo Bypass, including  
24 up to 20,000 acres of shallow, low-velocity inundated floodplain. Actions in the  
25 Yolo Bypass also would include improvements in fish passage at Fremont Weir  
26 for anadromous salmonids, sturgeon, and other native fish species.

27 Passage at Fremont Weir would be facilitated by correcting a variety of passage  
28 issues within the bypass, including modification of agricultural structures in the  
29 northern Tule Canal that impede flow and cause fish passage delays.  
30 Modification of these structures under the No Action Alternative could  
31 substantially reduce fish passage delays through the Tule Canal. Similarly,  
32 replacement or modification of Lisbon Weir could allow unimpeded fish passage,  
33 reduced maintenance of the weir, and at the same time be managed to impound  
34 water for agriculture. In addition, the Knights Landing Ridge Cut could be  
35 modified to provide an exit path for upstream-migrating fish. These actions,  
36 along with the grading of downstream channels to improve connectivity to the  
37 Tule Canal when water levels fall as inundations recede and provide exit points  
38 for fish that would otherwise be stranded when inundations recede, are expected  
39 to improve conditions for salmonid rearing and fish passage by 2030.

40 Implementation of these ecosystem restoration actions and improvements under  
41 the No Action Alternative could increase growth and survival of juvenile Chinook  
42 Salmon, steelhead, and other native fish by providing increased seasonal access to



1 productive foraging and high quality rearing habitat, depending on the extent and  
2 duration of restoration and inundation. These actions may also reduce migratory  
3 delays or losses by reducing predation, straying, and delays for salmonids and  
4 other migratory native fish species.

5 *Aquatic Habitat Conditions in the Delta*

6 Under the No Action Alternative, flows, water quality, and aquatic habitat  
7 conditions in the Delta would continue to be influenced by CVP and SWP  
8 operations as described in Chapter 5, Surface Water Resources and Water  
9 Supplies and Chapter 6, Surface Water Quality. Overall, long-term average CVP  
10 and SWP water supply deliveries in 2030 through the Delta would decline as  
11 compared to historical long-term average deliveries. Because entrainment of fish  
12 in the Delta export facilities is related to the amount of water exported,  
13 entrainment would decline relative to recent conditions as a result of reduced  
14 water supply delivery.

15 Under the No Action Alternative, climate change is anticipated to have more of an  
16 effect on Delta flows during wetter years than during drier years because CVP  
17 and SWP operations occur with more flexibility during wet years, within the  
18 constraints of flood control requirements, compared to drier years when the CVP  
19 and SWP operations may be more frequently constrained to maintain instream  
20 flows and other environmental objectives. Overall, it is anticipated that due to  
21 climate change, sea level rise, and increased water demands in the Sacramento  
22 Valley, there would be less CVP and SWP water available for export in the Delta  
23 and CVP and SWP exports would decline. The reduction in Delta exports would  
24 result in more positive OMR flows by 2030 as compared to recent historical  
25 conditions. In other words, it is expected that fish in the channels surrounding the  
26 CVP and SWP projects will be exposed to lower entrainment risks than under  
27 recent historical conditions as a result of changes in operation due to factors  
28 described above (i.e., climate change, sea level rise, and increased water demands  
29 in the Sacramento Valley) climate change by 2030.

30 The No Action Alternative includes a variety of RPA actions or action suites from  
31 both the USFWS and NMFS biological opinions intended to improve conditions  
32 in the Delta for Delta Smelt, Longfin Smelt, salmonids and sturgeon. These  
33 actions individually or in combination could influence aquatic habitat conditions  
34 in the Delta by 2030. These include:

- 35 • 2008 USFWS BO RPA Component 1 (Actions 1 and 2). Protection of the  
36 Adult Delta Smelt Life Stage.
- 37 • 2008 USFWS BO RPA Component 2 (Actions 3 and 5). Protection of Larval  
38 and Juvenile Delta Smelt.
- 39 • 2008 USFWS BO RPA Component 3 (Action 4). Improve Habitat for Delta  
40 Smelt Growth and Rearing (Fall X2).
- 41 • 2008 USFWS BO RPA Component 4 (Action 6). Habitat Restoration.

- 1 • 2009 NMFS BO RPA Action Suite IV.1. Modify DCC gate operations and  
2 evaluate methods to control access to Georgiana Slough and the Interior Delta  
3 to reduce diversion of listed fish from the Sacramento River into the southern  
4 or central Delta.
- 5 • 2009 NMFS BO RPA Action Suite IV.2. Control the net negative flows  
6 toward the export pumps in Old and Middle rivers to reduce the likelihood  
7 that fish will be diverted from the San Joaquin or Sacramento River into the  
8 southern or central Delta.
- 9 • 2009 NMFS BO RPA Action IV.3. Curtail exports when protected fish are  
10 observed near the export facilities to reduce mortality from entrainment and  
11 salvage.
- 12 • 2009 NMFS BO RPA Action Suite IV.4. Improve fish screening and salvage  
13 operations to reduce mortality from entrainment and salvage.

14 Component 1 of the 2008 USFWS BO RPA is designed to reduce entrainment of  
15 pre-spawning adult Delta Smelt during December to March by controlling OMR  
16 flows during vulnerable periods, including adaptive management of OMR flows  
17 based on input and guidance from the Smelt Working Group to further reduce  
18 entrainment. Action 1 is designed to protect upmigrating Delta Smelt and  
19 Action 2 is designed to protect adult Delta Smelt that have migrated upstream and  
20 are residing in the Delta prior to spawning. Overall, RPA Component 1 is  
21 expected to increase the suitability of spawning habitat for Delta Smelt by  
22 decreasing the amount of Delta habitat affected by export pumping prior to, and  
23 during, the critical spawning period.

24 Component 2 is intended to improve flow conditions in the Central and South  
25 Delta such that larval and juvenile Delta Smelt could successfully rear in the  
26 Central Delta and move downstream when appropriate. The spring HORB would  
27 be installed only if the USFWS determines Delta Smelt entrainment is not a  
28 concern.

29 Implementation of Component 3 of the 2008 USFWS BO RPA requires the  
30 provision of sufficient Delta outflow to maintain a monthly average X2 no greater  
31 than 74 km in Wet water year types and 81 km in Above Normal water years.  
32 The objective of this component is to improve fall habitat for Delta Smelt through  
33 increasing Delta outflow during fall. Increases in fall habitat quality and quantity  
34 are anticipated to improve conditions for Delta Smelt under the No Action  
35 Alternative. However, implementation of this action would result in reduced  
36 storage in upstream reservoirs which could adversely affect temperature  
37 management in the Sacramento, Feather, and American rivers.

38 Component 4 of the 2008 USFWS BO RPA is intended to improve conditions for  
39 Delta Smelt habitat to supplement the improvements resulting from the flow  
40 actions described above. DWR is required to implement a program to create or  
41 restore a minimum of 8,000 acres of intertidal and associated subtidal habitat in  
42 the Delta and Suisun Marsh. It is assumed under the No Action Alternative that  
43 this requirement would be met by the Suisun Marsh Restoration Program and

1 would result in the restoration of more than 10,000 acres of intertidal and  
2 associated subtidal wetlands in Suisun Marsh and Cache Slough.

3 Implementation of the 2008 USFWS BO RPA would increase the likelihood that  
4 Delta Smelt habitat conditions and attributes for migration, spawning,  
5 recruitment, growth, and survival would be provided under the No Action  
6 Alternative. Implementation of actions under the 2008 USFWS BO RPA to  
7 restore tidally influenced habitat also is expected to increase salmonid and  
8 sturgeon rearing habitat and potentially food production for salmonids and Delta  
9 Smelt. Depending on the amount and type of restoration that would occur in  
10 brackish estuarine areas, restoration could increase rearing habitat for Sacramento  
11 Splittail, and alter conditions for predators and non-native fish species. Spawning  
12 habitat for roach, Hardhead, Sacramento Splittail, and Delta Smelt could be  
13 increased depending on whether restoration occurs in freshwater areas or in  
14 brackish estuarine areas. In addition, habitat restoration has the potential to alter  
15 habitat conditions for some invasive aquatic macrophyte species during some  
16 seasons, and in some locations, which could have indirect effects on predation.

17 Action Suite IV.1 of the 2009 NMFS BO RPA requires continued funding of  
18 monitoring programs at the RBDD, in spring-run Chinook Salmon tributaries to  
19 the Sacramento River, on the Sacramento River at Knights Landing and  
20 Sacramento, and sites within the Delta. In addition, salvage and loss of juvenile  
21 Chinook Salmon would be monitored at the Delta fish collection facilities  
22 operated by the CVP and SWP. A working group, composed of representatives  
23 from Reclamation, DWR, NMFS, USFWS, and CDFW, would develop and  
24 evaluate engineering solutions to reduce adverse impacts on listed fish and their  
25 critical habitat.

26 The DCC gate operations would be modified to reduce loss of emigrating  
27 salmonids and green sturgeon. The operating criteria provide for longer periods  
28 of gate closures during the outmigration season to reduce direct and indirect  
29 mortality of yearling spring-run and winter-run Chinook Salmon, and juvenile  
30 steelhead. Although route selection by Chinook Salmon and the mechanisms  
31 governing selection are complex (Perry et al. (2015), the closure of the DCC gates  
32 may increase the survival of salmonid emigrants through the Delta, and the early  
33 closures could reduce loss of fish with unique and valuable life history strategies  
34 in the spring-run Chinook Salmon and Central Valley steelhead populations.

35 Conditions under the No Action Alternative would be influenced by  
36 implementation of Action Suite IV.2 of the 2009 NMFS BO RPA. This action  
37 suite requires the maintenance of adequate flows in both the Sacramento River  
38 and San Joaquin River basins to increase survival of steelhead emigrating to the  
39 estuary from the San Joaquin River, and of Chinook Salmon, steelhead, and  
40 Green Sturgeon emigrating from the Sacramento River through the Delta to  
41 Chipps Island. This action suite includes actions to reduce the vulnerability of  
42 emigrating steelhead within the lower San Joaquin River to entrainment into the  
43 channels of the South Delta and at the export facilities by increasing the inflow to  
44 export ratio. Cunningham et al. (2015) found a negative influence of the  
45 export/inflow ratio on the survival of fall-run Chinook populations and a negative

1 influence of increased total Delta exports on the survival of spring-run Chinook  
2 populations. In addition, there are actions to enhance the likelihood of salmonids  
3 successfully exiting the Delta at Chipps Island by creating more suitable hydraulic  
4 conditions in the main stem of the San Joaquin River for emigrating fish,  
5 including greater net downstream flows. Historical data suggest that high San  
6 Joaquin River flows in the spring result in higher survival of outmigrating  
7 Chinook Salmon smolts and greater returns of adults. The data also suggest that  
8 when the ratio between spring flows and exports increase, Chinook Salmon  
9 production increases. Increased flows within the San Joaquin River portion of the  
10 Delta could also enhance the survival of Sacramento River salmonids. Those fish  
11 from the Sacramento River that have been diverted through the interior Delta to  
12 the San Joaquin River could benefit by the increased net flow towards the ocean  
13 caused by the higher flows in the San Joaquin River from upstream and the  
14 reduced influence of the export pumps.

15 2009 NMFS BO RPA Action Suite IV.2 also includes flow management for the  
16 Old and Middle rivers that would be implemented in conjunction with the  
17 restrictions on exports under the 2008 USFWS BO RPA. Old and Middle river  
18 flow management is designed to ensure that emigrating steelhead from the San  
19 Joaquin Basin and the east-side tributaries remain in the mainstem of the San  
20 Joaquin River to the greatest extent possible and reduce their exposure to the  
21 adverse effects that are present in the channels leading south toward the export  
22 facilities. This is anticipated to increase the likelihood of survival of steelhead  
23 emigrating from the San Joaquin River. Reducing the risk of diversion into the  
24 central and southern Delta waterways also could increase survival of listed  
25 salmonids and Green Sturgeon entering the San Joaquin River via Georgiana  
26 Slough and the lower Mokelumne River. However, recent coded wire tagging  
27 and acoustic studies have shown survival to be reach specific for both Chinook  
28 Salmon and steelhead and that survival of hatchery-origin (Feather River) juvenile  
29 Chinook Salmon was higher through the south Delta via the Old River route than  
30 via the San Joaquin River (Buchanan et al. 2013, 2015). However, most fish in  
31 the Old River that survived to the end of the Delta had been salvaged from the  
32 federal water export facility on the Old River and trucked around the remainder of  
33 the Delta (Buchanan et al. 2013, SJRGA 2013). Zeug and Cavallo (2014) suggest  
34 that entrainment losses at the diversions may be small relative to overall migration  
35 mortality.

36 The 2009 NMFS BO RPA Action IV.3 requires operations of the Tracy and  
37 Skinner Fish Collection Facilities to be modified according to monitoring data  
38 from upstream of the Delta. In conjunction with the two alerts for closure of the  
39 DCC (Action IV.1.1), a third alert would be used to signal that export operations  
40 may need to be altered due to large numbers of juvenile Chinook Salmon  
41 migrating into the upper Delta region, increasing their risk of entrainment into the  
42 central and south Delta and then to the export pumps. When more fish are  
43 present, more fish are at risk of diversion and losses would be higher. The third  
44 alert is important for real-time operation of the export facilities because the  
45 collection and dissemination of field data to the resource agencies and  
46 coordination of response actions could take several days. This action is designed

1 to work in concert with the Old and Middle River flow management in action  
2 suite IV.2. Under the No Action Alternative, implementation of this action is  
3 anticipated to reduce losses of winter-run and spring-run Chinook Salmon,  
4 steelhead, and Green Sturgeon by reducing exports when large numbers of  
5 juvenile Chinook Salmon are migrating into the upper Delta region.

6 Action Suite IV.4 of the 2009 NMFS BO RPA is designed to increase the  
7 efficiency of the Tracy and Skinner Fish Collection Facilities to improve the  
8 overall salvage survival of winter-run and spring-run Chinook Salmon, steelhead,  
9 and Green Sturgeon to achieve a 75 percent performance goal for whole facility  
10 salvage at both state and Federal facilities. Reclamation and DWR will (1)  
11 conduct studies to evaluate current operations and salvage criteria to reduce take  
12 associated with salvage, (2) develop new procedures and modifications to  
13 improve the current operations, and (3) implement changes to the physical  
14 infrastructure of the facilities where information indicates such changes need to  
15 be made. In addition, Reclamation would continue to fund and implement the  
16 CVPIA Tracy Fish Facility Program. Reclamation and DWR would fund quality  
17 control and quality assurance programs, genetic analysis, louver cleaning loss  
18 studies, release site studies and predation studies. Funding would also be  
19 provided for new studies to estimate Green Sturgeon screening efficiency at both  
20 facilities and survival through the trucking and handling process. Under the No  
21 Action Alternative, implementation of measures to fund fish screens, reduce pre-  
22 screen loss, improve screening efficiency, and improve reporting could reduce  
23 entrainment and salvage, and result in improved survival for juvenile Salmonids  
24 migrating downstream through the Delta, as well as for Sacramento Splittail,  
25 Delta Smelt, and other native fish species.

26 Abundance and habitat conditions for Delta Smelt and other fish species in the  
27 Delta under the No Action Alternative in 2030 are difficult to predict. Abundance  
28 levels for Delta Smelt, Longfin Smelt, Striped Bass, Threadfin Shad, and  
29 American Shad under recent conditions are very low compared to pre-POD levels,  
30 as evidenced by the number of fish collected in sampling programs such as the  
31 FMWT surveys conducted by the IEP. Numbers of fish collected have continued  
32 to decline in recent years, even with implementation of the RPAs. Annual  
33 reviews conducted by the Delta Science Program Independent Review Panel  
34 (IRP) for the Long-Term Operations Biological Opinions have called for better  
35 metrics to measure the effects of the BO RPAs on the protected species (IRP  
36 2011, 2013, 2014) to allow more informed decision-making, while  
37 acknowledging challenges, constraints, and the complexity of the issues.

38 Currently low levels of relative abundance do not bode well for the Delta Smelt or  
39 other fish species in the Delta in 2030. Challenges to fish species in the Delta are  
40 many, and would continue in the future under the No Action Alternative,  
41 including high water temperatures, reduced flows, habitat degradation, barriers,  
42 predation, low DO, contamination, entrainment, salvage, poaching, disease,  
43 competition, non-native species, and lack of available food. Use of observations  
44 on current conditions to predict future long-term changes for Delta fish is  
45 especially challenging when combined with other potentially adverse future

1 changes foreseen for the Delta, e.g., altered hydrology due to drought, rising  
2 temperatures, and potential sea level rise (Sommer and Meija, 2013).

### 3 **9.4.2.2.3 Special Status Species and Critical Habitat**

#### 4 *Clear Creek*

5 Clear Creek is designated critical habitat for spring-run Chinook Salmon and  
6 Central Valley steelhead. The Primary Constituent Element (PCEs) of critical  
7 habitat for both species include freshwater spawning sites, freshwater rearing  
8 areas, and freshwater migration corridors. Spawning and rearing habitat for  
9 spring-run Chinook Salmon in Clear Creek has been negatively affected by flow  
10 and water temperature conditions associated with current operations. As  
11 described above, it is anticipated minimum flows in Clear Creek would be  
12 increased during the fall and winter to improve conditions for spawning  
13 salmonids as a result of recently completed IFIM studies. Continuation of spring  
14 pulse flows (RPA Action I.1.1) and implementation of channel maintenance flows  
15 (RPA Action I.1.2), in conjunction with ongoing gravel augmentation in Clear  
16 Creek, is expected to result in improvements in the PCEs of critical habitat for  
17 spring-run Chinook Salmon and steelhead relative to recent conditions.

#### 18 *Sacramento River*

19 The Sacramento River provides three of the six PCEs essential to support one or  
20 more life stages, including freshwater spawning sites, rearing sites, and migration  
21 corridors for winter-run and spring-run Chinook Salmon and steelhead. The  
22 Sacramento River is also designated critical habitat for the Southern DPS of  
23 Green Sturgeon. Flow and temperature changes under the No Action  
24 Alternative and the effects on spawning and rearing habitat quality were described  
25 previously.

26 Climate change is likely to reduce the conservation value of the spawning habitat  
27 PCE of critical habitat by increasing water temperatures, which would reduce the  
28 availability of suitable spawning habitat. Cold water in Shasta Lake is expected  
29 to be depleted sooner in the summer, impacting winter-run and spring-run  
30 Chinook Salmon spawning habitat. This reduction in an essential feature of the  
31 spawning habitat PCE could reduce the spatial structure, abundance, and  
32 productivity of salmonids. Similarly, as described above, climate change is likely  
33 to reduce availability of rearing habitat, and in turn, the value of the rearing  
34 habitat PCE of critical habitat, by increasing water temperatures.

35 The year-round opening of the gates at the RBDD in accordance with Action  
36 Suite I.3 of the 2009 NMFS BO RPA allows salmonids to pass unimpeded,  
37 enhancing the conservation value of the PCE for migration. Critical habitat for  
38 Green Sturgeon would also improve from unimpeded access to suitable spawning  
39 habitat upstream of the RBDD. The improved passage at the RBDD location is  
40 expected to increase the number of deep holding pools that adult Green Sturgeon  
41 can access, thereby increasing the conservation value of the water depth PCE. In  
42 addition, predation on salmon, steelhead, and sturgeon would be reduced relative  
43 to conditions when the RBDD was operational.

1 *American River*

2 The lower American River downstream of Nimbus Dam is designated critical  
3 habitat for Central Valley steelhead. The PCEs of critical habitat in the lower  
4 American River include freshwater spawning sites, freshwater rearing areas, and  
5 freshwater migration corridors. Flow and temperature changes under the No  
6 Action Alternative and the effects on spawning and rearing habitat quality were  
7 described previously. In addition, the influence of climate change is expected to  
8 alter hydrologic and temperature conditions in the region and could adversely  
9 affect the PCEs for Central Valley steelhead critical habitat in the American  
10 River, primarily through increased water temperatures.

11 *Stanislaus River*

12 The lower Stanislaus River downstream of Goodwin Dam is designated critical  
13 habitat for Central Valley steelhead. The PCEs of critical habitat in the Stanislaus  
14 River include freshwater spawning sites, freshwater rearing areas, and freshwater  
15 migration corridors. Flow and temperature changes under the No Action  
16 Alternative and the effects on spawning and rearing habitat quality were described  
17 previously. The PCEs for spawning and rearing habitat have been adversely  
18 affected by elimination of geomorphic processes that replenish and rejuvenate  
19 spawning riffles and inundate floodplain terraces to provide nutrients and rearing  
20 habitat for juvenile salmonids. In addition, moderation of flood events also  
21 eliminates or reduces the intensity and duration of freshets and storm flows,  
22 which adversely affects the PCE for migration corridors. The influence of climate  
23 change could begin to alter hydrologic and temperature conditions in the region  
24 and adversely affect the PCEs for Central Valley steelhead critical habitat in the  
25 Stanislaus River, primarily through increased water temperatures.

26 *Delta*

27 Critical habitat for both winter-run and spring-run Chinook Salmon is designated  
28 in the Sacramento River adjacent to the location of the DCC gates. The DCC is  
29 specifically not included in designated critical habitat for winter-run Chinook  
30 Salmon because the biological opinions issued by NMFS in 1992 and 1993  
31 included measures on the operations of the gates that were designed to exclude  
32 winter-run Chinook Salmon from the channel and the waters of the Central Delta.  
33 However, for spring-run Chinook Salmon, designated critical habitat does include  
34 the DCC from its point of origin on the Sacramento River to its terminus at  
35 Snodgrass Slough, including the location of the gates. Designated critical habitat  
36 for Central Valley steelhead includes most of the Delta and its waterways, but not  
37 the DCC waterway.

38 Operation of the DCC gates affects the PCEs for critical habitat designated for  
39 these species. Primarily, DCC gate operations interfere with the use of the  
40 Sacramento River as a migratory corridor for Chinook Salmon and steelhead  
41 juveniles during their downstream migration from spawning grounds upstream of  
42 the Delta to San Francisco Bay and the Pacific Ocean. The operation of the gates  
43 permits fish to enter habitat and waterways they would not normally access, with  
44 substantially higher predation risks than the migratory corridor available in the  
45 Sacramento River channel. Under the No Action Alternative, operation of the

1 gates could have a direct effect on the entrainment rate and hence the functioning  
2 of the Sacramento River as a migratory corridor.

#### 3 **9.4.2.2.4 Effects Related to Cross Delta Water Transfers**

4 Because all water transfers would be required to avoid adverse impacts to other  
5 water users and biological resources (see Section 3.A.6.3, Transfers), including  
6 impacts associated with changes in reservoir storage and river flow patterns.  
7 Potential effects to aquatic resources could be similar to those identified in a  
8 recent environmental analysis conducted by Reclamation for long-term water  
9 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014d).  
10 Potential effects were identified as changes to fish in the reservoirs and in the  
11 rivers downstream of the reservoirs and the Delta. The analysis indicated that the  
12 reservoirs did not support primary populations of fish species of management  
13 concern, and that the reservoirs would continue to be operated within the  
14 historical range of operations. The analysis also indicated that mean monthly  
15 flows in the major rivers or creeks in the Sacramento and San Joaquin rivers  
16 watersheds would be similar (less than 10 percent change) with water transfers as  
17 compared to without water transfers; and therefore, changes to aquatic resources  
18 would be less than substantial. Delta conditions also would be similar with water  
19 transfers as compared to without water transfers, including less than 5 percent  
20 changes in Delta exports and less than 1.3 percent changes in Delta outflow and  
21 X2 position. Therefore, changes to aquatic resources would be less than  
22 substantial. For the purposes of this EIS, it is anticipated that similar conditions  
23 would occur due to cross Delta water transfers under the No Action  
24 Alternative and the Second Basis of Comparison.

25 Under the No Action Alternative, the timing of cross Delta water transfers would  
26 be limited to July through September in accordance with the 2008 USFWS BO  
27 and 2009 NMFS BO. The maximum amount of water to be transferred would be  
28 600,000 acre-feet/year in critical dry years or in dry years following a dry or  
29 critical dry year. In all other water year types, the maximum amount of water  
30 would be 360,000 acre-feet/year.

#### 31 **9.4.2.2.5 Conditions for Fish Passage**

32 As described in Chapter 3, Description of Alternatives, the No Action  
33 Alternative includes a suite of RPA actions intended to examine the  
34 reintroduction of salmonids into historical habitats upstream of currently  
35 impassable artificial barriers. The actions include consideration for passage of  
36 winter-run and spring-run Chinook Salmon, and steelhead above Shasta Dam on  
37 the Sacramento River, steelhead above Nimbus and Folsom dams on the  
38 American River, and steelhead above Goodwin, Tulloch, and New Melones dams  
39 on the Stanislaus River. The action suite outlines multiple planning and  
40 implementation steps to evaluate the efficacy of passage before long-term fish  
41 passage is provided. However, for the purposes of the describing the No Action  
42 Alternative, fish passage at each of these facilities (likely through interim means)  
43 is assumed to be functional by 2030.



1 As described in the Affected Environment, Reclamation is currently developing  
2 near-term and long-term fish passage solutions to provide access by anadromous  
3 salmonids to habitat upstream of Shasta Lake (2009 NMFS BO RPA  
4 Action I.2.5). The evaluation includes assessments of amount, suitability, and  
5 location of potential habitat, potential risks (e.g., predation by resident fish,  
6 disease transmission), as well as feasibility of providing upstream and  
7 downstream passage. There are approximately 60 mainstem miles and the  
8 McCloud River upstream of Shasta Lake. Reclamation (2014c) estimated  
9 approximately 9 river-miles of suitable winter-run Chinook Salmon spawning  
10 habitat in the upper Sacramento River below Box Canyon Dam, and  
11 approximately 12 river-miles of suitable spawning habitat for winter-run Chinook  
12 Salmon in the McCloud River below McCloud Dam. By 2030, access to this  
13 habitat could not only expand the amount of habitat available for winter-run  
14 Chinook Salmon relative to recent conditions, but provide access to areas of  
15 temperature refuge at a time when water temperatures in the river downstream of  
16 Keswick Dam are anticipated to increase. This could be particularly beneficial as  
17 winter-run Chinook Salmon are currently at high risk of extinction. Extinction  
18 factors include: winter-run Chinook Salmon is composed of only one population,  
19 which has been blocked from all of its historic spawning habitat; the potential for  
20 catastrophic risks associated with proximity to Mt. Lassen and the population's  
21 dependency on the cold water management of Shasta Lake; and the population  
22 has a "high" hatchery influence (Lindley et al. 2007). Combined with  
23 improvements on Battle Creek that are expected to support a second population  
24 component of winter-run Chinook Salmon, the provision for fish passage  
25 upstream of Shasta Dam may support a third population, which is consistent with  
26 the NMFS Recovery Plan for this species (NMFS 2014b).

27 Similarly, conditions for steelhead in the American River could be influenced by  
28 fish passage at Nimbus and Folsom dams afforded by implementation of 2009  
29 NMFS BO RPA Action II.5. As described in the Affected Environment, water  
30 temperature conditions in the lower American River downstream of Nimbus Dam  
31 currently present challenges for steelhead, especially rearing juveniles. Under the  
32 No Action Alternative, anticipated increases in temperature related to climate  
33 change could increase the vulnerability of steelhead to serious effects of elevated  
34 temperatures in most years, particularly in dry and critical dry years, even if  
35 actions are taken to improve temperature management. The provision of passage  
36 to upstream reaches of the American River, including tributaries, would give  
37 steelhead access to former spawning and rearing habitat higher in the system  
38 where water temperatures are cooler and remain cooler during the summer  
39 months. Assuming this action results in fish passage by 2030, conditions for  
40 steelhead are expected to improve because of the increased amount of available  
41 habitat and the ability to access cooler water temperatures.

42 Relative to recent conditions, substantial improvements also would be expected  
43 for steelhead on the Stanislaus River under the No Action Alternative, if 2009  
44 NMFS BO RPA Action II.2.4 is determined feasible and is implemented by 2030.  
45 As described in the Affected Environment, steelhead in the Stanislaus River are  
46 exposed to multiple stressors, including high water temperatures during adult

1 immigration, embryo incubation, juvenile rearing, and smolt outmigration. In  
 2 addition, flow-dependent habitat availability is limited, particularly for the  
 3 spawning, juvenile rearing, and smolt outmigration life stages. Access to former  
 4 habitat in upstream areas under the No Action Alternative are anticipated to  
 5 reduce many of the stressors associated with recent conditions and could provide  
 6 improved resilience to climate change.

#### 7 **9.4.2.2.6 Ocean Conditions**

8 Operation of the CVP and SWP would not directly affect ocean conditions;  
 9 however, operations have the potential to affect Southern Resident Killer Whales  
 10 indirectly by influencing the number of Chinook Salmon (produced in the  
 11 Sacramento-San Joaquin River and associated tributaries) that enter the Pacific  
 12 Ocean and become available as a food supply for the whales. The No Action  
 13 Alternative would not directly affect critical habitat for Killer Whales. However,  
 14 under the No Action Alternative, production of wild Chinook Salmon could  
 15 increase with increased area and quality of habitat for Chinook Salmon, as  
 16 discussed previously. Chinook Salmon from the Central Valley rivers and  
 17 streams likely represent only a very small proportion of the diet of this Killer  
 18 Whale population because most of their feeding is on Fraser River and Puget  
 19 Sound stocks (Hanson et al. 2010). Therefore, any increase in the population of  
 20 Chinook Salmon originating from the Central Valley under the No Action  
 21 Alternative is not expected to substantially influence the Southern Resident Killer  
 22 Whale population.

#### 23 **9.4.2.3 Second Basis of Comparison**

24 As described in Chapter 3, Description of Alternatives, the Second Basis of  
 25 Comparison is based upon:

- 26 • Coordinated long-term operation of the CVP and SWP in 2030 without  
 27 implementation of the 2008 USFWS BO and the 2009 NMFS BO RPAs
- 28 • Changes in CVP and SWP operations due to climate change and sea level rise,  
 29 and increased CVP and water rights water demand in portions of the  
 30 Sacramento Valley
- 31 • Implementation of reasonable and foreseeable non-CVP and -SWP water  
 32 resources projects to provide additional water supplies, as described in  
 33 Section 7.4.3.1, No Action Alternative
- 34 • Implementation of RPA actions that address programs and projects that were  
 35 ongoing prior to issuance of the 2008 USFWS BO and 2009 NMFS BO,  
 36 including restoration of Battle Creek for salmonids; replacement of the Red  
 37 Bluff Diversion Dam; restoration of more than 10,000 acres of intertidal and  
 38 associated subtidal wetlands in Suisun Marsh and Cache Slough; and  
 39 17,000 to 20,000 acres of seasonal floodplain restoration in the Yolo Bypass.

40 Overall, under the Second Basis of Comparison, long-term average CVP and  
 41 SWP water supply deliveries by 2030 through the Delta would increase, and late  
 42 summer and fall reservoir storage probably would decrease as compared to recent

1 historical conditions without consideration for climate change. However, the  
2 Second Basis of Comparison also includes changes not related to the coordinated  
3 long-term operation of the CVP and SWP, including changes in CVP and SWP  
4 operations due to climate change and sea level rise, increased CVP and water  
5 rights water demand in portions of the Sacramento Valley, and implementation of  
6 reasonable and foreseeable non-CVP or SWP water resources management  
7 projects to provide water supplies, as described under the No Action Alternative.  
8 Therefore, primarily due to climate change, both CVP and SWP reservoir storage  
9 and long-term average CVP and SWP water supply deliveries would decrease by  
10 2030 as compared to historical long-term average deliveries.

11 Under the Second Basis of Comparison it is assumed that fish and aquatic  
12 resources in 2030 would continue to be influenced by CVP and SWP operations.  
13 The resulting changes in ecological attributes and subsequent effects on aquatic  
14 resources would vary geographically, as described below.

#### 15 **9.4.2.3.1 Trinity River Region**

##### 16 *Aquatic Habitat Conditions in CVP and SWP Reservoirs*

17 End of September reservoir storage in Trinity Lake would be lower by 2030 as  
18 compared to recent historical conditions due to climate change and related lower  
19 snowfall. Lewiston Reservoir, a regulating reservoir, would be operated with  
20 daily changes similar to historical conditions. These changes are not anticipated  
21 to substantially affect aquatic resources in Trinity Lake or Lewiston Reservoir  
22 relative to recent historical conditions.

##### 23 *Fish Habitat Conditions in Trinity and Lower Klamath Rivers*

24 Under the Second Basis of Comparison, flow, water temperature, and aquatic  
25 habitat conditions in the Trinity River would continue to be influenced by CVP  
26 and SWP operations as described in the Affected Environment. Due to the  
27 increased potential for lower Trinity Lake surface water storage (see above), there  
28 could be an increased potential for reduced Trinity River flows during the summer  
29 and fall months under the Second Basis of Comparison as compared to recent  
30 historical conditions. The influence of climate change could result in higher  
31 water temperatures in Trinity Lake that could translate to higher release  
32 temperatures in the flow releases from Lewiston Dam and a reduction in habitat  
33 quality within the Trinity River for salmonids and other native species.

##### 34 *Effects Related to Water Transfers*

35 It is not anticipated that water would be transferred to or from the Trinity River  
36 Region. It also not anticipated that water transfers would result in changes to  
37 Trinity Lake operations. Therefore, there would be no change in aquatic habitat  
38 conditions as a result of water transfers.

#### 39 **9.4.2.3.2 Central Valley Region**

##### 40 *Aquatic Habitat Conditions in CVP and SWP Reservoirs*

41 Seasonal changes in reservoir surface elevations, storage volumes, and the volume  
42 of cold water held within the reservoirs would continue under the Second Basis of

1 Comparison. Conditions for reservoir fishes would continue to change seasonally  
 2 in response to inflow and downstream flow releases to meet demand. End of  
 3 September reservoir storage would be lower by 2030 as compared to recent  
 4 historical conditions in Shasta Lake, Lake Oroville, Folsom Lake, New Melones  
 5 Reservoir, and San Luis Reservoir due to climate change and related lower  
 6 snowfall. Whiskeytown Lake, Keswick Reservoir, Thermalito Forebay and  
 7 Afterbay, and Lake Natoma are regulating reservoirs and would be operated with  
 8 daily changes similar to historical conditions.

9 Under the Second Basis of Comparison, the magnitude of changes in seasonal  
 10 surface elevation and reservoir storage could be more pronounced because of  
 11 changes in the timing and intensity of storm events due to climate change and an  
 12 overall reduction in snow pack. By 2030, fish in these reservoirs that spawn in  
 13 shallow water (e.g., various species of black bass) could be subject to a  
 14 hydrologic regime that increases the frequency of reductions in surface elevation  
 15 during the spring spawning period, reducing spawning success. In addition,  
 16 reduced storage volumes and reduction of the cold water pools could reduce the  
 17 amount and suitability of habitat for cold water fishes (e.g., trout) within the  
 18 reservoirs relative to recent historical conditions.

19 *Aquatic Habitat Conditions in Rivers Downstream of CVP and SWP Facilities*

20 Surface water flows are anticipated to increase during the winter months as a  
 21 result of an increase in rainfall and decrease in snowfall, and to decrease in other  
 22 months because of the diminished snowmelt flows in the spring and early summer  
 23 months. Climate change is anticipated to result in higher water temperatures  
 24 during portions of the year, with a corresponding reduction in habitat quality for  
 25 salmonids and other cold water fishes. Increased downstream water demands and  
 26 climate change are anticipated to contribute to an inability to maintain an  
 27 adequate cold water pool in critical dry years and extended dry periods in the  
 28 future.

29 *Aquatic Habitat Conditions in Clear Creek from Whiskeytown Dam to*  
 30 *Sacramento River*

31 Under the Second Basis of Comparison, flow, water temperature, and aquatic  
 32 habitat conditions in Clear Creek would continue to be influenced by CVP and  
 33 SWP operations. Whiskeytown Reservoir would continue to be operated to  
 34 convey water from the Trinity River to the Sacramento River via the Spring Creek  
 35 tunnel and to release flows to Clear Creek to support anadromous fish.

36 The Second Basis of Comparison assumes that one of the 2009 NMFS BO RPA  
 37 actions intended to improve conditions for salmonids would be implemented,  
 38 2009 NMFS BO RPA Action I.3 Spawning Gravel Augmentation, which is  
 39 currently being implemented as part of the CVPIA. This action addresses the  
 40 limited availability of spawning habitat in Clear Creek through the placement of  
 41 gravel in selected sites in the creek. The gravel augmentation program is  
 42 expected to continue under the Second Basis of Comparison, resulting in  
 43 continued improvements to physical spawning habitat for steelhead, and spring-  
 44 run and fall-run Chinook Salmon by 2030.

1 Water temperatures in Clear Creek are influenced by the temperature of water in  
2 the Whiskeytown Reservoir, ambient air temperatures, and solar radiation, and to  
3 some extent the magnitude of Whiskeytown Dam release flows. As described  
4 above for the No Action Alternative, Whiskeytown Dam has limited temperature  
5 control capabilities; however, the Spring Creek Temperature Control Curtain  
6 continues to be operated under the Second Basis of Comparison. With increasing  
7 ambient air temperature and changes in precipitation patterns as result of global  
8 warming, it may not be possible to meet the temperature targets as often in 2030  
9 under the Second Basis of Comparison relative to recent conditions.

10 *Aquatic Habitat Conditions in the Sacramento River from Keswick to*  
11 *Freeport*

12 Under the Second Basis of Comparison, flow, water temperature, and aquatic  
13 habitat conditions in the Sacramento River downstream of Keswick Dam would  
14 continue to be influenced by CVP and SWP operations. Shasta Lake would  
15 continue to be operated to convey water from the Sacramento River to the Delta  
16 and release flows to the Sacramento River to support anadromous fish.  
17 Reclamation would continue to operate Shasta Lake to optimize use of the cold  
18 water pool and maintain carryover storage for temperature control in the  
19 Sacramento River downstream of Shasta and Keswick dams. As described above  
20 for the No Action Alternative, it is likely that temperature-related effects in the  
21 Sacramento River under the Second Basis of Comparison also would be  
22 unavoidable in some years; however, restoration of habitat in Battle Creek (see  
23 below) may compensate for these periods of unavoidably high temperatures by  
24 providing passage and habitat conditions to support a second population of  
25 winter-run Chinook Salmon.

26 The Red Bluff Pumping Plant and fish screen, which diverts water to the Tehama  
27 Colusa Canal and Corning Canal, was constructed to allow year-round opening of  
28 the gates at the RBDD. Allowing the dam gates at RBDD to remain open allows  
29 salmonids, sturgeon, and other fish species to pass unimpeded all year. These  
30 passage improvements are anticipated to improve conditions for fish species that  
31 spawn upstream of RBDD through improved access to spawning and rearing  
32 areas and a reduction in predation due to dispersal of predator species like Striped  
33 Bass and Sacramento Pikeminnow.

34 As described above for the No Action Alternative, it is anticipated that worsening  
35 temperature conditions under the Second Basis of Comparison would occur in  
36 some years as a result of increased demands for water by 2030, climate change,  
37 and less water being diverted from the Trinity River. Continued implementation  
38 of the Battle Creek Restoration Program would partially compensate for  
39 unavoidable adverse effects by restoring winter-run and spring-run Chinook  
40 Salmon habitat to the Battle Creek watershed. Full implementation of the Battle  
41 Creek Restoration Program is expected to substantially improve passage  
42 conditions for adult Chinook Salmon and steelhead relative to recent conditions.  
43 The Battle Creek Restoration Program has a goal of improving habitat for a  
44 second population component of winter-run Chinook Salmon, which could reduce

1 the risk of extinction of the species from lost resiliency and increased  
2 vulnerability to catastrophic events.

3 *Aquatic Habitat Conditions in the Feather River from Oroville Dam to*  
4 *Sacramento River*

5 Feather River flows in the high flow channel downstream of Thermalito Dam  
6 under the Second Basis of Comparison would be influenced by regulation to meet  
7 water temperature criteria and to coordinate Lake Oroville releases and Delta  
8 export operations. Flows in the low flow channel downstream of Lake Oroville  
9 would remain similar to recent conditions. As part of the ongoing FERC  
10 relicensing process for the Oroville facilities, DWR has entered into a Settlement  
11 Agreement (DWR 2006) that includes actions to be implemented and included as  
12 terms of the anticipated FERC license. Depending on the progress of the  
13 relicensing process, these actions could be implemented by 2030 under the  
14 Second Basis of Comparison and could improve fish habitat conditions in the  
15 Feather River relative to recent conditions.

16 Under the terms of the Settlement Agreement, DWR will develop a  
17 comprehensive Lower Feather River Habitat Improvement Plan. Implementation  
18 of the habitat improvement plan and other actions under the terms of the  
19 Settlement Agreement is anticipated to improve habitat conditions and water  
20 quality for salmonids and other fishes using the channels of the Feather River  
21 above the confluence with the Sacramento River under the Second Basis of  
22 Comparison.

23 *Aquatic Habitat Conditions in the American River from Nimbus Dam to*  
24 *Sacramento River*

25 Reclamation releases water to the lower American River consistent with flood  
26 control requirements; existing water rights; CVP operations; the Lower American  
27 River Flow Management Standard; and SWRCB Decision 893 (D-893). Under  
28 the Second Basis of Comparison, American River flows would be influenced by  
29 releases for regulation to meet water temperature criteria, and to coordinate timed  
30 Folsom Lake releases and Delta exports. It is anticipated that conditions for fish  
31 in the lower American River under the Second Basis of Comparison would  
32 worsen relative to recent past operations of the American River Division of the  
33 CVP because of continued operation of the American River Division through  
34 2030 to meet increasing water demands. In addition, the influence of climate  
35 change could alter hydrologic conditions in the region and affect habitat  
36 conditions for fish in the American River.

37 Through 2030, Reclamation would implement the flow schedule specified in the  
38 American River Flow Management Standard. The flow schedule specifies  
39 minimum flows and does not preclude Reclamation from making higher releases  
40 at Nimbus Dam. The flow schedule was developed to require more protective  
41 minimum flows in the lower American River in consideration of the river's  
42 aquatic resources, particularly steelhead and fall-run Chinook Salmon.

1        *Aquatic Habitat Conditions in the San Joaquin River from Friant Dam to the*  
2        *Stanislaus River*

3        Under the Second Basis of Comparison, fish and aquatic habitat conditions in the  
4        San Joaquin River downstream of Friant Dam would remain similar to those  
5        described under the Affected Environment, although water temperatures could  
6        increase as a result climate change.

7        *Aquatic Habitat Conditions in the Stanislaus River from Goodwin Dam to San*  
8        *Joaquin River*

9        Under the Second Basis of Comparison, flow, water temperature, and aquatic  
10       habitat conditions in the Stanislaus River downstream of Goodwin Dam would  
11       continue to be influenced by CVP and SWP operations as described in Chapter 5,  
12       Surface Water Resources and Water Supplies. However, by 2030, conditions for  
13       fish in the Stanislaus River fish are expected to worsen relative to recent  
14       conditions because of continued operation to meet increasing water demands.  
15       In addition, the influence of climate change is expected to begin to alter  
16       hydrologic conditions in the region and affect habitat conditions for fish in the  
17       Stanislaus River.

18       Under the Second Basis of Comparison, management of the cold water supply  
19       within New Melones Reservoir would continue, as would cold water releases  
20       from the reservoir to provide suitable temperatures for steelhead rearing,  
21       spawning, egg incubation smoltification, and adult migration in the Stanislaus  
22       River downstream of Goodwin Dam. There are no temperature control devices at  
23       New Melones, Goodwin, or Tulloch dams, so the only mechanism for temperature  
24       management is direct flow management. This has been achieved in the recent  
25       past through a combination of augmenting baseline water operations for meeting  
26       senior water right deliveries and D-1641 water quality standards with additional  
27       flows from: 1) the CDFW fish agreement, and 2) from b(2) or b(3) water  
28       acquisitions. Access to these resources to offset operational temperature effects  
29       on steelhead in the Stanislaus River would continue to be limited, particularly in  
30       Conference Years and in drier Mid-Allocation Years. Under the Second Basis of  
31       Comparison, steelhead would likely continue to be vulnerable to the effects of  
32       elevated temperatures in dry and critical dry years. The frequency of these  
33       occurrences is expected to increase with climate change and increased water  
34       demands.

35       Reclamation would continue to operate releases from the East Side Division  
36       reservoirs to achieve the minimum flow schedule specified in the 1997 New  
37       Melones Interim Plan of Operations as described in Chapter 5, Surface Water  
38       Resources and Water Supplies. Because this flow schedule has been in place for  
39       a number of years, habitat conditions for steelhead and other fish species in the  
40       Stanislaus River are not anticipated to improve under the Second Basis of  
41       Comparison relative to recent conditions.

42       Dam operations would continue to suppress channel-forming flows that replenish  
43       spawning beds. The physical presence of the dams impedes normal sediment  
44       transportation processes. Climate change may affect the types and cover rates of

1 vegetation upslope of the river, potentially increasing the rate of fine sediment  
 2 transport to the river and to spawning areas Ongoing gravel augmentation through  
 3 2030 is anticipated to maintain or improve physical spawning habitat conditions  
 4 for steelhead.

5 *Aquatic Habitat Conditions in the Yolo Bypass (including Cache Slough,*  
 6 *Lower Putah Creek, and Fremont Weir)*

7 Similar to the No Action Alternative, it is assumed under the Second Basis of  
 8 Comparison that restoration of up to 20,000 acres of seasonal floodplain  
 9 restoration in the Yolo Bypass would occur by 2030. Actions in the Yolo Bypass  
 10 also would include improvements in fish passage at Fremont Weir for  
 11 anadromous salmonids, sturgeon, and other native fish species. Implementation  
 12 of these ecosystem restoration actions and improvements could increase winter  
 13 and spring growth and survival (relative to recent conditions) of juvenile Chinook  
 14 Salmon, steelhead, and other native fish by providing increased seasonal access to  
 15 productive foraging and high quality rearing habitat, depending on the extent and  
 16 duration of restoration and inundation. These actions are also expected to reduce  
 17 migratory delays or losses by reducing predation, straying, and delays for  
 18 salmonids and other migratory native fish species.

19 *Aquatic Habitat Conditions in the Delta*

20 As described in Chapter 3, Description of Alternatives, the Second Basis of  
 21 Comparison is based on coordinated long-term operation of the CVP and SWP in  
 22 2030 without implementation of the 2008 USFWS BO and the 2009 NMFS BO  
 23 RPAs. Similar to the No Action Alternative, reasonable and foreseeable non-  
 24 CVP and -SWP water resources projects to provide additional water supplies  
 25 would be implemented, in addition to restoration of more than 10,000 acres of  
 26 intertidal and associated subtidal wetlands in Suisun Marsh and Cache Slough;  
 27 and up to 20,000 acres of seasonal floodplain restoration in the Yolo Bypass.

28 Under the Second Basis of Comparison, flows, water quality, and aquatic habitat  
 29 conditions in the Delta would continue to be influenced by CVP and SWP  
 30 operations. Climate change would result in increased stream flows in the winter  
 31 and spring months during storm events due to precipitation primarily occurring as  
 32 rain instead of snowfall. The increased stream flows also would increase Delta  
 33 outflow. Delta outflow also would be increased in the spring and summer months  
 34 as more water is released from the CVP and SWP reservoirs to maintain salinity  
 35 criteria in the western Delta in response to sea level rise.

36 Under the Second Basis of Comparison in 2030, many years will have passed  
 37 without seasonal limitations on OMR reverse (negative) flow rates, with the  
 38 anticipated result that fish entrainment would occur at levels comparable to recent  
 39 historical conditions. Future pumping operations would continue to expose fish to  
 40 the salvage facilities and entrainment losses into the future. As described above  
 41 for the No Action Alternative, recent coded wire tagging and acoustic studies  
 42 have shown that survival of hatchery-origin juvenile Chinook Salmon was higher  
 43 through the south Delta via the Old River route than via the San Joaquin River  
 44 and that this may be due to increased survival during salvage at the facilities



1 (Buchanan et al. 2013, 2015; SJRGA 2013). Zeug and Cavallo (2014) suggest  
2 that entrainment losses at the diversions may be small relative to overall migration  
3 mortality.

4 Furthermore, operation of the permanent gates would lead to losses associated  
5 with predation at the physical structures and the local and far-field hydraulic  
6 conditions created by the barriers. Under the Second Basis of Comparison,  
7 significant reductions in the abundance of steelhead and fall-run Chinook Salmon  
8 originating in the San Joaquin River basin, (as well as the Calaveras River and  
9 Mokelumne River basins) are likely to continue.

10 As described above for the No Action Alternative, abundance levels for Delta  
11 Smelt, Longfin Smelt, Striped Bass, Threadfin Shad, and American Shad are  
12 currently very low, and abundance and habitat conditions for fish in the Delta in  
13 future years are difficult to predict. It is not likely that operations of the CVP and  
14 SWP under the Second Basis of Comparison would result in improvement of  
15 habitat conditions in the Delta or increases in populations for these fish by 2030,  
16 and the recent trajectory of loss would likely continue.

### 17 **9.4.2.3.3 Special Status Species and Critical Habitat**

#### 18 *Clear Creek*

19 Clear Creek is designated critical habitat for spring-run Chinook Salmon and  
20 Central Valley steelhead. The PCEs of critical habitat for both species include  
21 freshwater spawning sites, freshwater rearing areas, and freshwater migration  
22 corridors. Spawning and rearing habitat for spring-run Chinook Salmon in Clear  
23 Creek has been negatively affected by flow and water temperature conditions  
24 associated with current operations. Under the Second Basis of Comparison, there  
25 would be little change in the PCEs of critical habitat for spring-run Chinook  
26 Salmon and Central Valley steelhead relative to recent conditions. Ongoing  
27 gravel augmentation in Clear Creek will likely result in improvements to Chinook  
28 Salmon and steelhead physical spawning habitat in Clear Creek. However, due to  
29 climate change, the conservation value of critical habitat for these species will  
30 likely be reduced under the Second Basis of Comparison by 2030, particularly in  
31 drier years when cold water releases cannot be maintained from  
32 Whiskeytown Dam.

#### 33 *Sacramento River*

34 The Sacramento River provides three of the six PCEs essential to support one or  
35 more life stages, including freshwater spawning sites, rearing sites, and migration  
36 corridors for winter-run Chinook Salmon, spring-run Chinook Salmon, and  
37 Central Valley steelhead. The Sacramento River is also designated critical habitat  
38 for the Southern DPS of green sturgeon. Flow and temperature changes under the  
39 Second Basis of Comparison and the effects on spawning and rearing habitat  
40 quality were described previously.

41 As described above for the No Action Alternative, climate change is likely to  
42 reduce the conservation value of the spawning and rearing habitat PCEs of critical  
43 habitat by increasing water temperatures. The reduction in essential features of

1 the spawning and rearing habitat PCEs could reduce the spatial structure,  
2 abundance, and productivity of salmonids.

3 The year-round opening of the gates at the RBDD allows salmonids to pass  
4 unimpeded, enhancing the conservation value of the PCE for migration. Critical  
5 habitat for green Sturgeon would also improve from unimpeded access to suitable  
6 spawning habitat upstream of the RBDD. The improved passage at the RBDD  
7 will increase the number of deep holding pools that adult Green Sturgeon can  
8 access, thereby increasing the conservation value of the water depth PCE. In  
9 addition, as described above, predation on salmon, steelhead, and sturgeon would  
10 be reduced relative to recent conditions when the RBDD was operational.

11 The No Action Alternative includes implementation of the CVPIA AFSP to  
12 reduce entrainment of juvenile anadromous fish from unscreened diversions. By  
13 providing funding to screen priority diversions as identified in the CVPIA AFSP,  
14 the loss of listed fish in water diversion channels by 2030 could be reduced. In  
15 addition, if new fish screens can be constructed so that diversions can occur at  
16 low water surface elevations to allow diversions below a flow of 5,000 cfs at  
17 Wilkins Slough, then cold water at Shasta Lake could be conserved during critical  
18 dry years for release to support winter-run and spring-run Chinook Salmon needs  
19 downstream.

#### 20 *American River*

21 The lower American River downstream of Nimbus Dam is designated critical  
22 habitat for Central Valley steelhead. The PCEs of critical habitat in the lower  
23 American River include freshwater spawning sites, freshwater rearing areas, and  
24 freshwater migration corridors. Flow and temperature changes under the Second  
25 Basis of Comparison and the effects on spawning and rearing habitat quality were  
26 described previously. In addition, the influence of climate change is expected to  
27 alter hydrologic and temperature conditions in the region and adversely affect the  
28 PCEs for Central Valley steelhead critical habitat in the American River,  
29 primarily through increased water temperatures.

#### 30 *Stanislaus River*

31 The lower Stanislaus River downstream of Goodwin Dam is designated critical  
32 habitat for Central Valley steelhead. The PCEs of critical habitat in the Stanislaus  
33 River include freshwater spawning sites, freshwater rearing areas, and freshwater  
34 migration corridors. Flow and temperature changes under the Second Basis of  
35 Comparison and the effects on spawning and rearing habitat quality were  
36 described previously. The PCEs for spawning and rearing habitat have been  
37 adversely affected by elimination of geomorphic processes that replenish and  
38 rejuvenate spawning riffles and inundate floodplain terraces to provide nutrients  
39 and rearing habitat for juvenile salmonids. In addition, moderation of flood  
40 events also eliminates or reduces the intensity and duration of freshets and storm  
41 flows, which adversely affects the PCE for migration corridors. The influence of  
42 climate change could begin to alter hydrologic and temperature conditions in the  
43 region and adversely affect the PCEs for Central Valley steelhead critical habitat  
44 in the Stanislaus River, primarily through increased water temperatures.

1 *Delta*

2 As described above for the No Action Alternative, designated critical habitat for  
3 both winter-run and spring-run Chinook Salmon lies adjacent to the location of  
4 the DCC gates and designated critical habitat for spring-run Chinook Salmon  
5 includes the DCC from its point of origin on the Sacramento River to its terminus  
6 at Snodgrass Slough. Designated critical habitat for Central Valley steelhead  
7 includes most of the Delta and its waterways; however, the DCC waterway was  
8 not included in designated critical habitat for this species.

9 Operation of the DCC gates under the Second Basis of Comparison will continue  
10 to affect the PCEs for critical habitat designated for spring-run Chinook Salmon  
11 and steelhead, primarily, the use of the Sacramento River as a migratory corridor.  
12 The operation of the gates permits fish to enter habitat and waterways they would  
13 not normally have access to with substantially higher predation risks than the  
14 migratory corridor available in the Sacramento River channel. Operation of the  
15 gates can have a direct effect on the entrainment rate and hence the functioning of  
16 the Sacramento River as a migratory corridor. Without the modifications to DCC  
17 gate operations to reduce loss of emigrating salmonids and green sturgeon  
18 described for the No Action Alternative, entrainment in the DCC will continue to  
19 be similar to recent historical conditions.

20 **9.4.2.3.4 Effects Related to Cross Delta Water Transfers**

21 As described under the No Action Alternative, all water transfers would be  
22 required to avoid adverse impacts to other water users and biological resources  
23 (see Section 3.A.6.3, Transfers), including impacts associated with changes in  
24 reservoir storage and river flow patterns. Potential effects to aquatic resources  
25 could be similar to those identified in a recent environmental analysis conducted  
26 by Reclamation for long-term water transfers from the Sacramento to San Joaquin  
27 valleys (Reclamation 2014d). Potential effects were identified as changes to fish  
28 in the reservoirs and in the rivers downstream of the reservoirs and the Delta. The  
29 analysis indicated that the reservoirs did not support primary populations of fish  
30 species of management concern, and that the reservoirs would continue to be  
31 operated within the historical range of operations. The analysis also indicated that  
32 mean monthly flows in the major rivers or creeks in the Sacramento and San  
33 Joaquin rivers watersheds would be similar (less than 10 percent change) with  
34 water transfers as compared to without water transfers; and therefore, changes to  
35 aquatic resources would be less than substantial. Delta conditions also would be  
36 similar with water transfers as compared to without water transfers, including less  
37 than 5 percent changes in Delta exports and less than 1.3 percent changes in Delta  
38 outflow and X2 position. Therefore, changes to aquatic resources would be less  
39 than substantial. For the purposes of this EIS, it is anticipated that similar  
40 conditions would occur due to cross Delta water transfers under the No Action  
41 Alternative and the Second Basis of Comparison.

42 Under the Second Basis of Comparison, water transfers could occur throughout  
43 the year depending upon limitations of available conveyance capacity and  
44 regulatory requirements.

1 **9.4.2.3.5 Conditions for Fish Passage**

2 Conditions for fish passage at Shasta, Folsom, and New Melones dams under the  
3 Second Basis of Comparison would be the same as described in the Affected  
4 Environment because passage of fish to river reaches above these dams would not  
5 be provided. Populations of anadromous fish under the Second Basis of  
6 Comparison would continue to be restricted to the river reaches downstream of  
7 these dams and subjected to increasing water temperatures associated primarily  
8 with climate change.

9 **9.4.2.3.6 Ocean Conditions**

10 Conditions for the Southern Resident Killer Whale under the Second Basis of  
11 Comparison would differ from those for the No Action Alternative, but the effects  
12 on Killer Whales would be the same.

13 **9.4.3 Evaluation of Alternatives**

14 Alternatives 1 through 5 have been compared to the No Action Alternative; and  
15 the No Action Alternative and Alternatives 1 through 5 have been compared to  
16 the Second Basis of Comparison.

17 **9.4.3.1 No Action Alternative Compared to the Second Basis of**  
18 **Comparison**

19 The No Action Alternative is compared to the Second Basis of Comparison.

20 **9.4.3.1.1 Trinity River Region**

21 *Coho Salmon*

22 The analysis of effects associated with changes in operation on Coho Salmon was  
23 conducted using temperature model outputs for Lewiston Dam to anticipate the  
24 likely effects on conditions in the Trinity River downstream of Lewiston Dam for  
25 Coho Salmon.

26 Long term average monthly water temperatures in the Trinity River at Lewiston  
27 Dam under No Action Alternative generally would be similar to the temperatures  
28 that would occur under the Second Basis of Comparison (Appendix 6B,  
29 Table B-1-4). Average monthly temperatures under the Second Basis of  
30 Comparison generally would be similar to those predicted under the No Action  
31 Alternative in most water year types, except from November through January in  
32 above- and below-normal water years when water temperatures under the No  
33 Action Alternative could be up to 1.5°F warmer than under the Second Basis of  
34 Comparison. In November of critical years, water temperatures under the No  
35 Action Alternative could be as much as 2.4°F cooler than under the Second Basis  
36 of Comparison (Appendix 6B, Table B-1-4). Average monthly water  
37 temperatures generally would be similar (less than 0.5°F difference) under the No  
38 Action Alternative and Second Basis of Comparison from July through  
39 September, except in September of wet years when temperatures would be  
40 slightly lower (0.6°F) and in August of critical years when temperatures could be

1 slightly (0.7°F) higher under the No Action Alternative (Appendix 6B,  
2 Table B-1-4).

3 Overall, the temperature differences between the No Action Alternative and  
4 Second Basis of Comparison would be relatively minor and likely would have  
5 little effect on Coho Salmon in the Trinity River. The substantially lower water  
6 temperatures in November of critical dry years (and higher temperatures in  
7 December) under the No Action Alternative would likely have little effect on  
8 Coho Salmon as water temperatures in the Trinity River are typically low during  
9 this time period.

10 The USFWS established a water temperature threshold of 56°F for Coho Salmon  
11 spawning in the reach of the Trinity River from Lewiston Dam to the confluence  
12 with the North Fork Trinity River from October through December. Although not  
13 entirely reflective of water temperatures throughout the reach, the temperature  
14 model provides average monthly water temperature outputs for releases from  
15 Lewiston Dam, which may provide perspective on temperature conditions in the  
16 reach below. In October and November, average monthly water temperatures  
17 under both the No Action Alternative and Second Basis of Comparison would  
18 exceed 56°F at Lewiston Dam in some years (Appendix 9N). Under the No  
19 Action Alternative, the threshold would be exceeded about 8 percent of the time  
20 in October, about 1 percent more frequently than under the Second Basis of  
21 Comparison. In November, both scenarios would result in an exceedance  
22 frequency of about 2 percent. There would be no exceedance of the threshold in  
23 December under both the No Action Alternative and the Second Basis of  
24 Comparison.

25 Overall, the temperature model outputs for each of the Coho Salmon life stages  
26 suggest that the temperature of water released at Lewiston Dam generally would  
27 be similar under both scenarios, although the exceedance of water temperature  
28 thresholds would be slightly more frequent (1 percent) under the No Action  
29 Alternative. Given the similarity of the results and the inherent uncertainty  
30 associated with the resolution of the temperature model (average monthly  
31 outputs), it is concluded that the No Action Alternative and Second Basis of  
32 Comparison are likely to have similar effects on the Coho Salmon population in  
33 the Trinity River.

#### 34 *Spring-run Chinook Salmon*

35 As described above for Coho Salmon, the temperature differences between the No  
36 Action Alternative and Second Basis of Comparison (Appendix 6B, Table B-1-4)  
37 would be relatively minor (less than 0.5°F) and likely would have little effect on  
38 spring-run Chinook Salmon in the Trinity River. The lower water temperatures in  
39 November of critical dry years (and higher temperatures in December) under the  
40 No Action Alternative would likely have little effect on spring-run Chinook  
41 Salmon as water temperatures in the Trinity River are typically low during this  
42 time period.

1 Under both the No Action Alternative and the Second Basis of Comparison,  
2 average monthly water temperatures in the Trinity River at Lewiston Dam would  
3 infrequently (1 percent to 2 percent of the time) exceed 60°F (Appendix 9N), the  
4 threshold for spring-run Chinook Salmon holding. There would be no difference  
5 in the frequency of exceedance of the 60°F threshold under the No Action  
6 Alternative as compared to the Second Basis of Comparison. In September,  
7 however, the threshold for spawning (56°F) would be exceeded 9 percent of the  
8 time under the No Action Alternative, which is 2 percent less frequently than  
9 under the Second Basis of Comparison (11 percent).

10 The differences in the frequency of threshold exceedance between the No Action  
11 Alternative and Second Basis of Comparison would be relatively minor, although  
12 temperature conditions under the No Action Alternative could be less likely to  
13 affect spring-run Chinook Salmon spawning than under the Second Basis of  
14 Comparison because of the slightly (2 percent) reduced frequency of exceedance  
15 of the 56°F threshold at Lewiston Dam in September.

16 Overall, water temperature differences could adversely influence spring-run  
17 Chinook Salmon in the Trinity River under the Second Basis of Comparison;  
18 however, these effects would not occur in every year and are not anticipated to be  
19 substantial based on the relatively small differences in water temperatures under  
20 the No Action Alternative as compared to the Second Basis of Comparison. In  
21 addition, the implementation of the Hatchery Management Plan (RPA  
22 Action II.6.3) under the No Action Alternative could reduce the impacts of  
23 hatchery Chinook Salmon on natural spring-run Chinook Salmon in the Trinity  
24 River and increase the genetic diversity and diversity of run-timing for these  
25 stocks relative to the Second Basis of Comparison. However, the potential  
26 magnitude of these benefits is uncertain. Thus, given these relatively minor  
27 changes in temperature and temperature threshold exceedance, the inherent  
28 uncertainty associated with the resolution of the temperature model (average  
29 monthly outputs), and the uncertainty of the hatchery benefits, it is concluded that  
30 the No Action Alternative and Second Basis of Comparison are likely to have  
31 similar effects on the spring-run Chinook Salmon in the Trinity River.

### 32 *Fall-Run Chinook Salmon*

33 The potential effects of operations on fall-run Chinook Salmon were evaluated  
34 based on water temperature differences and threshold comparisons as described  
35 above for Coho and spring-run Chinook Salmon. In addition, the Reclamation  
36 Salmon Mortality Model (Appendix 9C) was applied to examine the anticipated  
37 effects of water temperature on egg mortality.

38 The water temperature differences in the Trinity River at Lewiston Dam between  
39 the No Action Alternative and Second Basis of Comparison (Appendix 6B,  
40 Table B-1-4) would be relatively minor (less than 0.5°F) and likely would have  
41 little effect on fall-run Chinook Salmon. The lower water temperatures in  
42 November of critical years (and higher temperatures in December) under the No  
43 Action Alternative would likely have little effect on fall-run Chinook Salmon as  
44 water temperatures in the Trinity River are typically low during this time period.

1 The temperature threshold and months during which it applies for fall-run  
2 Chinook Salmon are the same as those for Coho Salmon. Under the No Action  
3 Alternative, the threshold would be exceeded about 8 percent of the time in  
4 October, about 1 percent more frequently than under the Second Basis of  
5 Comparison. In November, both conditions would result in an exceedance  
6 frequency of about 2 percent. There would be no exceedance of the threshold in  
7 December under either the No Action Alternative or the Second Basis of  
8 Comparison.

9 The water temperatures in the Trinity River downstream of Lewiston Dam are  
10 reflected in the analysis the Reclamation Salmon Mortality Model. For fall-run  
11 Chinook Salmon in the Trinity River, the long-term average egg mortality rate is  
12 predicted to be relatively low (around 4 percent), with higher mortality rates  
13 (nearly 15 percent) occurring in critical years under the No Action  
14 Alternative (Appendix 9C, Table B-1-1). Overall, egg mortality under the No  
15 Action Alternative and the Second Basis of Comparison would be similar.

16 In summary, the temperature threshold exceedance suggests that temperature  
17 conditions under the No Action Alternative could be slightly more likely to affect  
18 fall-run Chinook Salmon spawning than under the Second Basis of Comparison  
19 because of the slightly (1 percent) increased frequency of exceedance of the 56°F  
20 threshold at Lewiston Dam in October. However, this would occur prior to the  
21 peak spawning period for fall-run Chinook Salmon.

22 Although the combined analysis based on water temperature suggests that  
23 operations under the No Action Alternative could be slightly more adverse than  
24 under the Second Basis of Comparison, these effects would not occur in every  
25 year and are not anticipated to be substantial based on the relatively small  
26 differences in water temperatures (as well as egg mortality) between the No  
27 Action Alternative as compared to the Second Basis of Comparison. In addition,  
28 these potential adverse effects could be offset by implementation of the Hatchery  
29 Management Plan (RPA Action II.6.3) under the No Action Alternative, which  
30 could reduce the impacts of hatchery Chinook Salmon on natural fall-run Chinook  
31 Salmon in the Trinity River, and increase the genetic diversity and diversity of  
32 run-timing for these stocks relative to the Second Basis of Comparison. Overall,  
33 given the small differences in the numerical model results and the inherent  
34 uncertainty in the temperature model, as well as the potential for offsetting  
35 benefits associated with actions that were not modeled, it is concluded that the No  
36 Action Alternative and Second Basis of Comparison are likely to have similar  
37 effects on the fall-run Chinook Salmon population in the Trinity River.

### 38 *Steelhead*

39 The temperature differences between the No Action Alternative and Second Basis  
40 of Comparison (Appendix 6B) would be relatively minor (less than 0.5°F) and  
41 likely would have little effect on steelhead in the Trinity River. The substantially  
42 lower water temperatures in November of critical years (and higher temperatures  
43 in December) under the No Action Alternative would likely have little effect on

1 steelhead as water temperatures in the Trinity River are typically low during this  
2 time period.

3 The temperature threshold for spawning and the months during which it applies  
4 for steelhead are the same as those for Coho Salmon. Thus, the frequency of  
5 average monthly water temperatures in the Trinity River at Lewiston Dam  
6 exceeding the spawning threshold of 56°F for steelhead would be the same as  
7 those described above for Coho Salmon. The differences in the frequency of  
8 threshold exceedance between the No Action Alternative and Second Basis of  
9 Comparison would be relatively minor, although temperature conditions under the  
10 No Action Alternative could be more likely to affect steelhead spawning than  
11 under the Second Basis of Comparison because of the slightly (1 percent)  
12 increased frequency of exceedance of the 56°F threshold at Lewiston Dam in  
13 October.

14 Although the combined analysis based on water temperature suggests that  
15 operations under the No Action Alternative could be slightly more adverse than  
16 under the Second Basis of Comparison, these effects would not occur in every  
17 year and are not anticipated to be substantial based on the relatively small  
18 differences in water temperatures between the No Action Alternative as compared  
19 to the Second Basis of Comparison. Overall, given these small differences and  
20 the inherent uncertainty in the temperature model, the No Action Alternative and  
21 Second Basis of Comparison are likely to have similar effects on the steelhead  
22 population in the Trinity River.

### 23 *Green Sturgeon*

24 As described in the Affected Environment and species accounts (Appendix 9B)  
25 Green Sturgeon spawn in the lower reaches of the Trinity River from April  
26 through June, and water temperatures above about 63°F are believed stressful to  
27 embryos (Van Eenennaam et al. 2005). Average monthly water temperature  
28 conditions from April through June in the Trinity River at Lewiston Dam under  
29 the No Action Alternative would be similar to temperatures under the Second  
30 Basis of Comparison and would not exceed 58°F during this period  
31 (Appendix 6B, Table B-1-4). In addition, water temperatures in the reach of the  
32 river where Green Sturgeon spawn are likely controlled by other factors  
33 (e.g., ambient air temperatures and tributary inflows) more than water operations  
34 at Trinity and Lewiston dams.

35 Overall, given the similarities between average monthly water temperatures at  
36 Lewiston Dam under the No Action Alternative and the Second Basis of  
37 Comparison, it is likely that temperature conditions for Green Sturgeon in the  
38 Trinity River or lower Klamath River and estuary would be similar under both  
39 scenarios.

### 40 *Reservoir Fishes*

41 The analysis of effects associated with changes in operation on reservoir fishes in  
42 Trinity Lake relied on evaluation of changes in available habitat (reservoir  
43 storage) and anticipated changes in black bass nesting success.



1 Changes in CVP water supplies and operations under the No Action  
2 Alternative as compared to the Second Basis of Comparison would result in lower  
3 reservoir storage in Trinity Lake. Storage in Trinity Lake could be reduced up to  
4 around 10 percent in some months of some water year types. Additional  
5 information related to monthly reservoir elevations is provided in Appendix 5A,  
6 CalSim II and DSM2 Modeling. Using storage volume is an indicator of how  
7 much habitat is available to fish species inhabiting these reservoirs, the amount of  
8 habitat for reservoir fishes could be reduced under the No Action Alternative as  
9 compared to the Second Basis of Comparison.

10 As shown in Appendix 9F, bass nest survival in Trinity Lake is near 100 percent  
11 in March and April in response to increasing reservoir elevations. For May, the  
12 likelihood of survival for Largemouth Bass in Trinity Lake being in the 40 to  
13 100 percent range is slightly (about 1-2 percent) lower under the No Action  
14 Alternative as compared to the Second Basis of Comparison. For June, the  
15 likelihood of survival being greater than 40 percent for Largemouth Bass is lower  
16 than in May and is slightly (about 3 percent) higher under the No Action  
17 Alternative than the Second Basis of Comparison. For Spotted Bass, the  
18 likelihood of survival being greater than 40 percent is 100 percent in May and  
19 June under both the No Action Alternative and the Second Basis of Comparison.

20 Overall, the comparison of storage and the analysis of nesting suggest that effects  
21 of the No Action Alternative on reservoir fishes would be similar to those under  
22 the Second Basis of Comparison.

### 23 *Pacific Lamprey*

24 Little information is available on factors that influence populations of Pacific  
25 Lamprey in the Trinity River, but they are likely affected by many of the same  
26 factors as salmon and steelhead because of the parallels in their life cycles. On  
27 average, the temperature of water released at Lewiston Dam under the No Action  
28 Alternative would be similar to (within 0.5°F) water temperatures under the  
29 Second Basis of Comparison. Changes in CVP water supplies and operations  
30 under the No Action Alternative would result in lower reservoir storage in Trinity  
31 Lake and somewhat reduced Trinity River flows in December through February  
32 in wetter years as compared to the Second Basis of Comparison. The highest  
33 reductions in flow would be less than 10 percent in the Trinity River  
34 (Appendix 5A), with a smaller relative reduction in the lower Klamath River  
35 and Klamath River estuary.

36 Overall, given the similarities between average monthly water temperatures at  
37 Lewiston Dam under the No Action Alternative and the Second Basis of  
38 Comparison, it is likely that the No Action Alternative would have a similar  
39 potential to affect Pacific Lamprey in the Trinity River as the Second Basis of  
40 Comparison. This conclusion likely applies to other species of lamprey that  
41 inhabit the Trinity and lower Klamath rivers (e.g., River Lamprey).

1 *Eulachon*

2 As described in the Affected Environment, the last noticeable runs of Eulachon  
3 were observed in 1988 and 1989 by Yurok tribal fishers. It is unclear whether this  
4 species has been extirpated from the Klamath River. Given that the highest  
5 reductions in flow would be less than 10 percent in the Trinity River, which  
6 would represent even a smaller proportion in the lower Klamath River and  
7 Klamath River estuary, and that water temperatures in the Klamath River are  
8 unlikely to be affected by changes upstream at Lewiston Dam, it is likely that the  
9 No Action Alternative would have a similar potential to influence Eulachon in the  
10 Klamath River as would the Second Basis of Comparison.

11 **9.4.3.1.2 Sacramento River System**

12 *Winter-run Chinook Salmon*

13 Changes in operations that influence temperature and flow conditions in the  
14 Sacramento River downstream of Keswick Dam could affect winter-run Chinook  
15 Salmon. The following describes those changes and their potential effects.

16 *Changes in Water Temperature*

17 Long-term average monthly water temperatures in the Sacramento River at  
18 Keswick Dam under the No Action Alternative would generally be similar (less  
19 than 0.5°F difference) to water temperatures under the Second Basis of  
20 Comparison. An exception is during September and October of critical dry years  
21 when water temperatures could be up to 1.1°F and 0.8°F higher, respectively,  
22 under the No Action Alternative as compared to the Second Basis of Comparison  
23 and up to 1°F cooler in September of wetter years (Appendix 6B, Table B-5-4).  
24 A similar temperature pattern generally would be exhibited downstream at Ball's  
25 Ferry, Jelly's Ferry, and Bend Bridge, although average monthly temperatures  
26 would increase with average monthly temperature differences between the  
27 scenarios progressively decreasing, except in September (up to 2.8°F cooler at  
28 Bend Bridge) during wetter years under the No Action Alternative (Appendix 6B,  
29 Table B-8-4).

30 Overall, the temperature differences between the No Action Alternative and  
31 Second Basis of Comparison would be relatively minor (less than 0.5°F) and  
32 likely would have similar effects on winter-run Chinook Salmon in the  
33 Sacramento River. Spawning for winter-run Chinook Salmon in the Sacramento  
34 River takes place from mid-April to mid-August with incubation occurring over  
35 the same time period and extending into October. The somewhat higher water  
36 temperatures in September and October of critical dry years under the No Action  
37 Alternative could increase the likelihood of adverse effects on winter-run Chinook  
38 Salmon egg incubation during this water year type. Whereas, the reduced water  
39 temperatures during September and October under the No Action Alternative in  
40 wetter years could reduce the likelihood of adverse effects on egg incubation  
41 relative to the Second Basis of Comparison.

1            *Changes in Exceedances of Water Temperature Thresholds*

2    With the exception of April, average monthly water temperatures from April to  
3    September under both the No Action Alternative and Second Basis of  
4    Comparison would show exceedances of the water temperature threshold of 56°F  
5    established in the Sacramento River at Ball's Ferry for winter-run Chinook  
6    Salmon spawning and egg incubation (Appendix 9N). Under the No Action  
7    Alternative, the temperature threshold generally would be exceeded more  
8    frequently than under the Second Basis of Comparison (by about 1 percent to  
9    3 percent) in the April through August period, with the temperature threshold in  
10   September exceeded in 42 percent of the simulated years, about 10 percent less  
11   frequently under the No Action Alternative than the Second Basis of Comparison  
12   (52 percent).

13   Farther downstream at Bend Bridge, the frequency of exceedances would  
14   increase, with exceedances under both the No Action Alternative and Second  
15   Basis of Comparison as high as about 90 percent in some months. Under the No  
16   Action Alternative, temperature exceedances generally would be more frequent  
17   (by up to 8 percent) than under the Second Basis of Comparison, with the  
18   exception of September, when threshold exceedances under the No Action  
19   Alternative would be about 29 percent less frequent.

20   Overall, there would be substantial differences in the frequency of threshold  
21   exceedance between the No Action Alternative and Second Basis of Comparison,  
22   particularly in September. Water temperature conditions under the No Action  
23   Alternative could be more likely to result in adverse effects on winter-run  
24   Chinook Salmon spawning than under the Second Basis of Comparison because  
25   of the increased frequency of exceedance of the 56°F threshold from April  
26   through August. However, the substantial reduction in the frequency of  
27   exceedance in September under the No Action Alternative may reduce the  
28   likelihood of adverse effects on winter-run Chinook Salmon egg incubation  
29   during this limited portion of the spawning and egg incubation period.

30            *Changes in Egg Mortality*

31   The temperatures described above for the Sacramento River downstream of  
32   Keswick Dam are reflected in the analysis of egg mortality using the Reclamation  
33   salmon mortality model (Appendix 9C). For winter-run Chinook Salmon in the  
34   Sacramento River, the long-term average temperature induced egg mortality rate  
35   is predicted to be relatively low (around 5 percent), with higher mortality rates  
36   (exceeding 20 percent) occurring in critical dry years under the No Action  
37   Alternative. In critical dry years the average egg mortality rate would be  
38   5.4 percent greater under the No Action Alternative compared to the Second Basis  
39   of Comparison (Appendix 9C, Table B-4). Overall, egg mortality in the  
40   Sacramento River under the No Action Alternative and the Second Basis of  
41   Comparison would be similar, except in critical dry water years.

1        *Changes in Weighted Usable Area*

2    As described above for the assessment methodology, Weighted Usable Area  
3    (WUA) is a function of flow, but the relationship is not linear due to differences  
4    in depths and velocities present in the wetted channel at different flows. Because  
5    the combination of depths, velocities, and substrates preferred by species and life  
6    stages varies, WUA values at a given flow can differ substantially for the life  
7    stages evaluated.

8    As an indicator of the amount of suitable spawning habitat for winter-run Chinook  
9    Salmon between Keswick Dam and Battle Creek, modeling results indicate that,  
10   in general, there would be similar amounts of spawning habitat available from  
11   May through September under the No Action Alternative and the Second Basis of  
12   Comparison (Appendix 9E).

13   Modeling results indicate that, in general, there would be similar amounts of  
14   suitable fry rearing habitat available from June through October under the No  
15   Action Alternative and the Second Basis of Comparison (Appendix 9E).

16   Similar to the results for fry rearing WUA, modeling results indicate that there  
17   would be similar amounts of suitable juvenile rearing habitat available during the  
18   juvenile rearing period from September through August under the No Action  
19   Alternative and the Second Basis of Comparison (Appendix 9E).

20        *Changes in SALMOD Output*

21   SALMOD results indicate that potential juvenile production would be similar  
22   (less than 5 percent differences) under the No Action Alternative and Second  
23   Basis of Comparison in all water year types (Appendix 9D, Table B-4-16).

24        *Changes in Delta Passage Model Output*

25   The Delta Passage Model predicted similar estimates of annual Delta survival  
26   across the 81-year time period for winter-run Chinook Salmon between the No  
27   Action Alternative and the Second Basis of Comparison  
28   Alternative (Appendix 9J). Median Delta survival was 0.349 for the No Action  
29   Alternative and 0.352 for the Second Basis of Comparison  
30   Alternative (Appendix 9J) indicating that Delta survival of winter-run Chinook  
31   Salmon would be similar under the No Action Alternative and the Second Basis  
32   of Comparison.

33        *Changes in Oncorhynchus Bayesian Analysis Output*

34   Escapement of winter-run Chinook Salmon and Delta survival was modeled by  
35   the Oncorhynchus Bayesian Analysis (OBAN) model for winter-run Chinook  
36   salmon. Escapement was generally higher under the No Action Alternative as  
37   compared to the Second Basis alternative (Appendix 9I). The median escapement  
38   under the No Action Alternative was higher in 19 of the 22 years of simulation  
39   (1971 to 2002), and there was typically greater than a 25 percent chance that the  
40   No Action Alternative values would be greater than under the Second Basis of  
41   Comparison. Median delta survival was approximately 12 percent higher under  
42   the No Action Alternative as compared to the Second Basis of Comparison.

1 However, the probability intervals indicated that no difference between scenarios  
2 was a highly probable outcome (Appendix 9I).

3 *Changes in Interactive Object-Oriented Simulation Output*

4 The IOS model predicted similar adult escapement trajectories for winter-run  
5 Chinook Salmon between the No Action Alternative and the Second Basis of  
6 Comparison across the 81 years (Appendix 9H). Under the No Action  
7 Alternative, median adult escapement was 3,935 and under the Second Basis of  
8 Comparison median escapement was 4,042.

9 Similar to adult escapement, the IOS model predicted similar egg survival  
10 trajectories for winter-run Chinook Salmon under the No Action Alternative and  
11 the Second Basis of Comparison Alternative across the 81 water years. Under the  
12 No Action Alternative, median egg survival was 0.990 and under the Second  
13 Basis of Comparison median egg survival was 0.987 (Appendix 9H).

14 *Changes in Delta Hydrodynamics*

15 Winter-run Chinook Salmon smolts are most abundant in the Delta during  
16 January, February, and March. On the Sacramento River near the confluence of  
17 Georgiana Slough, the median proportion of positive velocities under the No  
18 Action Alternative was indistinguishable from the Second Basis of Comparison.  
19 On the San Joaquin River near the Mokelumne River confluence, the  
20 median percent of positive velocities was slightly higher in January and February  
21 but similar in March. In Old River downstream of the facilities, the  
22 median percent of positive velocities was substantially higher under the No  
23 Action Alternative during January, moderately higher in February and slightly  
24 higher in March. On Old River upstream of the facilities, median percent of  
25 positive velocities were moderately lower under No Action Alternative relative to  
26 Second Basis of Comparison in January but similar in February and March. On  
27 the San Joaquin River downstream of Head of Old River, the median percent of  
28 positive velocities was similar for both scenarios in January, February and March.  
29 See Appendix 9K for detailed results.

30 *Changes in Junction Entrainment*

31 Entrainment at Georgiana Slough was similar under both scenarios during  
32 January, February, and March when winter-run Chinook Salmon smolts are most  
33 abundant in the Delta. At the Head of Old River, median entrainment  
34 probabilities were moderately lower under the No Action Alternative during  
35 January, slightly lower during February and similar in March. At the Turner Cut  
36 junction, median entrainment probabilities under the No Action Alternative were  
37 slightly lower than the Second Basis of Comparison in January and February, and  
38 similar in March. Overall, entrainment patterns at the Columbia Cut junction  
39 were similar to those observed at Turner Cut. Patterns at the Middle River and  
40 Old River junctions were similar to those observed at Columbia and Turner Cut  
41 junctions. See Appendix 9L for detailed results.

1            *Changes in Salvage*

2     The median proportion salvaged of Sacramento River-origin Chinook salmon is  
3     predicted to be greater under Second Basis of Comparison relative to No Action  
4     Alternative in every month. Winter-run Chinook Salmon smolts migrating  
5     through the Delta would be most susceptible in the months of January, February,  
6     and March. Predicted values in January and February indicated a moderately  
7     reduced proportion of fish salvaged under the No Action Alternative relative to  
8     the Second Basis of Comparison. See Appendix 9M for detailed results.

9            *Changes in Fish Passage on the Sacramento and American Rivers*

10    The No Action Alternative includes provision for passage of winter-run Chinook  
11    Salmon at Shasta Dam. Similar actions are underway at some locations in the  
12    Pacific Northwest, but none have been attempted for large storage and flood  
13    control reservoirs such as Shasta Lake. There is considerable uncertainty about  
14    whether such a program could be effective. For example, the size of the reservoir  
15    would require that adults be transported not just into the lake, but possibly to the  
16    river many miles upstream. Also because of the size of the reservoir, successful  
17    volitional passage of juveniles through the reservoir is unlikely. Thus, in order  
18    for juvenile salmonid emigrants to contribute to the population, they must be  
19    captured in the river (or at the entrance to the lake) and provided with safe  
20    transport downstream. A high level of capture efficiency for emigrating  
21    juveniles is essential for the program to be successful at generating a self-  
22    sustaining population.

23    If a fish passage program could establish self-sustaining populations of winter-run  
24    Chinook Salmon, spring-run Chinook Salmon, and steelhead, it would contribute  
25    substantially to satisfaction of the spatial diversity viability standard. The passage  
26    program could also contribute to abundance and productivity, if average returns  
27    consistently exceeded approximately 500 individuals. However, the passage  
28    program could also function as a population sink if fish transported above the  
29    reservoir achieved a cohort replacement rate of less than 1.

30    Insufficient information is available currently the on the productivity of habitat  
31    upstream of these impoundments. Given the technical uncertainties discussed  
32    previously, it is not possible to determine if (or how much) fish passage at Shasta  
33    Dam would be likely to affect the status of Central Valley winter-run Chinook  
34    Salmon populations.

35            *Summary of Effects on Winter-Run Chinook Salmon*

36    The multiple model and analysis outputs described above characterize the  
37    anticipated conditions for winter-run Chinook Salmon and their response to  
38    change under the No Action Alternative as compared to the Second Basis of  
39    Comparison. For the purpose of analyzing effects on winter-run Chinook Salmon  
40    and developing conclusions, greater reliance was placed on the outputs from the  
41    two life cycle models, IOS and OBAN because they each integrate the available  
42    information to produce single estimates of winter-run Chinook Salmon  
43    escapement. The output from IOS indicated that winter-run Chinook Salmon  
44    escapement would be similar under both scenarios, whereas the OBAN results

1 indicated that production escapement under the No Action Alternative would be  
2 higher than under the Second Basis of Comparison, although there would be some  
3 chance (less than a 25 percent) that escapement under the Second Basis of  
4 Comparison could be greater than the No Action Alternative in some years.

5 The model results suggest that effects on winter-run Chinook Salmon would be  
6 similar under both the No Action Alternative and Second Basis of Comparison,  
7 with a small likelihood that winter-run Chinook Salmon escapement would be  
8 higher under the No Action Alternative. This distinction, however, likely would  
9 be greater because of the potential benefits of providing fish passage under the  
10 No Action Alternative intended to address the limited availability of suitable  
11 habitat for winter-run Chinook Salmon in the Sacramento River reaches  
12 downstream of Keswick Dam. This potential beneficial effect and its magnitude  
13 would depend on the success of the fish passage program. In addition, benefits to  
14 winter-run Chinook Salmon may accrue under the No Action Alternative as a  
15 result of implementation of the 2009 NMFS BO RPA action suite (IV.4), which is  
16 intended to increase the efficiency of the Tracy and Skinner Fish Collection  
17 Facilities to improve the overall salvage survival of listed salmonids, including  
18 winter-run Chinook Salmon.

19 Overall, the quantitative results from the numerical models suggest that operation  
20 under the No Action Alternative would be less likely to result in adverse effects  
21 on winter-run Chinook Salmon than would operation under the Second Basis of  
22 Comparison. However, in consideration of the potentially beneficial effects  
23 resulting from the RPA actions that are not included in the numerical models (see  
24 Appendix 5A, Section B), the No Action Alternative has a much greater potential  
25 to address the long-term sustainability of winter-run Chinook Salmon than does  
26 the Second Basis of Comparison. The No Action Alternative includes provisions  
27 for fish passage upstream of Shasta Dam to address long-term temperature  
28 increases associated with climate change. The Second Basis of Comparison does  
29 not include fish passage provisions. Even though the success of fish passage is  
30 uncertain, it is concluded that the potential for adverse effects on winter-run  
31 Chinook Salmon under the No Action Alternative would be less than potential  
32 effects under the Second Basis of Comparison, principally because the Second  
33 Basis of Comparison does not include a fish passage strategy to address water  
34 temperatures that NMFS (2009) indicates is critical to winter-run Chinook  
35 Salmon sustainability over the long term with climate change by 2030.

#### 36 *Spring-run Chinook Salmon*

37 Changes in operations that influence temperature and flow conditions in the  
38 Sacramento River downstream of Keswick Dam, Clear Creek downstream of  
39 Whiskeytown Dam, and Feather River downstream of Oroville Dam could affect  
40 spring-run Chinook Salmon. The following describes those changes and their  
41 potential effects.

1            *Changes in Water Temperature*

2       Changes in water temperature that could affect spring-run Chinook Salmon could  
3       occur in the Sacramento River, Clear Creek, and Feather River. The following  
4       describes temperature conditions in those water bodies.

5            *Sacramento River*

6       Long-term average monthly water temperatures in the Sacramento River at  
7       Keswick Dam under the No Action Alternative would generally be similar (less  
8       than 0.5°F difference) to water temperatures under the Second Basis of  
9       Comparison. An exception is during September and October of critical dry years  
10      when water temperatures could be up to 1.1°F and 0.8°F higher respectively,  
11      under the No Action Alternative as compared to the Second Basis of Comparison  
12      and up to 1°F cooler in September of wetter years under the No Action  
13      Alternative (Appendix 6B, Table B-5-4). A similar pattern in water temperatures  
14      generally would be exhibited downstream at Ball's Ferry, Jelly's Ferry, Bend  
15      Bridge and Red Bluff, with average monthly temperatures increasing in a  
16      downstream direction and temperature differences between scenarios  
17      progressively decreasing except in September (up to 3.2°F cooler at Red Bluff)  
18      during wetter years under the No Action Alternative (Appendix 6B, Table B-9-4).

19      Overall, the temperature differences between the No Action Alternative and  
20      Second Basis of Comparison would be relatively minor (less than 0.5°F) and  
21      likely would have little effect on spring-run Chinook Salmon in the Sacramento  
22      River. The somewhat lower water temperatures in September of wetter years may  
23      reduce the likelihood of adverse effects on spring-run Chinook Salmon spawning,  
24      although the increased temperatures in September of critical dry years under the  
25      No Action Alternative may increase the likelihood of adverse effects on spring-  
26      run Chinook Salmon spawning in this water year type. There would be little  
27      difference in potential effects on spring-run Chinook Salmon holding over the  
28      summer due to the similar water temperatures during this time period under the  
29      No Action Alternative and the Second Basis of Comparison.

30           *Clear Creek*

31      Average monthly water temperatures in Clear Creek at Igo under the No Action  
32      Alternative relative to the Second Basis of Comparison are generally predicted to  
33      be similar (less than 0.5°F differences) from September through April and June  
34      through August (Appendix 6B, Table B-3-4). Average monthly water  
35      temperatures during May under the No Action Alternative would be lower by up  
36      to 0.8°F compared to the Second Basis of Comparison. The lower water  
37      temperatures in May associated with the No Action Alternative reflect the effects  
38      of additional water discharged from Whiskeytown Dam to meet the spring  
39      attraction flow requirements to promote attraction of spring-run Chinook Salmon  
40      into the creek. While the reduction in May water temperatures indicated by the  
41      modeling could improve thermal conditions for spring-run Chinook Salmon, the  
42      duration of the two pulse flows may not be of sufficient duration (3 days each) to  
43      provide biologically meaningful temperature benefits. Overall, thermal



1 conditions for spring-run Chinook Salmon in Clear Creek would be similar under  
2 the No Action Alternative and the Second Basis of Comparison.

3 *Feather River*

4 Average monthly water temperatures in the Feather River in the low flow channel  
5 generally were predicted to be similar (less than 0.5°F differences) under the No  
6 Action Alternative and Second Basis of Comparison, except during November  
7 and December when average monthly water temperatures could be up to 1.4°F  
8 higher in some water year types (Appendix 6B, Table B-20-4). Average monthly  
9 water temperatures in September under the No Action Alternative could be up to  
10 1.3°F lower than under the Second Basis of Comparison in wetter years.

11 Although temperatures in the river generally become progressively higher in the  
12 downstream direction, the differences between the No Action Alternative and  
13 Second Basis of Comparison exhibit a similar pattern at the downstream locations  
14 (Robinson Riffle and Gridley Bridge), with water temperature differences  
15 between the No Action Alternative and the Second Basis of Comparison generally  
16 decreasing in most water year types. However, water temperatures from July to  
17 September under the No Action Alternative could be somewhat (0.7°F to 1.6°F)  
18 cooler on average and up to 4.0°F cooler at the confluence with Sacramento River  
19 in wetter years (Appendix 6B, Table B-23-4).

20 Overall, the temperature differences in the Feather River between the No Action  
21 Alternative and Second Basis of Comparison would be relatively minor (less than  
22 0.5°F) and likely would have little effect on spring-run Chinook Salmon in the  
23 Feather River. The slightly higher water temperatures in November and  
24 December under the No Action Alternative would likely have little effect on  
25 spring-run Chinook Salmon as water temperatures in the Feather River are  
26 typically low during this time period. The somewhat lower water temperatures in  
27 September of wetter years may reduce the likelihood of adverse effects on  
28 spring-run Chinook Salmon spawning, although the increased temperatures in  
29 September of critical dry years under the No Action Alternative may increase the  
30 likelihood of adverse effects on spring-run Chinook Salmon spawning in this  
31 water year type. There would be little difference in potential effects on spring-run  
32 Chinook Salmon holding over the summer due to the similar water temperatures  
33 during this time period under the No Action Alternative as compared and the  
34 Second Basis of Comparison.

35 *Changes in Exceedances of Water Temperature Thresholds*

36 Changes in water temperature could result in the exceedance of established water  
37 temperature thresholds for spring-run Chinook Salmon in the Sacramento River,  
38 Clear Creek, and Feather River. The following describes the extent of water  
39 temperature threshold exceedances for each of those water bodies.

40 *Sacramento River*

41 Average monthly water temperatures under both the No Action Alternative and  
42 Second Basis of Comparison indicate exceedances of the water temperature  
43 threshold of 56°F established in the Sacramento River at Red Bluff for spring-run  
44 Chinook Salmon (egg incubation) in October, November, and again in April. The

1 exceedances were predicted to occur at the greatest frequency in October  
2 (82 percent of the time under the No action Alternative); the water temperature  
3 threshold would be exceeded more frequently in November (8 percent under the  
4 No Action Alternative) and not exceeded at all from December through March  
5 under the No Action Alternative (Appendix 9N). As water temperatures warm in  
6 the spring, the thresholds were predicted to be exceeded in April by 15 percent  
7 under the No Action Alternative. In the months when the greatest frequency of  
8 exceedances occur (October, November, and April), model results generally  
9 indicate more frequent exceedances (by up to 4 percent in October) under the No  
10 Action Alternative than under the Second Basis of Comparison. Temperature  
11 conditions in the Sacramento River under the No Action Alternative could be  
12 more likely to result in adverse effects on spring-run Chinook Salmon egg  
13 incubation than under the Second Basis of Comparison because of the increased  
14 frequency of exceedance of the 56°F threshold in October, November, and April.  
15 However, this difference may be partially offset if the water temperature  
16 management and fish passage measures associated with 2009 NMFS BO RPA  
17 under the No Action Alternative are successful in improving water temperatures.

#### 18 *Clear Creek*

19 Average monthly water temperatures under both the No Action Alternative and  
20 Second Basis of Comparison would not exceed the water temperature threshold of  
21 60°F established in Clear Creek at Igo for spring-run Chinook Salmon pre-  
22 spawning and rearing in June through August. However, water temperatures  
23 under the No Action Alternative and Second Basis of Comparison would exceed  
24 the water temperature threshold of 56°F established for spawning in September  
25 and October about 10 to 15 percent of the time. Water temperatures under the No  
26 Action Alternative could exceed the threshold about 3 percent more frequently  
27 than under the Second Basis of Comparison in September and about 2 percent  
28 more frequently in October (Appendix 9N). Temperature conditions in Clear  
29 Creek under the No Action Alternative could be more likely to result in adverse  
30 effects on spring-run Chinook Salmon spawning than under the Second Basis of  
31 Comparison because of the increased frequency of exceedance of the 56°F  
32 threshold in September and October. However, this difference may be partially  
33 offset if the thermal stress reduction measures associated with 2009 NMFS BO  
34 RPA Action I.1.5 under the No Action Alternative are successful in improving  
35 water temperatures in Clear Creek.

#### 36 *Feather River*

37 Average monthly water temperatures under both the No Action Alternative and  
38 the Second Basis of Comparison would exceed the water temperature threshold of  
39 56°F established in the Feather River at Robinson Riffle for spring-run Chinook  
40 Salmon egg incubation and rearing during some months, particularly in October  
41 and November, and March and April, when temperature thresholds could be  
42 exceeded frequently (Appendix 9N). The frequency of exceedance was highest in  
43 October, a month in which average monthly water could get as high as about  
44 68°F. Water temperatures under the No Action Alternative would exceed the  
45 spawning temperature threshold about 1 percent more frequently than under the

1 Second Basis of Comparison in October, November, and December, and about  
2 2 percent less frequently in March.

3 The established water temperature threshold of 63°F for rearing from May  
4 through August would be exceeded often under both the No Action  
5 Alternative and Second Basis of Comparison in May and June, but not at all in  
6 July and August. Water temperatures under the No Action Alternative would  
7 exceed the rearing temperature threshold about 9 percent more frequently than  
8 under the Second Basis of Comparison in May. Temperature conditions in the  
9 Feather River under the No Action Alternative could be more likely to result in  
10 adverse effects on spring-run Chinook Salmon spawning and rearing than under  
11 the Second Basis of Comparison because of the increased frequency of  
12 exceedance of the 56°F threshold from October through December.

13 *Changes in Egg Mortality*

14 These temperature differences described above are reflected in the analysis of egg  
15 mortality using the Reclamation salmon mortality model (Appendix 9C). For  
16 spring-run Chinook Salmon in the Sacramento River, the long-term average egg  
17 mortality rate is predicted to be relatively high (exceeding 20 percent), with high  
18 mortality rates (exceeding 70 percent) occurring in critical dry years. In critical  
19 dry years the average egg mortality rate under the No Action Alternative is  
20 predicted to be 10.4 percent greater than under the Second Basis of Comparison  
21 (Appendix 9C, Table B-3). Overall, egg mortality under the No Action  
22 Alternative and the Second Basis of Comparison would be similar, except in  
23 critical dry water years.

24 *Changes in Weighted Usable Area*

25 Weighted usable area curves are available for spring-run Chinook Salmon in  
26 Clear Creek. As described above, flows in Clear Creek downstream of  
27 Whiskeytown Dam are not anticipated to differ under the No Action  
28 Alternative relative to the Second Basis of Comparison except in May due to the  
29 release of spring attraction flows in accordance with the 2009 NMFS BO.  
30 Therefore, there would be no change in the amount of potentially suitable  
31 spawning and rearing habitat for spring-run Chinook Salmon (as indexed by  
32 WUA) available under the No Action Alternative as compared to the Second  
33 Basis of Comparison. However, the results of the habitat suitability/IFIM studies  
34 associated with the 2009 NMFS BO Action I.1.6 could result in changes in  
35 releases from Whiskeytown Reservoir to Clear Creek. Any changes as a result of  
36 these studies would be implemented to improve habitat for fish.

37 *Changes in SALMOD Output*

38 SALMOD results indicate that potential juvenile spring-run production would be  
39 similar under the No Action Alternative and the Second Basis of Comparison,  
40 except in critical dry water years when production under the No Action  
41 Alternative could be 11 percent less than under the Second Basis of Comparison  
42 (Appendix 9D, Table B-3-16).

1        *Changes in Delta Passage Model Output*

2        The Delta Passage Model predicted similar estimates of annual Delta survival  
3        across the 81-year time period for spring-run between the No Action  
4        Alternative and the Second Basis of Comparison (Appendix 9J). Median Delta  
5        survival was 0.296 for the No Action Alternative and 0.286 for the Second Basis  
6        of Comparison.

7        *Changes in Delta Hydrodynamics*

8        Spring-run Chinook Salmon are most abundant in the Delta from March through  
9        May. Near the junction of Georgiana Slough, the median percent of time that  
10       velocity was positive was similar in March, April, and May for both scenarios  
11       (Appendix 9K). Near the confluence of the San Joaquin River and the  
12       Mokelumne River, the median percent of times with positive velocities was  
13       similar in March and slightly greater under the No Action Alternative relative to  
14       the Second Basis of Comparison in April and May. A similar pattern was  
15       observed in the San Joaquin River downstream of the Head of Old River; the  
16       median percent of time that velocity was positive was similar in March, whereas  
17       values for the No Action Alternative were slightly to moderately lower relative to  
18       the Second Basis of Comparison in April and May. In Old River upstream of the  
19       facilities median percent of time with positive velocities was similar in March,  
20       slightly higher in April, and moderately higher in May under the No Action  
21       Alternative relative to the Second Basis of Comparison. In Old River  
22       downstream of the facilities, the median percent of time with positive velocity  
23       was slightly greater in March and increasingly greater in April and May under the  
24       No Action Alternative relative to the Second Basis of Comparison.

25       *Changes in Junction Entrainment*

26       Entrainment at Georgiana Slough was similar under both scenarios during March,  
27       April, and May when spring-run are most abundant in the Delta (Appendix 9L).  
28       At the Head of Old River, median entrainment probabilities were much greater  
29       under the No Action Alternative during April and May, whereas probabilities  
30       were similar in March. At the Turner Cut junction, median entrainment  
31       probabilities under the No Action Alternative and the Second Basis of  
32       Comparison were similar in March. During April and May, median entrainment  
33       probabilities were more divergent with moderately lower values for the No Action  
34       Alternative relative to the Second Basis of Comparison. Overall, entrainment was  
35       slightly lower at the Columbia Cut junction relative to Turner Cut, but patterns of  
36       median entrainment probabilities between the scenarios were similar. Patterns of  
37       entrainment probability at the Middle River and Old River junctions were similar  
38       to those observed at Columbia and Turner Cut junctions.

39       *Changes in Salvage*

40       Salvage of Sacramento River-origin Chinook Salmon is predicted to be lower  
41       under the No Action Alternative relative to the Second Basis of Comparison in  
42       every month (Appendix 9M). Spring-run smolts migrating through the Delta  
43       would be most susceptible in the months of March, April, and May. Predicted  
44       values in April and May indicated a substantially reduced fraction of fish salvaged

1 under the No Action Alternative. Predicted salvage was more similar in March,  
2 but still moderately lower under the No Action Alternative than under the Second  
3 Basis of Comparison.

4 *Summary of Effects on Spring-Run Chinook Salmon*

5 The multiple model and analysis outputs described above characterize the  
6 anticipated conditions for spring-run Chinook Salmon and their response to  
7 change under the No Action Alternative as compared to the Second Basis of  
8 Comparison. For the purpose of analyzing effects on spring-run Chinook Salmon  
9 in the Sacramento River, greater reliance was placed on the outputs from the  
10 SALMOD model because it integrates the available information on temperature  
11 and flows to produce estimates of mortality for each life stage and an overall,  
12 integrated estimate of potential spring-run Chinook Salmon juvenile production.  
13 The output from SALMOD indicated that spring-run Chinook Salmon production  
14 in the Sacramento River would be similar under the No Action Alternative and  
15 the Second Basis of Comparison, although production under the No Action  
16 Alternative could be over 10 percent less than under the Second Basis of  
17 Comparison in critical dry years. The analyses attempting to assess the effects on  
18 routing, entrainment, and salvage of juvenile salmonids in the Delta suggest that  
19 salvage (as an indicator of potential losses of juvenile salmon at the export  
20 facilities) of Sacramento River-origin Chinook Salmon is predicted to be lower  
21 under the No Action Alternative relative to the Second Basis of Comparison in  
22 every month.

23 In Clear Creek and the Feather River, the analysis of the effects of the No Action  
24 Alternative and Second Basis of Comparison for spring-run Chinook Salmon  
25 relied on output from the WUA analysis and water temperature output for Clear  
26 Creek at Igo, and in the Feather River low flow channel and downstream of the  
27 Thermalito complex. The WUA analysis suggests that there would be little  
28 difference in the availability of spawning and rearing habitat in Clear Creek. The  
29 temperature model outputs suggest that thermal conditions and effects on each of  
30 the spring-run Chinook Salmon life stages generally would be similar under both  
31 scenarios in Clear Creek and the Feather River, although water temperatures  
32 could be somewhat less suitable for spring-run Chinook Salmon holding and  
33 spawning/egg incubation in the Feather River under the No Action Alternative.  
34 This conclusion is supported by the water temperature threshold exceedance  
35 analysis that indicated that water temperature thresholds for spawning and egg  
36 incubation would be exceeded slightly more frequently under the No Action  
37 Alternative in Clear Creek and the Feather River. The water temperature  
38 threshold for rearing spring-run Chinook Salmon would also be exceeded slightly  
39 more frequently in the Feather River. Because of the inherent uncertainty  
40 associated with the resolution of the temperature model (average monthly  
41 outputs), the slightly greater likelihood of exceeding water temperature thresholds  
42 under the No Action Alternative could increase the potential for adverse effects  
43 on the spring-run Chinook Salmon populations in the Feather River. Given the  
44 similarity of the results, the No Action Alternative and Second Basis of

1 Comparison are likely to have similar effects on the spring-run Chinook Salmon  
2 population in Clear Creek.

3 The numerical model results suggest that, overall, effects on spring-run Chinook  
4 Salmon could be slightly more adverse under the No Action Alternative than  
5 under the Second Basis of Comparison, and with a small likelihood that spring-  
6 run Chinook Salmon production would be lower under the No Action Alternative.  
7 This potential distinction between the two scenarios, however, may be offset by  
8 the benefits of implementation of fish passage under the No Action  
9 Alternative intended to address the limited availability of suitable habitat for  
10 spring-run Chinook Salmon in the Sacramento River reaches downstream of  
11 Keswick Dam. This beneficial effect and its magnitude would depend on the  
12 success of the fish passage program. In addition, spring-run Chinook Salmon  
13 may benefit under the No Action Alternative by implementation of the 2009  
14 NMFS BO RPA action suite (IV.4), which is intended to increase the efficiency  
15 of the Tracy and Skinner Fish Collection Facilities to improve the overall salvage  
16 survival of listed salmonids, including spring-run Chinook Salmon.

17 Thus, it is concluded that the potential for adverse effects on spring-run Chinook  
18 Salmon under the No Action Alternative suggested by the results of the numerical  
19 models may be offset by the potential benefits of the RPA actions that are not  
20 included in the numerical models, principally because the Second Basis of  
21 Comparison does not include a fish passage strategy to address water  
22 temperatures that NMFS (2009) indicates is critical to spring-run Chinook Salmon  
23 sustainability over the long term with climate change by 2030. On balance and  
24 over the long term, the adverse effects on spring-run Chinook Salmon under the  
25 No Action Alternative would be less than those under the Second Basis of  
26 Comparison.

### 27 *Fall-Run Chinook Salmon*

28 Changes in operations that influence temperature and flow conditions in the  
29 Sacramento River downstream of Keswick Dam, Clear Creek downstream of  
30 Whiskeytown Dam, Feather River downstream of Oroville Dam and American  
31 River below Nimbus could affect fall-run Chinook Salmon. The following  
32 describes those changes and their potential effects.

#### 33 *Changes in Water Temperature*

34 Changes in water temperature could affect fall-run Chinook Salmon in the  
35 Sacramento, Feather, and American rivers, and Clear Creek. The following  
36 describes temperature conditions in those water bodies.

#### 37 *Sacramento River*

38 Average monthly water temperatures in the Sacramento River at Keswick Dam  
39 under the No Action Alternative would generally be similar (less than 0.5°F  
40 difference) to water temperatures under the Second Basis of Comparison. An  
41 exception is during September and October of critical dry years when water  
42 temperatures could be up to 1.1°F and 0.8°F higher, respectively, under the No  
43 Action Alternative as compared to the Second Basis of Comparison and up to 1°F

1 cooler in September of wetter years under the No Action  
2 Alternative (Appendix 6B). A similar pattern in temperature differences  
3 generally would be exhibited at downstream locations along the Sacramento River  
4 (i.e., Ball's Ferry Jelly's Ferry, Bend Bridge, Red Bluff, Hamilton City, and  
5 Knights Landing), with average monthly temperatures increasing in a downstream  
6 direction and temperature differences between scenarios at Knights Landing  
7 progressively increasing (up to 0.9°F warmer) in June and up to 4.6°F cooler in  
8 September during the wetter years under the No Action Alternative relative to the  
9 Second Basis of Comparison.

10 Overall, the temperature differences between the No Action Alternative and  
11 Second Basis of Comparison would be relatively minor (less than 0.5°F) and  
12 likely would have little effect on fall-run Chinook Salmon in the Sacramento  
13 River. The somewhat lower water temperatures in September of wetter years may  
14 reduce the likelihood of adverse effects on early spawning fall-run Chinook  
15 Salmon, although the increased water temperatures in September of critical dry  
16 years under the No Action Alternative may increase the likelihood of adverse  
17 effects on fall-run Chinook Salmon spawning in this water year type.

18 *Clear Creek*

19 Long-term average monthly water temperatures in Clear Creek at Igo under the  
20 No Action Alternative and the Second Basis of Comparison generally would be  
21 similar (less than 0.5°F differences) in most months (Appendix 6B, Table B-3-4).  
22 Modeled average monthly water temperatures during May under the No Action  
23 Alternative would be up to 0.8°F lower than under the Second Basis of  
24 Comparison. Fall-run Chinook Salmon spawn and rear in the lower portion of  
25 Clear Creek, generally downstream of Igo. Average monthly temperatures at the  
26 confluence with the Sacramento River would be similar under the No Action  
27 Alternative and the Second Basis of Comparison, except during May. Modeled  
28 average monthly water temperatures at the confluence during May could be 0.9°F  
29 to 1.3°F lower under the No Action Alternative than under the Second Basis of  
30 Comparison.

31 The lower water temperatures in May associated with the No Action  
32 Alternative reflect the effects of the additional water discharged from  
33 Whiskeytown Dam to meet the spring attraction flow requirements to promote  
34 attraction of spring-run Chinook Salmon into Clear Creek. While the reduction in  
35 water temperature indicated by the modeling could improve thermal conditions  
36 for fall-run Chinook Salmon, the duration of the two pulse flows may not be of  
37 sufficient duration (3 days each) to provide biologically meaningful temperature  
38 benefits. Overall, thermal conditions for fall-run Chinook Salmon in Clear Creek  
39 would be similar under the No Action Alternative and the Second Basis of  
40 Comparison.

41 *Feather River*

42 Long-term average monthly water temperatures in the Feather River in the low  
43 flow channel generally are predicted to be similar (less than 0.5°F differences)  
44 under the No Action Alternative and the Second Basis of Comparison, except

1 during November and December when average monthly water temperatures could  
2 be up to 1.4°F higher in some water year types. Average monthly water  
3 temperatures in September under the No Action Alternative could be up to 1.3°F  
4 lower than under the Second Basis of Comparison in wetter years. Although  
5 temperatures in the river generally become progressively higher in the  
6 downstream direction, the differences between the No Action Alternative and  
7 Second Basis of Comparison exhibit a similar pattern at the downstream locations  
8 (Robinson Riffle and Gridley Bridge), with water temperature differences  
9 between the No Action Alternative and Second Basis of Comparison generally  
10 decreasing in most water year types. However water temperatures from July to  
11 September under the No Action Alternative could be somewhat (0.7°F to 1.6°F)  
12 cooler on average and up to 4.0°F cooler at the confluence with Sacramento River  
13 in wetter years.

14 Overall, the temperature differences in the Feather River between the No Action  
15 Alternative and Second Basis of Comparison would be relatively minor (less than  
16 0.5°F) and likely would have little effect on fall-run Chinook Salmon in the  
17 Feather River. The slightly higher water temperatures in November and  
18 December under the No Action Alternative would likely have little effect on  
19 fall-run Chinook Salmon as water temperatures in the Feather River are typically  
20 low during this time period. The somewhat lower water temperatures in  
21 September of wetter years may reduce the likelihood of adverse effects on early  
22 spawning fall-run Chinook Salmon, although the increased temperatures in  
23 September of critical dry years under the No Action Alternative may increase the  
24 likelihood of adverse effects on fall-run Chinook Salmon spawning in this water  
25 year type.

#### 26 *American River*

27 Average monthly water temperatures in the American River at Nimbus Dam  
28 under the No Action Alternative generally would be similar (differences less than  
29 0.5°F) to the Second Basis of Comparison, with the exception of June and  
30 August, when temperatures under the No Action Alternative could be as much as  
31 0.9°F higher in below normal years (Appendix 6B, Table B-12-4). This pattern  
32 generally would persist downstream to Watt Avenue and the mouth, although  
33 temperatures under the No Action Alternative would be up to 1.6°F and 2.0°F  
34 greater, respectively, than under the Second Basis of Comparison in June. In  
35 addition, average monthly water temperatures at the mouth generally would be  
36 lower under the No Action Alternative than the Second Basis of Comparison in  
37 September of wetter years when water temperatures under the No Action  
38 Alternative could be up to 1.7°F cooler (Appendix 6B, Table B-14-4).

39 Overall, the temperature differences in the American River between the No  
40 Action Alternative and Second Basis of Comparison would be relatively minor  
41 (less than 0.5°F) and likely would have little effect on fall-run Chinook Salmon in  
42 the American River. The slightly higher water temperatures in June and August  
43 in some water year types under the No Action Alternative may increase the  
44 likelihood of adverse effects on fall-run Chinook Salmon rearing in the American



1 River if they are present. The slightly lower water temperatures during  
2 September under the No Action Alternative would have little effect on fall-run  
3 Chinook Salmon spawning in the American River because most spawning occurs  
4 later, in November, but conditions for holding would be improved.  
5 Implementation of water temperature management structural improvements (2009  
6 NMFS BO RPA Action II.3) could contribute to better water temperature  
7 conditions for fish in the American River under the No Action Alternative than  
8 under the Second Basis of Comparison.

9 *Changes in Exceedances of Water Temperature Thresholds*

10 Changes in water temperature could result in the exceedance of water  
11 temperatures that are protective of fall-run Chinook Salmon in the Sacramento  
12 River, Clear Creek, Feather River, and American River. The following describes  
13 the extent of those exceedances for each of those water bodies.

14 *Sacramento River*

15 Average monthly water temperatures under both the No Action Alternative and  
16 Second Basis of Comparison indicate exceedances of the water temperature  
17 threshold of 56°F established in the Sacramento River at Red Bluff for Chinook  
18 Salmon spawning and egg incubation in October, November, and again in April.  
19 In the months when the greatest frequency of exceedances occur (October,  
20 November, and April), model results generally indicate more frequent  
21 exceedances (by up to 4 percent in October) under the No Action Alternative than  
22 under the Second Basis of Comparison. Temperature conditions in the  
23 Sacramento River under the No Action Alternative could be more likely to affect  
24 fall-run Chinook Salmon spawning and egg incubation than under the Second  
25 Basis of Comparison because of the increased frequency of exceedance of the  
26 56°F threshold in October, November, and April. However, this difference may  
27 be partially offset if water temperature management and fish passage measures  
28 associated with 2009 NMFS BO RPA under the No Action Alternative are  
29 successful.

30 *Clear Creek*

31 Fall-run Chinook Salmon spawning in lower Clear Creek typically occurs during  
32 October through December (USFWS 2015). Average monthly water  
33 temperatures at Igo during this period are generally below 56°F, except in  
34 October. Under the No Action Alternative, the 56°F threshold would be exceeded  
35 in October about 12 percent of the time as compared to 10 percent under the  
36 Second Basis of Comparison (Appendix 9N). At the confluence with the  
37 Sacramento River, average monthly water temperatures in October would be  
38 warmer, with 56°F exceeded nearly 20 percent of the time under the No Action  
39 Alternative, about 6 percent more frequently than under the Second Basis of  
40 Comparison (Appendix 6B, Figure B-4-1). During November and December,  
41 average monthly water temperatures generally would remain below 56°F at both  
42 locations (Appendix 6B, Figure B-4-2 and B-4-3). Temperature conditions in  
43 Clear Creek under the No Action Alternative could be more likely to result in  
44 adverse effects on fall-run Chinook Salmon spawning and egg incubation than

1 under the Second Basis of Comparison because of the increased frequency of  
2 exceedance of the 56°F threshold in October.

3 For fall-run Chinook Salmon rearing (January through August), the average  
4 monthly temperatures at Igo would likely remain below the 60°F threshold in all  
5 months. Downstream at the mouth of Clear Creek, average monthly water  
6 temperatures would exceed the 60°F threshold often during the summer, but the  
7 frequency of exceedance would be similar under the No Action Alternative and  
8 the Second Basis of Comparison (Appendix 6B). Temperature conditions for  
9 fall-run Chinook Salmon rearing in Clear Creek would be similar under the No  
10 Action Alternative and the Second Basis of Comparison.

#### 11 *Feather River*

12 Average monthly water temperatures under both the No Action Alternative and  
13 Second Basis of Comparison would exceed the water temperature threshold of  
14 56°F established in the Feather River at Gridley Bridge for fall-run Chinook  
15 Salmon spawning and egg incubation during some months, particularly in  
16 October, November, March, and April, when water temperature thresholds would  
17 be exceeded frequently (Appendix 9N). The frequency of exceedance would be  
18 greatest in October, when average monthly temperatures under both the No  
19 Action Alternative and Second Basis of Comparison would be above the  
20 threshold in nearly every year. The magnitude of the exceedances would be high  
21 as well, with average monthly temperatures in October reaching about 68°F. The  
22 threshold would be exceeded under both the No Action Alternative and Second  
23 Basis of Comparison about 75 percent of the time in April. The differences  
24 between the No Action Alternative and Second Basis of Comparison, however,  
25 would be relatively small, with the No Action Alternative generally exceeding  
26 temperature thresholds about 1-2 percent more frequently than the Second Basis  
27 of Comparison during the October through April period. Temperature conditions  
28 in the Feather River under the No Action Alternative could be more likely to  
29 result in adverse effects on fall-run Chinook Salmon spawning and egg incubation  
30 than under the Second Basis of Comparison because of the increased frequency of  
31 exceedance of the 56°F threshold from October through April.

#### 32 *Changes in Egg Mortality*

33 Water temperatures influence the viability of incubating fall-run Chinook Salmon  
34 eggs. The following describes the differences in egg mortality for the  
35 Sacramento, Feather, and American rivers.

#### 36 *Sacramento River*

37 For fall-run Chinook Salmon in the Sacramento River, the long-term average egg  
38 mortality rate is predicted to be around 17 percent, with higher mortality rates (in  
39 excess of 35 percent) occurring in critical dry years under the No Action  
40 Alternative. Predicted egg mortality would be similar under the No Action  
41 Alternative and the Second Basis of Comparison in all water year types  
42 (Appendix 9C, Table B-1).

1            *Feather River*

2 For fall-run Chinook Salmon in the Feather River, the long-term average egg  
3 mortality rate is predicted to be relatively low (around 7 percent), with higher  
4 mortality rates (around 14.5 percent) occurring in critical dry years under the No  
5 Action Alternative. Predicted egg mortality would be similar under the No  
6 Action Alternative and the Second Basis of Comparison in all water year types  
7 (Appendix 9C, Table B-7).

8            *American River*

9 For fall-run Chinook Salmon in the American River, the long-term average egg  
10 mortality rate is predicted to range from approximately 23 to 25 percent in all  
11 water year types under the No Action Alternative. Overall, egg mortality would  
12 be similar under the No Action Alternative and the Second Basis of Comparison  
13 (Appendix 9C, Table B-6).

14           *Changes in Weighted Usable Area*

15 Weighted usable area, which is influenced by flow, is a measure of habitat  
16 suitability. The following describes changes in WUA for fall-run Chinook  
17 Salmon in the Sacramento, Feather, and American rivers and Clear Creek.

18           *Sacramento River*

19 As an indicator of the amount of suitable spawning habitat for fall-run Chinook  
20 Salmon between Keswick Dam and Battle Creek, WUA modeling results indicate  
21 that, in general, there would be lesser amounts of spawning habitat available in  
22 September and November under the No Action Alternative as compared to the  
23 Second Basis of Comparison. Fall-run spawning WUA would be similar in  
24 October and December under the No Action Alternative and the Second Basis of  
25 Comparison (Appendix 9E, Table C-11-4). The long-term average spawning  
26 WUA during September (prior to the peak spawning period) under the No Action  
27 Alternative would be more than 20 percent lower, and around 6 percent lower in  
28 November compared to the Second Basis of Comparison. November is during the  
29 peak spawning period for fall-run Chinook Salmon in the Sacramento River.  
30 Results for the reach from Battle Creek to Deer Creek show the same pattern for  
31 changes in WUA for spawning fall-run Chinook Salmon between the No Action  
32 Alternative and the Second Basis of Comparison (Appendix 9E, Table C-10-4).  
33 Overall, spawning habitat availability would be somewhat lower under the No  
34 Action Alternative relative to the Second Basis of Comparison.

35 Modeling results indicate that, in general, the amount of suitable fry rearing  
36 habitat available from December to March under the No Action Alternative would  
37 be similar to the amount of fry rearing habitat available under the Second Basis of  
38 Comparison (Appendix 9E, Table C-12-4).

39 Similar to the results for fry rearing WUA, modeling results indicate that there  
40 would be similar amounts of suitable juvenile rearing habitat available during the  
41 juvenile rearing period from February to June under the No Action  
42 Alternative and the Second Basis of Comparison. (Appendix 9E, Table C-13-4).

1            *Clear Creek*

2    As described above, flows in Clear Creek downstream of Whiskeytown Dam are  
 3    not anticipated to differ under the No Action Alternative relative to the Second  
 4    Basis of Comparison except in May due to the release of spring attraction flows in  
 5    accordance with the 2009 NMFS BO. Therefore, there would be no change in the  
 6    amount of potentially suitable spawning and rearing habitat for fall-run Chinook  
 7    Salmon (as indexed by WUA) available under the No Action Alternative as  
 8    compared to the Second Basis of Comparison.

9            *Feather River*

10    As described above, flows in the low flow channel of the Feather River are not  
 11    anticipated to differ under the No Action Alternative relative to the Second Basis  
 12    of Comparison. Therefore, there would be no change in the amount of potentially  
 13    suitable spawning habitat for fall-run Chinook Salmon (as indexed by WUA)  
 14    available under the No Action Alternative as compared to the Second Basis of  
 15    Comparison. The majority of spawning activity by fall-run Chinook Salmon in  
 16    the Feather River occurs in this reach with a lesser amount of spawning occurring  
 17    downstream of the Thermalito Complex.

18    Modeling results indicate that, in general, there would be lesser amounts of  
 19    spawning habitat available in the Feather River downstream of the Thermalito  
 20    Complex during September under the No Action Alternative as compared to the  
 21    Second Basis of Comparison. Fall-run Chinook Salmon spawning WUA would  
 22    be similar under the No Action Alternative and Second Basis of Comparison in  
 23    October and November (the peak spawning months) and in December (after the  
 24    peak spawning period) in this reach (Appendix 9E, Table C-24-4). The decrease  
 25    in long-term average spawning WUA during September (prior to the peak  
 26    spawning period) under the No Action Alternative would be relatively large  
 27    (more than 15 percent). Overall, spawning habitat availability would be similar  
 28    under the No Action Alternative and the Second Basis of Comparison.

29           *American River*

30    Modeling results indicate that, in general, there would be similar amounts of  
 31    spawning habitat available for fall-run Chinook Salmon in the American River  
 32    from October through December under the No Action Alternative as compared to  
 33    the Second Basis of Comparison (Appendix 9E, Table C-25-4).

34           *Changes in SALMOD Output – Sacramento River*

35    SALMOD results indicate that potential juvenile production would similar under  
 36    the No Action Alternative and the Second Basis of Comparison, except in critical  
 37    dry water years when production could be 7 percent lower under the No Action  
 38    Alternative than under the Second Basis of Comparison (Appendix 9D,  
 39    Table B-1-16).

40           *Changes in Delta Passage Model Output*

41    The Delta Passage Model predicted similar estimates of annual Delta survival  
 42    across the 81-year time period for fall-run Chinook Salmon between the No Action  
 43    Alternative and the Second Basis of Comparison (Appendix 9J). Median Delta

1 survival was 0.248 for the No Action Alternative and 0.245 for the Second Basis  
2 of Comparison.

3 *Changes in Delta Hydrodynamics*

4 Fall-run Chinook Salmon smolts are most abundant in the Delta during the  
5 months of April, May, and June. At the junction of Georgiana Slough and the  
6 Sacramento River, the median percent of time with positive velocity was similar  
7 under both scenarios in the months of April, May and June (Appendix 9K). Near  
8 the Confluence of the San Joaquin River and the Mokelumne River, the median  
9 proportion of positive velocities was slightly greater under the No Action  
10 Alternative relative to the Second Basis of Comparison in April and May and  
11 similar in June. In Old River downstream of the facilities, the median proportion  
12 of positive velocities was substantially greater in April and May, but became  
13 more similar in June. In Old River upstream of the facilities, the median  
14 proportion of positive velocities was slightly to moderately greater for the No  
15 Action Alternative relative to the Second Basis of Comparison in April and May,  
16 respectively, and slightly lower in June. On the San Joaquin River downstream of  
17 the Head of Old River, the median proportion of positive velocities was slightly  
18 moderately lower under the No Action Alternative relative to the Second Basis of  
19 Comparison in April and May, respectively, whereas the values were similar  
20 in June.

21 *Changes in Junction Entrainment*

22 Entrainment at Georgiana Slough was similar under both scenarios in most  
23 months, but was slightly lower under the No Action Alternative relative to the  
24 Second Basis of Comparison in the month of June (Appendix 9L). Median  
25 entrainment probabilities at the Head of Old River were much greater under the  
26 No Action Alternative relative to the Second Basis of Comparison during April  
27 and May. The median entrainment probability was similar under both scenarios  
28 in the month of June. At the Turner Cut junction, median entrainment  
29 probabilities under the No Action Alternative were slightly lower than the Second  
30 Basis of Comparison in June. During April and May, median entrainment  
31 probabilities were more divergent with moderately lower values for the No Action  
32 Alternative relative to the Second Basis of Comparison. Overall, entrainment was  
33 slightly lower at the Columbia Cut junction relative to Turner Cut, but patterns of  
34 entrainment between the two scenarios were similar. Patterns in entrainment  
35 probabilities at the Middle River and Old River junctions were similar to those  
36 observed at Columbia and Turner Cut junctions.

37 *Changes in Salvage*

38 Salvage of Sacramento River-origin Chinook Salmon is predicted to be lower  
39 under the No Action Alternative relative to the Second Basis of Comparison in  
40 every month (Appendix 9M). Fall-run smolts migrating through the Delta would  
41 be most susceptible in the months of April, May, and June. Predicted values in  
42 April and May indicated a substantially reduced fraction of fish salvaged under  
43 the No Action Alternative relative to the Second Basis of Comparison. Predicted  
44 salvage was more similar in March but still lower under the No Action  
45 Alternative.

1        *Summary of Effects on Fall-Run Chinook Salmon*

2        The multiple model and analysis outputs described above characterize the  
3        anticipated conditions for fall-run Chinook Salmon and their response to change  
4        under the No Action Alternative as compared to the Second Basis of Comparison.  
5        For the purpose of analyzing effects on fall-run Chinook Salmon in the  
6        Sacramento River, greater reliance was placed on the outputs from the SALMOD  
7        model because it integrates the available information on temperature and flows to  
8        produce estimates of mortality for each life stage and an overall, integrated  
9        estimate of potential fall-run Chinook Salmon juvenile production. The output  
10       from SALMOD indicated that fall-run Chinook Salmon production would be  
11       similar in most water year types under the No Action Alternative than under the  
12       Second Basis of Comparison, and up to 7 percent less than under the Second  
13       Basis of Comparison in critical dry years. The analyses attempting to assess the  
14       effects on routing, entrainment, and salvage of juvenile salmonids in the Delta  
15       suggest that salvage (as an indicator of potential losses of juvenile salmon at the  
16       export facilities) of Sacramento River-origin Chinook Salmon is predicted to be  
17       lower under the No Action Alternative relative to the Second Basis of  
18       Comparison in every month.

19       In Clear Creek and the Feather and American rivers, the analysis of the effects of  
20       the No Action Alternative and Second Basis of Comparison for fall-run Chinook  
21       Salmon relied on the WUA analysis for habitat and water temperature model  
22       output for the rivers at various locations downstream of the CVP and SWP  
23       facilities. The WUA analysis indicated that the availability of spawning and  
24       rearing habitat in Clear Creek and spawning habitat in the Feather and American  
25       rivers would be similar under the No Action Alternative and the Second Basis of  
26       Comparison. The temperature model outputs for each of the fall-run Chinook  
27       Salmon life stages suggest that thermal conditions and effects on fall-run Chinook  
28       Salmon in all of these streams generally would be similar under both scenarios.  
29       The water temperature threshold exceedance analysis that indicated that the water  
30       temperature thresholds for fall-run Chinook Salmon spawning and egg incubation  
31       would be exceeded slightly more frequently in the Feather River and Clear Creek  
32       under the No Action Alternative and could increase the potential for adverse  
33       effects on the fall-run Chinook Salmon populations in Clear Creek and the  
34       Feather River. Results of the analysis using Reclamation's salmon mortality  
35       model indicate that there would be little difference in fall-run Chinook Salmon  
36       egg mortality under the No Action Alternative and the Second Basis of  
37       Comparison.

38       These model results suggest that overall, effects on fall-run Chinook Salmon  
39       could be slightly more adverse under the No Action Alternative than under the  
40       Second Basis of Comparison, with a small likelihood that fall-run Chinook  
41       Salmon production would be lower under the No Action Alternative.

42       Additional RPA actions in the 2009 NMFS BO could help improve conditions for  
43       fall-run Chinook Salmon under the No Action Alternative relative to the Second  
44       Basis of Comparison, such as structural improvements for water temperature  
45       management in the American River (NMFS RPA Action II.3), development of a

1 hatchery management plan for the Nimbus Hatchery (NMFS RPA Action II.6.3)  
2 and actions (NMFS RPA Action Suite IV.4) intended to increase the efficiency of  
3 the Tracy and Skinner Fish Collection Facilities to improve the overall salvage  
4 survival of salmonids.

5 The implementation of fish passage under the No Action Alternative intended to  
6 address the limited availability of suitable habitat for winter-run and spring-run  
7 Chinook Salmon in the Sacramento River reaches downstream of Shasta Dam is  
8 unlikely to benefit fall-run Chinook Salmon unless passage is provided to fall-run  
9 Chinook Salmon. It is unlikely that providing similar fish passage at Folsom Dam  
10 for steelhead would benefit fall-run Chinook Salmon for the same reason.

11 Overall, the results of the numerical models suggest the potential for greater  
12 adverse effects on fall-run Chinook Salmon under the No Action Alternative as  
13 compared to the Second Basis of Comparison. However, discerning a meaningful  
14 difference between these two scenarios based on the quantitative results is not  
15 possible because of the similarity in results (generally differences less than  
16 5 percent) and the inherent uncertainty of the models. In addition, any adverse  
17 effect of the No Action Alternative could be offset by the potentially beneficial  
18 effects resulting from the RPA actions evaluated qualitatively for the No Action  
19 Alternative. Thus, it is concluded that the effects on fall-run Chinook Salmon  
20 would be less adverse under the No Action Alternative than under the Second  
21 Basis of Comparison.

#### 22 *Late Fall-Run Chinook Salmon*

23 Changes in operations that influence temperature and flow conditions in the  
24 Sacramento River downstream of Keswick Dam could affect late fall-run Chinook  
25 Salmon. The following describes those changes and their potential effects.

#### 26 *Changes in Water Temperature*

27 As described above, long-term average monthly water temperatures in the  
28 Sacramento River at Keswick Dam under the No Action Alternative would  
29 generally be similar (less than 0.5°F difference) to water temperatures under the  
30 Second Basis of Comparison. An exception is during September and October of  
31 critical dry years when water temperatures could be up to 1.1°F and 0.8°F higher,  
32 respectively, under the No Action Alternative as compared to the Second Basis of  
33 Comparison and up to 1°F cooler in September of wetter years under the No  
34 Action Alternative (Appendix 6B, Table 5-5-4). A similar pattern in temperature  
35 differences generally would be exhibited at downstream locations along the  
36 Sacramento River (i.e., Ball's Ferry Jelly's Ferry, Bend Bridge, Red Bluff,  
37 Hamilton City, and Knights Landing), with average monthly temperatures  
38 increasing and water temperature differences between scenarios progressively  
39 increasing (up to 0.9°F warmer) in June and up to 4.6°F cooler in September  
40 during the wetter years under the No Action Alternative relative to the Second  
41 Basis of Comparison.

42 Overall, the temperature differences between the No Action Alternative and  
43 Second Basis of Comparison would be relatively minor (less than 0.5°F) and  
44 likely would have little effect on late fall-run Chinook Salmon in the Sacramento

1 River. Spawning of late fall-run Chinook Salmon in the Sacramento River takes  
 2 place from December to mid-April with incubation occurring over the same time  
 3 period and extending into June. The likelihood of adverse effects on late fall-run  
 4 Chinook Salmon spawning and egg incubation would be similar under the No  
 5 Action Alternative and the Second Basis of Comparison due to similar water  
 6 temperatures during the January to May time period.

7 Because late fall-run Chinook Salmon have an extended rearing period, the  
 8 similar water temperatures during the summer under the No Action  
 9 Alternative and Second Basis of Comparison would have similar effects on  
 10 rearing fry and juvenile late fall-run Chinook Salmon in the Sacramento River.  
 11 The lower water temperatures under the No Action Alternative in September of  
 12 wetter years may reduce the likelihood of adverse effects on fry and juvenile late  
 13 fall-run Chinook Salmon in the Sacramento River during this limited time period.

#### 14 *Changes in Exceedances of Water Temperature Thresholds*

15 Average monthly water temperatures under both the No Action Alternative and  
 16 Second Basis of Comparison indicate exceedances of the water temperature  
 17 threshold of 56°F established in the Sacramento River at Red Bluff for Chinook  
 18 Salmon spawning and egg incubation in October, November, and again in April.  
 19 There would be no exceedances of the threshold from December to March under  
 20 both the No Action Alternative and the Second Basis of Comparison. In April,  
 21 model results indicate that water temperatures under the No Action  
 22 Alternative could exceed the threshold about 2 percent more frequently than  
 23 under the Second Basis of Comparison. Temperature conditions in the  
 24 Sacramento River under the No Action Alternative could be slightly more likely  
 25 to affect late fall-run Chinook Salmon spawning and egg incubation than under  
 26 the Second Basis of Comparison because of the increased frequency of  
 27 exceedance of the 56°F threshold in April. However, this difference may be  
 28 partially offset if water temperature management and fish passage measures  
 29 associated with 2009 NMFS BO RPA under the No Action Alternative are  
 30 successful.

#### 31 *Changes in Egg Mortality*

32 For late fall-run Chinook Salmon in the Sacramento River, the long-term average  
 33 egg mortality rate is predicted to range from approximately 2.5 to nearly 5 percent  
 34 in all water year types under the No Action Alternative. Overall, egg mortality  
 35 would be similar under the No Action Alternative and the Second Basis of  
 36 Comparison (Appendix 9C, Table B-2).

#### 37 *Changes in Weighted Usable Area*

38 Modeling results indicate that there would be similar amounts of spawning habitat  
 39 available for late fall-run Chinook Salmon in the Sacramento River from January  
 40 through April under the No Action Alternative and the Second Basis of  
 41 Comparison (Appendix 9E, Table C-14-4). Modeling results also indicate that  
 42 there would be similar amounts of suitable late fall-run Chinook Salmon fry  
 43 rearing habitat available in the Sacramento River from April to June under the



1 No Action Alternative and Second Basis of Comparison (Appendix 9E,  
2 Table C-15-4).

3 A substantial fraction of late fall run Chinook Salmon juveniles oversummer in  
4 the Sacramento River before emigrating, which allows them to avoid predation  
5 through both their larger size and greater swimming ability. One implication of  
6 this life history strategy is that rearing habitat is most likely the limiting factor for  
7 late-fall-run Chinook Salmon, especially if availability of cool water determines  
8 the downstream extent of spawning habitat for late-fall-run Chinook Salmon.  
9 Modeling results indicate that, there would generally be similar amounts of  
10 suitable juvenile rearing habitat available from December through August under  
11 the No Action Alternative and Second Basis of Comparison. There could be  
12 decreases in the amount of late fall-run Chinook Salmon juvenile rearing WUA in  
13 September and November of up to 15 percent (Appendix 9E, Table C-16-4).  
14 Overall, late fall-run juvenile rearing habitat availability would be similar under  
15 the No Action Alternative and the Second Basis of Comparison.

16 *Changes in SALMOD Output – Sacramento River*

17 SALMOD results indicate that potential juvenile production would be similar  
18 under the No Action Alternative and the Second Basis of Comparison  
19 (Appendix 9D, Table B-2-16).

20 *Changes in Delta Passage Model Output*

21 For late fall-run Chinook Salmon, through-Delta survival was predicted to be  
22 slightly higher under the No Action Alternative relative to the Second Basis of  
23 Comparison for all 81 years simulated by the Delta Passage Model (Appendix 9J).  
24 Median Delta survival across all years was 0.244 for the No Action  
25 Alternative and 0.199 for the Second Basis of Comparison.

26 *Changes in Hydrodynamics*

27 The late fall-run Chinook Salmon migration period overlaps with winter-run  
28 Chinook Salmon. See the section on hydrodynamic analysis for winter-run  
29 Chinook Salmon for potential effects on late fall-run Chinook Salmon.

30 *Changes in Junction Entrainment*

31 Entrainment probabilities for late fall-run are assumed to mimic that of winter-run  
32 Chinook Salmon due to overlap in timing. See the section on winter-run Chinook  
33 Salmon entrainment for potential effects on late fall-run Chinook Salmon.

34 *Changes in Salvage*

35 Salvage of late fall-run Chinook Salmon is assumed to mimic that of winter-run  
36 Chinook Salmon due to overlap in timing. See the section on winter-run Chinook  
37 Salmon entrainment for potential effects on late fall-run Chinook Salmon.

38 *Summary of Effects on Late Fall-Run Chinook Salmon*

39 The multiple model and analysis outputs described above characterize the  
40 anticipated conditions for late fall-run Chinook Salmon and their response to  
41 change under the No Action Alternative as compared to the Second Basis of  
42 Comparison. For the purpose of analyzing effects on late fall-run Chinook

1 Salmon and developing conclusions, greater reliance was placed on the outputs  
2 from the SALMOD model because it integrates the available information on  
3 temperature and flows to produce estimates of mortality for each life stage and an  
4 overall, integrated estimate of potential fall-run Chinook Salmon juvenile  
5 production. The output from SALMOD indicated that late fall-run Chinook  
6 Salmon production would be similar under the No Action Alternative and the  
7 Second Basis of Comparison. The analyses attempting to assess the effects on  
8 routing, entrainment, and salvage of juvenile salmonids in the Delta suggest that  
9 salvage (as an indicator of potential losses of juvenile salmon at the export  
10 facilities) of Sacramento River-origin Chinook Salmon is predicted to be lower  
11 under the No Action Alternative relative to the Second Basis of Comparison in  
12 every month.

13 These model results suggest that overall, effects on late fall-run Chinook Salmon  
14 could be slightly less adverse under the No Action Alternative than under the  
15 Second Basis of Comparison. In addition, potential adverse effects may be  
16 lessened under the No Action Alternative by actions intended to increase the  
17 efficiency of the Tracy and Skinner Fish Collection Facilities (NMFS RPA Action  
18 Suite IV.4) and improve the overall salvage survival of salmonids, including late  
19 fall-run Chinook Salmon. Thus, it is concluded that the potential for adverse  
20 effects on late fall-run Chinook Salmon would be lower under the No Action  
21 Alternative compared to the Second Basis of Comparison.

## 22 *Steelhead*

23 Changes in operations that influence temperature and flow conditions could affect  
24 steelhead. The following describes those changes and their potential effects.

### 25 *Changes in Water Temperature*

26 Changes in water temperature could affect steelhead in the Sacramento, Feather,  
27 and American rivers, and Clear Creek. The following describes temperature  
28 conditions in those water bodies.

#### 29 *Sacramento River*

30 As described above, long-term average monthly water temperatures in the  
31 Sacramento River at Keswick Dam under the No Action Alternative would  
32 generally be similar (less than 0.5°F difference) to water temperatures under the  
33 Second Basis of Comparison. An exception is during September and October of  
34 critical dry years when water temperatures could be up to 1.1°F and 0.8°F higher,  
35 respectively, under the No Action Alternative as compared to the Second Basis of  
36 Comparison and up to 1°F cooler in September of wetter years under the No  
37 Action Alternative (Appendix 6B, Table 5-5-4). A similar temperature pattern  
38 generally would be exhibited downstream at Ball's Ferry, Jelly's Ferry, Bend  
39 Bridge and Red Bluff, with average monthly temperatures increasing in a  
40 downstream direction and temperature differences between scenarios  
41 progressively decreasing except in September (up to a 3.2°F difference at Red  
42 Bluff) during wetter years (Appendix 6B, Table B-9-4).

1 Overall, the temperature differences between the No Action Alternative and  
2 Second Basis of Comparison would be relatively minor (less than 0.5°F) and  
3 likely would have little effect on steelhead in the Sacramento River. Based on the  
4 life history timing for steelhead, the slightly higher water temperatures in  
5 September of drier years under the No Action Alternative may increase the  
6 likelihood of adverse effects on steelhead adults migrating upstream in the  
7 Sacramento River. The lower water temperatures in September of wetter years  
8 under the No Action Alternative may decrease the likelihood of adverse effects on  
9 steelhead migration compared to the Second Basis of Comparison.

10 *Clear Creek*

11 Long-term average monthly water temperatures in Clear Creek at Igo under the  
12 No Action Alternative and the Second Basis of Comparison generally would be  
13 similar (less than 0.5°F differences) in most months (Appendix 6B, Table B-3-4).  
14 Modeled average monthly water temperatures during May under the No Action  
15 Alternative would be up to 0.8°F lower than under the Second Basis of  
16 Comparison.

17 The lower water temperatures in May associated with the No Action  
18 Alternative reflect the effects of the additional water discharged from  
19 Whiskeytown Dam to meet the spring attraction flow requirements to promote  
20 attraction of spring-run Chinook Salmon into Clear Creek. While the reduction in  
21 water temperature indicated by the modeling could improve thermal conditions  
22 for steelhead, the duration of the two pulse flows may not be of sufficient duration  
23 (3 days each) to provide temperature benefits. Overall, thermal conditions for  
24 steelhead in Clear Creek would be similar under the No Action Alternative and  
25 the Second Basis of Comparison.

26 *Feather River*

27 Long-term average monthly water temperature in the Feather River in the low  
28 flow channel generally are predicted to be similar (less than 0.5°F differences)  
29 under the No Action Alternative and the Second Basis of Comparison, except  
30 during November and December when average monthly water temperatures could  
31 be up to 1.4°F higher in some water year types. Average monthly water  
32 temperatures in September under the No Action Alternative could be up to 1.3°F  
33 lower than the Second Basis of Comparison in wetter years. Although  
34 temperatures in the river generally become progressively higher in the  
35 downstream direction, the differences between the No Action Alternative and  
36 Second Basis of Comparison exhibit a similar pattern at the downstream locations  
37 (Robinson Riffle and Gridley Bridge), with water temperature differences  
38 between the No Action Alternative and Second Basis of Comparison generally  
39 decreasing in most water year types. However, water temperatures from July to  
40 September under the No Action Alternative could be somewhat (0.7°F to 1.6°F)  
41 cooler on average and up to 4.0°F cooler at the confluence with Sacramento River  
42 in wetter years.

43 Overall, the temperature differences in the Feather River between the No Action  
44 Alternative and Second Basis of Comparison would be relatively minor (less than

1 0.5°F) and likely would have little effect on steelhead in the Feather River. The  
 2 slightly higher water temperatures in November and December under the No  
 3 Action Alternative would likely have little effect on adult steelhead migration as  
 4 water temperatures in the Feather River are typically low during this time period.  
 5 The somewhat lower water temperatures in September of wetter years may reduce  
 6 the likelihood of adverse effects on adult steelhead migrating upstream and  
 7 juveniles rearing in the Feather River, although the increased temperatures in  
 8 September of critical dry years under the No Action Alternative may increase the  
 9 likelihood of adverse effects on migrating and rearing steelhead in this water  
 10 year type.

#### 11 *American River*

12 Average monthly water temperatures in the American River at Nimbus Dam  
 13 under the No Action Alternative generally would be similar (differences less than  
 14 0.5°F) to the Second Basis of Comparison, with the exception of June and  
 15 August, when differences under the No Action Alternative could be as much as  
 16 0.9°F higher in below normal years. This pattern generally would persist  
 17 downstream to Watt Avenue and the mouth, although temperatures under the No  
 18 Action Alternative would be up to 1.6°F and 2.0°F greater, respectively, than  
 19 under the Second Basis of Comparison in June. In addition, average monthly  
 20 water temperatures at the mouth generally would be lower under the No Action  
 21 Alternative than the Second Basis of Comparison in September of wetter years  
 22 when water temperatures under the No Action Alternative could be up to 1.7°F  
 23 cooler.

24 Overall, the temperature differences between the No Action Alternative and  
 25 Second Basis of Comparison would be relatively minor (less than 0.5°F) and  
 26 likely would have little effect on steelhead in the American River. The slightly  
 27 warmer water temperatures in June and August under the No Action  
 28 Alternative may increase the likelihood of adverse effects on steelhead rearing in  
 29 the American River compared to the Second Basis of Comparison.

#### 30 *Changes in Exceedances of Water Temperature Thresholds*

31 Changes in water temperature could result in the exceedance of established water  
 32 temperature thresholds for steelhead in the Sacramento River, Clear Creek, and  
 33 Feather River. The following describes the extent of exceedance for each of  
 34 those streams.

#### 35 *Sacramento River*

36 As described in the life history accounts (Appendix), steelhead spawning in the  
 37 mainstem Sacramento River generally occurs in the upper reaches from Keswick  
 38 Dam downstream to near Balls Ferry, with most spawning concentrated near  
 39 Redding. Most steelhead, however, spawn in tributaries to the Sacramento River.  
 40 Spawning generally takes place in the January through March period when water  
 41 temperatures in the river generally do not exceed 52°F under either the No Action  
 42 Alternative or Second Basis of Comparison. While there are no established  
 43 temperature thresholds for steelhead rearing in the mainstem Sacramento River,  
 44 average monthly temperatures when fry and juvenile steelhead are in the river

1 would generally remain below 56°F at Balls Ferry except in August and  
2 September when this temperature would be exceeded 30 to 40 percent of the time  
3 under both the No Action Alternative and Second Basis of Comparison.  
4 However, water temperatures in the Sacramento River at Balls Ferry would  
5 exceed 56°F about 10 percent more often in September under the Second Basis of  
6 Comparison. Overall, thermal conditions for steelhead in the Sacramento River  
7 would be similar under the No Action Alternative and the Second Basis of  
8 Comparison.

9 *Clear Creek*

10 While there are no established temperature thresholds for steelhead spawning in  
11 Clear Creek, average monthly water temperatures in the river generally would not  
12 exceed 48°F during the spawning period (December to April) under either the No  
13 Action Alternative or Second Basis of Comparison. Similarly, while there are no  
14 established temperature thresholds for steelhead rearing in Clear Creek, average  
15 monthly temperatures throughout the year would not exceed 56°F at Igo. Overall,  
16 thermal conditions for steelhead in Clear Creek would be similar under the No  
17 Action Alternative and the Second Basis of Comparison.

18 *Feather River*

19 Average monthly water temperatures under both the No Action Alternative and  
20 the Second Basis of Comparison would on occasion exceed the water temperature  
21 threshold of 56°F established in the Feather River at Robinson Riffle for steelhead  
22 spawning and incubation during some months, particularly in October and  
23 November, and March and April, when temperature thresholds could be exceeded  
24 frequently (Appendix 9N). There would be a 1 percent exceedance of the 56°F  
25 threshold in December under the No Action Alternative and no exceedances of  
26 the 56°F threshold in January and February under both the No Action  
27 Alternative and the Second Basis of Comparison. However, the differences in the  
28 frequency of exceedance between the No Action Alternative and Second Basis of  
29 Comparison during March and April would be relatively small with water  
30 temperatures under the No Action Alternative exceeding the threshold about  
31 2 percent less frequently in March (18 percent) and the same exceedance  
32 frequency (75 percent) as the Second Basis of Comparison in April.

33 The established water temperature threshold of 63°F for rearing from May  
34 through August would be exceeded often under both the No Action  
35 Alternative and Second Basis of Comparison in May and June, but not at all in  
36 July and August. Water temperatures under the No Action Alternative would  
37 exceed the rearing temperature threshold about 9 percent more frequently than  
38 under the Second Basis of Comparison in May, but no more frequently in June.  
39 Temperature conditions in the Feather River under the No Action  
40 Alternative could be more likely to affect steelhead spawning and rearing than  
41 under the Second Basis of Comparison because of the increased frequency of  
42 exceedance of the 56°F spawning threshold in March and the increased frequency  
43 of exceedance of the 63°F rearing threshold in May.

1            *American River*

2    In the American River, the water temperature threshold for steelhead rearing  
3    (May through October) is 65°F at the Watt Avenue Bridge. Average monthly  
4    water temperatures would exceed this threshold often under both the No Action  
5    Alternative and Second Basis of Comparison, especially in the July through  
6    September period when the threshold is exceeded nearly all of the time. In  
7    addition, the magnitude of the exceedance would be high, with average monthly  
8    water temperatures sometimes higher than 76°F. The differences between the No  
9    Action Alternative and Second Basis of Comparison, however, would be  
10   relatively small and occur only in June (1 percent less frequent exceedance under  
11   the No Action Alternative), and in September, when average monthly water  
12   temperatures under the No Action Alternative would exceed 65°F about 7 percent  
13   less frequently than under the Second Basis of Comparison. Temperature  
14   conditions in the American River under the No Action Alternative could be less  
15   likely to result in adverse effects on steelhead rearing than under the Second Basis  
16   of Comparison because of the reduced frequency of exceedance of the 65°F  
17   rearing threshold.

18           *Changes in Weighted Usable Area*

19   The following describes changes in WUA for steelhead in the Sacramento,  
20   Feather, and American rivers and Clear Creek.

21           *Sacramento River*

22   Modeling results indicate that, in general, there would be similar amounts of  
23   suitable steelhead spawning habitat available from December through March  
24   under the No Action Alternative and the Second Basis of Comparison  
25   (Appendix 9E, Table C-20-4).

26           *Clear Creek*

27   As described above, flows in Clear Creek downstream of Whiskeytown Dam are  
28   not anticipated to differ under the No Action Alternative relative to the Second  
29   Basis of Comparison except in May due to the release of spring attraction flows in  
30   accordance with the 2009 NMFS BO. Therefore, there would be no change in the  
31   amount of potentially suitable spawning and rearing habitat for steelhead (as  
32   indexed by WUA) available under the No Action Alternative as compared to the  
33   Second Basis of Comparison.

34           *Feather River*

35   As described above, flows in the low flow channel of the Feather River are not  
36   anticipated to differ under the No Action Alternative relative to the Second Basis  
37   of Comparison. Therefore, there would be no change in the amount of potentially  
38   suitable spawning habitat for steelhead (as indexed by WUA) available under the  
39   No Action Alternative as compared to the Second Basis of Comparison. The  
40   majority of spawning activity by steelhead in the Feather River occurs in this  
41   reach with a lesser amount of spawning occurring downstream of the  
42   Thermalito Complex.

1 Modeling results indicate that, in general, there would be similar amounts of  
2 spawning habitat for steelhead in the Feather River downstream of Thermalito  
3 available from December through April under the No Action Alternative and the  
4 Second Basis of Comparison (Appendix 9E, Table C-22-4).

5 *American River*

6 Modeling results indicate that, in general, there would be similar amounts of  
7 spawning habitat for steelhead in the American River downstream of Nimbus  
8 Dam available from December through April under the No Action Alternative and  
9 the Second Basis of Comparison (Appendix 9E, Table C-26-4).

10 *Changes in Delta Hydrodynamics*

11 Sacramento River-origin steelhead generally move through the Delta during  
12 spring; however, there is less information on their timing than there is for  
13 Chinook Salmon. Thus, hydrodynamics in the entire January through June period  
14 have the potential to affect juvenile steelhead. For a description of potential  
15 hydrodynamic effects on steelhead, see the descriptions for winter-run and  
16 fall-run Chinook Salmon above.

17 *Summary of Effects on Steelhead*

18 The multiple model and analysis outputs described above characterize the  
19 anticipated conditions for steelhead and their response to change under the No  
20 Action Alternative as compared to the Second Basis of Comparison. The analysis  
21 of the effects of the No Action Alternative and Second Basis of Comparison for  
22 steelhead relied on the WUA analysis for habitat and water temperature model  
23 output for the rivers at various locations downstream of the CVP and SWP  
24 facilities. The WUA analysis indicated that the availability of steelhead spawning  
25 and rearing habitat in Clear Creek and steelhead spawning habitat in the  
26 Sacramento, Feather and American rivers would be similar under the No Action  
27 Alternative and the Second Basis of Comparison. The temperature model outputs  
28 for each of the steelhead life stages suggest that thermal conditions and effects on  
29 steelhead in all of these streams generally would be similar under both scenarios.  
30 This conclusion is supported by the water temperature threshold exceedance  
31 analysis that indicated that the water temperature thresholds for steelhead  
32 spawning and egg incubation would be exceeded slightly less frequently in the  
33 Feather River under the No Action Alternative, although water temperature  
34 thresholds for steelhead rearing would be exceeded more frequently during some  
35 months in the Feather River and American River under the No Action Alternative.  
36 The increased frequency of exceedance of rearing temperature thresholds under  
37 the No Action Alternative could increase the potential for adverse effects on the  
38 steelhead population in the Feather and American rivers.

39 These numerical model results suggest that overall, effects on steelhead could be  
40 slightly more adverse under the No Action Alternative than under the Second  
41 Basis of Comparison, particularly in the Feather and American rivers. However,  
42 implementation of a fish passage program under the No Action  
43 Alternative intended to address the limited availability of suitable habitat for  
44 steelhead in the Sacramento River reaches downstream of Keswick Dam and in

1 the American River could provide a benefit to Central Valley steelhead in the  
2 Sacramento and American rivers. This is particularly important in light of  
3 anticipated increases in water temperature associated with climate change in  
4 2030. In addition to fish passage, preparation and implementation of an HGMP  
5 for steelhead at the Nimbus Fish Hatchery (NMFS RPA Action Suite II.6) and  
6 actions under the No Action Alternative intended to increase the efficiency of the  
7 Tracy and Skinner Fish Collection Facilities (NMFS RPA Action Suite IV.4)  
8 could benefit steelhead under the No Action Alternative in comparison to the  
9 Second Basis of Comparison. Thus, it is concluded that the effects on steelhead  
10 would be less adverse under the No Action Alternative than under the Second  
11 Basis of Comparison.

### 12 *Green Sturgeon*

13 Potential effects on Green Sturgeon were evaluated based on anticipated water  
14 temperature conditions and exceedances of established temperature thresholds in  
15 the Sacramento and Feather rivers. In addition, potential effects on Green  
16 Sturgeon during the Delta portion of their life cycle were evaluated based on  
17 changes in Delta outflow. The effects are described and summarized below.

#### 18 *Changes in Water Temperature*

19 The effects of the No Action Alternative compared to the Second Basis of  
20 Comparison on Green Sturgeon were analyzed based on water temperature model  
21 outputs and comparisons of the frequency of water temperature threshold  
22 exceedances in the Sacramento and Feather rivers.

#### 23 *Sacramento River*

24 Long-term average monthly water temperatures in the Sacramento River at  
25 Keswick Dam under the No Action Alternative would generally be similar (less  
26 than 0.5°F difference) to water temperatures under the Second Basis of  
27 Comparison. An exception is during September and October of critical years  
28 when water temperatures could be up to 1.1°F and 0.8°F higher, respectively,  
29 under the No Action Alternative as compared to the Second Basis of Comparison  
30 and up to 1°F cooler in September of wetter years under the No Action  
31 Alternative (Appendix 6B). A similar pattern in temperature differences  
32 generally would be exhibited at downstream locations along the Sacramento River  
33 (i.e., Ball's Ferry Jelly's Ferry, Bend Bridge, Red Bluff, Hamilton City, and  
34 Knights Landing), with average monthly temperatures increasing in a downstream  
35 direction and temperature differences between scenarios at Knights Landing  
36 progressively increasing (up to 0.9°F warmer) in June and up to 4.6°F cooler in  
37 September during the wetter years under the No Action Alternative relative to the  
38 Second Basis of Comparison. Overall, the temperature differences between the  
39 No Action Alternative and Second Basis of Comparison would be relatively  
40 minor (less than 0.5°F) and likely would have little effect on Green Sturgeon in  
41 the Sacramento River.



1            *Feather River*

2 Long-term average monthly water temperatures in the Feather River in the low  
3 flow channel generally are predicted to be similar (less than 0.5°F differences)  
4 under the No Action Alternative and the Second Basis of Comparison, except  
5 during November and December when average monthly water temperatures could  
6 be up to 1.4°F higher in some water year types. Average monthly water  
7 temperatures in September under the No Action Alternative could be up to 1.3°F  
8 lower than the Second Basis of Comparison in wetter years. Although  
9 temperatures in the river would become progressively higher in the downstream  
10 directions, the water temperature differences between the No Action  
11 Alternative and Second Basis of Comparison exhibit a similar pattern at the  
12 downstream locations (Robinson Riffle and Gridley Bridge), with water  
13 temperature differences between the No Action Alternative and Second Basis of  
14 Comparison generally decreasing in most water year types at the confluence with  
15 Sacramento River (Appendix 6B, Table B-23-1). However, water temperatures  
16 from July to September under the No Action Alternative could be somewhat  
17 (0.7°F to 1.6°F) cooler on average and up to 4.0°F cooler at the confluence with  
18 Sacramento River in wetter years. Overall, the temperature differences between  
19 the No Action Alternative and Second Basis of Comparison would be relatively  
20 minor (less than 0.5°F) and likely would have little effect on Green Sturgeon in  
21 the Feather River.

22            *Changes in Exceedances of Water Temperature Thresholds*

23 Changes in water temperature could result in the exceedance of established water  
24 temperature thresholds for Green Sturgeon in the Sacramento and Feather rivers.  
25 The following describes the exceedances for each of those rivers.

26            *Sacramento River*

27 Average monthly water temperatures in the Sacramento River at Bend Bridge  
28 under both the No Action Alternative and Second Basis of Comparison would  
29 exceed the water temperature threshold of 63°F established for Green Sturgeon  
30 larval rearing in August and September, with exceedances under the No Action  
31 Alternative occurring about 7 percent of the time in August and about 12 percent  
32 of the time in September. This is 1 to 2 percent more frequently than under the  
33 Second Basis of Comparison. Average monthly water temperatures at Bend  
34 Bridge could exceed the threshold by up to 10 degrees (reaching 73°F) during this  
35 period. Temperature conditions in the Sacramento River under the No Action  
36 Alternative could be more likely to result in adverse effects on Green Sturgeon  
37 rearing than under the Second Basis of Comparison because of the increased  
38 frequency of exceedance of the 63°F threshold in August and September.

39            *Feather River*

40 Average monthly water temperatures in the Feather River at Gridley Bridge under  
41 both the No Action Alternative and Second Basis of Comparison would exceed  
42 the water temperature threshold of 64°F established for Green Sturgeon spawning,  
43 incubation, and rearing in May, June, and September; no exceedances under either  
44 scenario would occur in July and August. The frequency of exceedances would

1 be high, with both the No Action Alternative and Second Basis of Comparison  
2 exceeding the threshold in June nearly 100 percent of the time. The magnitude of  
3 the exceedance also would be substantial, with average monthly temperatures  
4 higher than 72°F in June, and higher than 75°F in July and August. Average  
5 monthly water temperatures under the No Action Alternative would exceed the  
6 threshold about 9 percent more frequently than under the Second Basis of  
7 Comparison during May and about 35 percent less frequently in September.  
8 Temperature conditions in the Feather River under the No Action  
9 Alternative could be more likely result in adverse effects on Green Sturgeon  
10 spawning and egg incubation than under the Second Basis of Comparison because  
11 of the increased frequency of exceedance of the 64°F threshold in May. The  
12 reduction in exceedance frequency in September may have little effect on rearing  
13 Green Sturgeon as many juvenile sturgeon may have migrated downstream to the  
14 lower Sacramento River and Delta by this time.

#### 15 *Changes in Delta Outflow*

16 As described in Appendix 9P, mean (March to July) Delta outflow was used an  
17 indicator of potential year class strength and the likelihood of producing a strong  
18 year class of sturgeon. The median value over the 82-year CalSim II modeling  
19 period of mean (March to July) Delta outflow was predicted to be 13 percent  
20 higher under the No Action Alternative than under the Second Basis of  
21 Comparison. In addition, the likelihood of mean (March to July) Delta outflow  
22 exceeding the threshold of 50,000 cfs was the same under both alternatives.

#### 23 *Summary of Effects on Green Sturgeon*

24 The analysis of the effects of the No Action Alternative and Second Basis of  
25 Comparison for Green Sturgeon relied on water temperature model output for the  
26 Sacramento and Feather rivers at various locations downstream of Shasta Dam  
27 and the Thermalito complex. The temperature model outputs for each of these  
28 rivers suggest that thermal conditions and effects on Green Sturgeon in the  
29 Sacramento and Feather rivers generally would be slightly more adverse under the  
30 No Action Alternative. This conclusion is supported by the water temperature  
31 threshold exceedance analysis that indicated that the water temperature thresholds  
32 for Green Sturgeon spawning, incubation, and rearing would be exceeded more  
33 frequently under the No Action Alternative in the Sacramento River. The water  
34 temperature threshold for Green Sturgeon spawning, incubation, and rearing  
35 would also be exceeded more frequently during some months in the Feather River  
36 but would be exceeded substantially less frequently in September under the No  
37 Action Alternative.

38 The increased frequency of exceedance of temperature thresholds under the No  
39 Action Alternative could increase the potential for adverse effects on Green  
40 Sturgeon in the Sacramento and Feather rivers relative to the Second Basis of  
41 Comparison. The analysis based on Delta outflows suggests that the No Action  
42 Alternative provides higher mean (March to July) outflows which could result in  
43 stronger year classes of juvenile Green Sturgeon relative to the Second Basis of  
44 Comparison. In addition, actions under the No Action Alternative intended to  
45 increase the efficiency of the Tracy and Skinner Fish Collection Facilities could

1 improve the overall salvage survival of Green Sturgeon. However, early life stage  
2 survival in the natal rivers is crucial in development of a strong year class.  
3 Therefore, based primarily on the analysis of water temperatures, the No Action  
4 Alternative could be more likely to result in adverse effects on Green Sturgeon  
5 than the Second Basis of Comparison.

6 *White Sturgeon*

7 Changes in water temperature conditions in the Sacramento River would be the  
8 same as those described above for Green Sturgeon in the Sacramento River.  
9 Overall, the temperature differences between the No Action Alternative and  
10 Second Basis of Comparison would be relatively minor (less than 0.5°F) and  
11 likely would have little effect on White Sturgeon in the Sacramento River.

12 The water temperature threshold established for White Sturgeon spawning and  
13 egg incubation in the Sacramento River at Hamilton City is 61°F from March  
14 through June. Although there would be no exceedances of the threshold in March  
15 and April, water temperatures under both the No Action Alternative and Second  
16 Basis of Comparison would exceed this threshold in May and June. The average  
17 monthly water temperatures in May under the No Action Alternative would  
18 exceed this threshold about 55 percent of the time (about 6 percent more  
19 frequently than under the Second Basis of Comparison). In June, average  
20 monthly water temperatures under the No Action Alternative would exceed the  
21 threshold about 86 percent of the time (about 13 percent more frequently than  
22 under the Second Basis of Comparison). Average monthly water temperatures  
23 during May and June under the No Action Alternative would as high as about  
24 65°F which is below the 68°F threshold considered lethal for White Sturgeon  
25 eggs and may cause higher growth rates in juvenile white sturgeon. Temperature  
26 conditions in the Sacramento River under the No Action Alternative could be  
27 more likely to result in adverse effects on White Sturgeon rearing than under the  
28 Second Basis of Comparison because of the increased frequency of exceedance of  
29 the 61°F threshold in May and June.

30 The analysis of the effects of the No Action Alternative and Second Basis of  
31 Comparison for White Sturgeon relied on water temperature model output for the  
32 Sacramento River at various locations downstream of Shasta Dam. The  
33 temperature model outputs suggest that thermal conditions and effects on White  
34 Sturgeon in the Sacramento River generally would be slightly more adverse under  
35 the No Action Alternative. This conclusion is supported by the water temperature  
36 threshold exceedance analysis that indicated that the water temperature thresholds  
37 for White Sturgeon spawning, incubation, and rearing would be exceeded more  
38 frequently under the No Action Alternative in the Sacramento River.

39 Changes in Delta outflows would be the same as those described above for Green  
40 Sturgeon. Mean (March to July) Delta outflow was predicted to be 13 percent  
41 higher under the No Action Alternative than under the Second Basis of  
42 Comparison. In addition, the likelihood of mean (March to July) Delta outflow  
43 exceeding the threshold of 50,000 cfs was the same under both alternatives. In  
44 addition, actions under the No Action Alternative intended to increase the

1 efficiency of the Tracy and Skinner Fish Collection Facilities could improve the  
2 overall salvage survival of White Sturgeon.

3 Overall, the increased frequency of exceedance of temperature thresholds in June  
4 under the No Action Alternative could increase the potential for effects on White  
5 Sturgeon in the Sacramento River relative to the Second Basis of Comparison,  
6 however these effects are uncertain and may include reduced spawning and/or  
7 increased growth. The analysis based on Delta outflows suggests that the No  
8 Action Alternative provides higher mean (March to July) outflows which could  
9 result in stronger year classes of juvenile White Sturgeon relative to the Second  
10 Basis of Comparison. However, early life stage survival in the natal rivers is  
11 crucial in development of a strong year class. Therefore, based primarily on the  
12 analysis of water temperatures, the No Action Alternative could be more likely to  
13 result in adverse effects on White Sturgeon than the Second Basis of Comparison.

#### 14 *Delta Smelt*

15 The potential effects of the No Action Alternative as compared to the Second  
16 Basis of Comparison were analyzed based on differences in proportional  
17 entrainment and the fall abiotic index as described below.

18 As described in Appendix 9G, a proportional entrainment regression model  
19 (based on Kimmerer 2008, 2011) was used to simulate adult Delta Smelt  
20 entrainment, as influenced by OMR flow in December through March. Results  
21 indicate that the percentage of entrainment of migrating and spawning adult Delta  
22 Smelt under the No Action Alternative would be 7 to 8.3 percent, depending on  
23 the water year type, with a long-term average percent entrainment of 7.6 percent.  
24 Percent entrainment of adult Delta Smelt under the No Action Alternative would  
25 be similar to results under the Second Basis of Comparison.

26 A proportional entrainment regression model (based on Kimmerer 2008) was also  
27 used to simulate larval and early juvenile Delta Smelt entrainment, as influenced  
28 by OMR flow and location of X2 in March through June (Appendix 9G). Results  
29 indicate that the percentage of entrainment of larval and early juvenile Delta  
30 Smelt under the No Action Alternative would be 1.3 to 19.3 percent, depending  
31 on the water year type, with a long term average percent entrainment of  
32 8.6 percent, and highest entrainment under critical water year conditions. Percent  
33 entrainment of larval and early juvenile Delta Smelt under the No Action  
34 Alternative would be lower than projected entrainment under the Second Basis of  
35 Comparison by up to 9.4 percent. Under the Second Basis of Comparison, the  
36 long-term average percent entrainment would be 15.5 percent, and highest  
37 entrainment would occur under critical water year conditions, at 23.6 percent.

38 The predicted position of Fall X2 (in September through December) is used as an  
39 indicator of fall abiotic habitat index for Delta Smelt. Feyrer et al. (2010) used  
40 X2 location as an indicator of the extent of habitat available with suitable salinity  
41 for the rearing of older juvenile Delta Smelt. Feyrer et al. (2010) concluded that  
42 when X2 is located downstream (west) of the confluence of the Sacramento and  
43 San Joaquin Rivers, at a distance of 70 to 80 km from the Golden Gate Bridge,  
44 there is a larger area of suitable habitat. The overlap of the low salinity zone (or

1 X2) with the Suisun Bay/Marsh results in a two-fold increase in the habitat index  
2 (Feyrer et al. 2010).

3 The average September through December X2 position in km was used to  
4 evaluate the fall abiotic habitat availability for Delta Smelt under the Alternatives.  
5 X2 values simulated in the CalSim II model for each Alternative were averaged  
6 over September through December, and compared. Results indicate that under  
7 the No Action Alternative, the X2 position would range from 75.9 km to 92.4 km,  
8 depending on the water year type, with a long term average X2 position of 84 km.  
9 The most eastward location of X2 is predicted under Critical water year  
10 conditions. The X2 positions predicted under the No Action Alternative would be  
11 similar to results under the Second Basis of Comparison in drier water year types.  
12 In wetter years, the X2 location would be further west under the No Action  
13 Alternative than under the Second Basis of Comparison, by 6.1 to 9.8 km. This  
14 difference is largely due to implementation of 2008 USFWS BO RPA  
15 Component 3 (Action 4), under the No Action Alternative, which requires  
16 Reclamation and DWR to provide sufficient Delta outflow to maintain a monthly  
17 average X2 no more eastward than 74 km in above normal and wet year types.  
18 Under the Second Basis of Comparison, the long-term average X2 position would  
19 be 88.1 km, a location that does not provide for the advantageous overlap of the  
20 low salinity zone with Suisun Bay/Marsh.

21 Overall, the No Action Alternative likely would result in better conditions for  
22 Delta Smelt than would the Second Basis of Comparison, primarily due to  
23 lower percentage entrainment for larval and juvenile life stages, and more  
24 favorable location of Fall X2 in wetter years, and on average. Given the current  
25 condition of the Delta Smelt population, even small differences between  
26 alternatives may be important.

### 27 *Longfin Smelt*

28 The effects of the No Action Alternative as compared to the Second Basis of  
29 Comparison were analyzed based on the direction and magnitude of OMR flows  
30 during the period (December through June) when adult, larvae, and young  
31 juvenile Longfin Smelt are present in the Delta in the vicinity of the export  
32 facilities (Appendix 5A). The analysis was augmented with calculated Longfin  
33 Smelt abundance index values (Appendix 9G) per Kimmerer et al. (2009), which  
34 is based on the assumptions that lower X2 values reflect higher flows and that  
35 transporting Longfin Smelt farther downstream leads to greater Longfin Smelt  
36 survival. The index value indicates the relative abundance of Longfin Smelt and  
37 not the calculated population.

38 As described in Appendix 5A, OMR flows would generally be negative in all  
39 months under the Second Basis of Comparison, with the long-term average  
40 ranging from -3,700 to -7,400 cfs from December through June; whereas the  
41 OMR flows would generally be less negative during this time period under the No  
42 Action Alternative. The greatest differences between alternatives would be in  
43 April and May, where long-term average OMR flows would be positive under the  
44 No Action Alternative (Appendix 5A, Table C-17-4). The decrease in the  
45 magnitude of negative flows, with positive flows in April and May, under the No

1 Action Alternative as compared to the Second Basis of Comparison suggests that  
2 it could reduce the potential for entrainment of Delta Smelt at the export facilities.

3 Under the No Action Alternative, Longfin Smelt abundance index values range  
4 from 1,147, under critical water year conditions, to a high of 16,635 under wet  
5 water year conditions, with a long-term average value of 7,951. Under the  
6 Second Basis of Comparison, Longfin Smelt abundance index values range from  
7 947 during critical water year conditions to a high of 15,822 under wet water year  
8 conditions, with a long-term average value of 7,257. These results suggest that  
9 the Longfin Smelt abundance index values would be higher in every water year  
10 type under the No Action Alternative as compared to the Second Basis of  
11 Comparison, with a long-term average index for the No Action Alternative that is  
12 almost 10 percent higher than the long-term average index for the Second Basis of  
13 Comparison. For below normal, dry, and critical water years, the Longfin Smelt  
14 abundance index values would be over 20 percent higher under the No Action  
15 Alternative than under the Second Basis of Comparison, with the greatest  
16 difference (26.2 percent) predicted under dry conditions.

17 Overall, based on the decrease in frequency and magnitude of negative OMR  
18 flows and the higher Longfin Smelt abundance index values, especially in dry and  
19 critical years, potential adverse effects on the Longfin Smelt population under the  
20 No Action Alternative likely would be less than under the Second Basis of  
21 Comparison.

## 22 *Sacramento Splittail*

23 Sacramento Splittail could benefit from the increase in inundated floodplain  
24 resulting from implementation of 2009 NMFS BO RPA Action I.6.1, Restoration  
25 of Floodplain Rearing Habitat, which would restore 17,000 to 20,000 acres for the  
26 primary purpose of enhancing rearing habitat for juvenile salmonids. The efforts  
27 currently underway in the Yolo Bypass to comply with this action apply to all  
28 alternatives under consideration and it is assumed that a notch in the Fremont  
29 Weir (6,000 cfs capacity) will be constructed and that the inundation objectives  
30 will be met by 2030. It is not currently known if and how the notch would be  
31 operated and how flows entering the bypass would be managed to accommodate  
32 floodplain rearing.

33 While this action is common to all alternatives, changes in operations that  
34 influence the hydrology in the Sacramento River could affect the frequency and  
35 duration of flows available to provide inundation on the bypass. To generally  
36 evaluate the potential influence of these changes in hydrology, the flows entering  
37 the Yolo Bypass during December through April were examined to determine the  
38 differences among alternatives. It was assumed that the magnitude of flow (and  
39 flow change) roughly corresponds to the amount of inundated floodplain.

40 Under the No Action Alternative, flows entering the Yolo Bypass generally would  
41 be lower than under the Second Basis of Comparison from December through  
42 March, especially during wetter years (Appendix 5A, Table C-26-4). These  
43 decreases would occur during periods of relatively high flow in the bypass, and  
44 may only slightly decrease the potential area of inundation.

1 Overall, the slight flow decreases under the No Action Alternative could result in  
2 less spawning habitat for Sacramento Splittail than under the Second Basis of  
3 Comparison because of the decreased area of potential habitat (inundation).  
4 Given the relatively minor changes in flows into the Yolo Bypass, and the  
5 inherent uncertainty associated with the resolution of the CalSim II model  
6 (average monthly outputs), it is concluded that there would be no definitive  
7 difference in effects on Sacramento Splittail between the No Action  
8 Alternative and Second Basis of Comparison.

9 *Reservoir Fishes*

10 The analysis of effects associated with changes in operation on reservoir fishes  
11 relied on evaluation of changes in available habitat (reservoir storage) and  
12 anticipated changes in black bass nesting success.

13 *Changes in Available Habitat (Storage)*

14 As described in Chapter 5, Surface Water Resources and Water Supplies, changes  
15 in CVP and SWP water supplies and operations under the No Action  
16 Alternative as compared to the Second Basis of Comparison generally would  
17 result in lower reservoir storage in CVP and SWP reservoirs in the Central Valley  
18 Region. Storage levels in Shasta Lake, Lake Oroville, and Folsom Lake would be  
19 lower under the No Action Alternative as compared to the Second Basis of  
20 Comparison, as summarized in Tables 5.12 through 5.14, in the fall and winter  
21 months due to the inclusion of Fall X2 criteria under the No Action Alternative.

22 The highest reductions in Shasta Lake and Lake Oroville storage could be in  
23 excess of 20 percent. Storage in Folsom Lake could be reduced up to around  
24 10 percent in some months of some water year types. Additional information  
25 related to monthly reservoir elevations is provided in Appendix 5A, CalSim II and  
26 DSM2 Modeling. It is anticipated that aquatic habitat within the CVP and SWP  
27 water supply reservoirs is not limiting; however, storage volume is an indicator of  
28 how much habitat is available to fish species inhabiting these reservoirs.  
29 Therefore, the amount of habitat for reservoir fishes could be reduced under the  
30 No Action Alternative as compared to the Second Basis of Comparison.

31 *Changes in Black Bass Nesting Success*

32 Black bass nest survival in CVP and SWP reservoirs is anticipated to be near  
33 100 percent in March and April due to increasing reservoir elevations  
34 (Appendix 9F). For May and June, the likelihood of nest survival for Largemouth  
35 Bass in Shasta Lake being in the 40 to 100 percent range is similar under the No  
36 Action Alternative and the Second Basis of Comparison; however, nest survival  
37 of greater than 40 percent in June is likely only in about 20 percent of the years  
38 evaluated. The likelihood of nest survival for Smallmouth Bass in Shasta Lake  
39 exhibits nearly the same pattern. For Spotted Bass, the likelihood of nest survival  
40 being greater than 40 percent is generally high (near 100 percent) from March to  
41 May under both the No Action Alternative and the Second Basis of Comparison.  
42 For June, Spotted Bass nest survival would be less than for May due to greater  
43 daily reductions in water surface elevation as Shasta Lake is drawn down. The

1 likelihood of survival being greater than 40 percent is about 10 percent higher  
2 under the No Action Alternative as compared to the Second Basis of Comparison.

3 For May and June, the likelihood of nest survival for Largemouth Bass in Lake  
4 Oroville being in the 40 to 100 percent range is higher under the No Action  
5 Alternative as compared to the Second Basis of Comparison; about 10 percent  
6 higher in May and 3 percent higher in June. However, June nest survival of  
7 greater than 40 percent is likely only in about 40 percent of the years evaluated.  
8 The likelihood of nest survival for Smallmouth Bass in Lake Oroville exhibits  
9 nearly the same pattern. For Spotted Bass, the likelihood of nest survival being  
10 greater than 40 percent is high (>90 percent) in May under both the No Action  
11 Alternative and the Second Basis of Comparison with the likelihood of greater  
12 than 40 percent survival similar under the No Action Alternative and the Second  
13 Basis of Comparison. For June, Spotted Bass survival would be less than for May  
14 due to greater daily reductions in water surface elevation as Lake Oroville is  
15 drawn down. The likelihood of survival being greater than 40 percent is  
16 substantially (about 20 percent) higher under the No Action Alternative as  
17 compared to the Second Basis of Comparison.

18 Black bass nest survival in Folsom Lake is near 100 percent in March, April, and  
19 May due to increasing reservoir elevations. For June, the likelihood of nest  
20 survival for Largemouth Bass and Smallmouth Bass in Folsom Lake being in the  
21 40 to 100 percent range is around 5 percent higher under the No Action  
22 Alternative than under the Second Basis of Comparison. For Spotted Bass, nest  
23 survival for June would be less than for May due to greater daily reductions in  
24 water surface elevation. However, the likelihood of survival being greater than  
25 40 percent is about 5 percent higher under the No Action Alternative as compared  
26 to the Second Basis of Comparison.

### 27 *Summary of Effects on Reservoir Fishes*

28 Reservoir storage is anticipated to be reduced under the No Action  
29 Alternative relative to the Second Basis of Comparison and this reduction could  
30 affect the amount of warm and cold water habitat available within the reservoirs.  
31 However, it is unlikely that aquatic habitat within the CVP and SWP water supply  
32 reservoirs is limiting.

33 The analysis of black bass nest survival based on changes in water surface  
34 elevation during the spawning period indicated that the likelihood of high  
35 (>40 percent) nest survival in most of the reservoirs under the No Action  
36 Alternative would be similar under the Second Basis of Comparison from March  
37 through May and somewhat higher in June. Most black bass spawning likely  
38 occurs prior to June, such that drawdowns during June would likely affect only a  
39 small proportion of the spawning population. Thus, it is concluded that effects on  
40 black bass nesting success would be similar under the No Action Alternative and  
41 the Second Basis of Comparison.



1 *Pacific Lamprey*

2 Little information is available on factors that influence populations of Pacific  
3 Lamprey in the Sacramento River, but they are likely affected by many of the  
4 same factors as salmon and steelhead because of the parallels in their life cycles.

5 *Changes in Water Temperature*

6 The following describes anticipated changes in average monthly water  
7 temperature in the Sacramento, Feather, and American rivers and the potential for  
8 those changes to affect Pacific Lamprey.

9 *Sacramento River*

10 Long-term average monthly water temperatures in the Sacramento River at  
11 Keswick Dam under the No Action Alternative would generally be similar (less  
12 than 0.5°F difference) to water temperatures under the Second Basis of  
13 Comparison. An exception is during September and October of critical dry years  
14 when water temperatures could be up to 1.1°F and 0.8°F higher, respectively,  
15 under the No Action Alternative as compared to the Second Basis of Comparison  
16 and up to 1°F cooler in September of wetter years under the No Action  
17 Alternative (Appendix 6B, Table 5-5-4). A similar temperature pattern generally  
18 would be exhibited downstream at Ball's Ferry, Jelly's Ferry, and Bend Bridge,  
19 with average monthly temperatures increasing in a downstream direction and  
20 temperature differences between scenarios progressively decreasing except in  
21 September (up to 2.8°F cooler) at Bend Bridge) during wetter years under the No  
22 Action Alternative. Due to the similarity of water temperatures under the No  
23 Action Alternative and Second Basis of Comparison from January through the  
24 summer, there would be little difference in potential effects on Pacific Lamprey  
25 adults during their migration, holding, and spawning periods.

26 *Feather River*

27 Long-term average monthly water temperature in the Feather River in the low  
28 flow channel (downstream of the Thermalito Complex) generally are predicted to  
29 be similar (less than 0.5°F differences) under the No Action Alternative and the  
30 Second Basis of Comparison, except during November and December when  
31 average monthly water temperatures could be up to 1.4°F higher in some water  
32 year types. Average monthly water temperatures in September under the No  
33 Action Alternative could be up to 1.3°F lower than under the Second Basis of  
34 Comparison in wetter years (Appendix 6B, Table B-20-4). Although  
35 temperatures in the river would become progressively higher in the downstream  
36 directions, the differences in water temperatures between the No Action  
37 Alternative and Second Basis of Comparison would exhibit a similar pattern at the  
38 downstream locations (Robinson Riffle and Gridley Bridge), with water  
39 temperature differences between the No Action Alternative and Second Basis of  
40 Comparison generally decreasing in most water year types. However, water  
41 temperatures from July to September under the No Action Alternative could be  
42 somewhat (0.7°F to 1.6°F) cooler on average and up to 4.0°F cooler at the  
43 confluence with Sacramento River in wetter years (Appendix 6B, Table B-23-4).

1 Due to the similarity of water temperatures under the No Action Alternative and  
2 Second Basis of Comparison from January through the summer, there would be  
3 little difference in potential effects on Pacific Lamprey adults during their  
4 migration, holding, and spawning periods.

5 *American River*

6 Average monthly water temperatures in the American River at Nimbus Dam  
7 under the No Action Alternative generally would be similar (differences less than  
8 0.5°F) to the Second Basis of Comparison, with the exception of during June and  
9 August, when differences under the No Action Alternative could be as much as  
10 0.9°F higher in below normal years. This pattern generally would persist  
11 downstream to Watt Avenue and the mouth, although temperatures under the No  
12 Action Alternative would be up to 1.6°F and 2.0°F greater, respectively, than  
13 under the Second Basis of Comparison in June. In addition, average monthly  
14 water temperatures at the mouth generally would be lower under the No Action  
15 Alternative than the Second Basis of Comparison in September of wetter years  
16 when water temperatures under the No Action Alternative could be up to 1.7°F  
17 cooler. Due to the similarity of water temperatures under the No Action  
18 Alternative and Second Basis of Comparison from January through the summer,  
19 there would be little difference in potential effects on Pacific Lamprey adults  
20 during their migration, holding, and spawning periods.

21 *Summary of Effects on Pacific Lamprey*

22 In general, Pacific Lamprey can tolerate higher temperatures than salmonids, up  
23 to around 72°F during their entire life history. Given the relatively minor changes  
24 in water temperature and water temperature threshold exceedance, and the  
25 inherent uncertainty associated with the resolution of the temperature model  
26 (average monthly outputs), it is likely that effects on Pacific Lamprey in the  
27 Sacramento, Feather, and American rivers would be similar under the No Action  
28 Alternative and the Second Basis of Comparison. This conclusion likely applies  
29 to other species of lamprey that inhabit these rivers (e.g., River Lamprey).

30 *Striped Bass, American Shad, and Hardhead*

31 Changes in operations influence temperature and flow conditions that could affect  
32 Striped Bass, American Shad, and Hardhead. The following describes those  
33 changes and their potential effects.

34 *Changes in Water Temperature*

35 The following describes temperature conditions in the Sacramento, Feather, and  
36 American rivers.

37 *Sacramento River*

38 Long-term average monthly water temperatures in the Sacramento River at  
39 Keswick Dam under the No Action Alternative would generally be similar (less  
40 than 0.5°F difference) to water temperatures under the Second Basis of  
41 Comparison. An exception is during September and October of critical dry years  
42 when water temperatures could be up to 1.1°F and 0.8°F higher, respectively,  
43 under the No Action Alternative as compared to the Second Basis of Comparison

1 and up to 1°F cooler in September of wetter years under the No Action  
2 Alternative (Appendix 6B, Table 5-5-4). A similar temperature pattern generally  
3 would be exhibited downstream at Ball's Ferry, Jelly's Ferry, and Bend Bridge,  
4 with average monthly temperatures increasing in a downstream direction and  
5 temperature differences between scenarios progressively increasing (up to 0.9°F  
6 warmer) in June and up to 4.6°F cooler in September during the wetter years  
7 under the No Action Alternative relative to the Second Basis of Comparison. In  
8 general, Striped Bass, American Shad, and Hardhead can tolerate higher  
9 temperatures than salmonids. Therefore, it is unlikely that the slightly increased  
10 temperatures during some months under the No Action Alternative would have  
11 substantial adverse effects on these species.

12 *Feather River*

13 Average monthly water temperature in the Feather River in the low flow channel  
14 (below the Thermalito Complex) generally were predicted to be similar (less than  
15 0.5°F differences) under the No Action Alternative and the Second Basis of  
16 Comparison, except during November and December when average monthly  
17 water temperatures would be up to 1.4°F higher in some water year types  
18 (Appendix 6B, Table B-20-4). Average monthly water temperatures in  
19 September under the No Action Alternative could be up to 1.3°F lower than under  
20 the Second Basis of Comparison in wetter years. Although temperatures in the  
21 river would become progressively higher in the downstream directions, the  
22 differences between the No Action Alternative and Second Basis of Comparison  
23 exhibit a similar pattern at the downstream locations (Appendix 6B,  
24 Table B-23-4). As described above for the Sacramento River, Striped Bass,  
25 American Shad, and Hardhead can tolerate higher temperatures than salmonids.  
26 Therefore, it is unlikely that the slightly increased temperatures during some  
27 months under the No Action Alternative would have substantial adverse effects  
28 on these species in the Feather River.

29 *American River*

30 Average monthly water temperatures in the American River at Nimbus Dam  
31 under the No Action Alternative generally would be similar (differences less than  
32 0.5°F) to the Second Basis of Comparison, with the exception of during June and  
33 August, when differences under the No Action Alternative could be as much as  
34 0.9°F higher in below normal years. This pattern generally would persist  
35 downstream to Watt Avenue and the mouth, although temperatures under the No  
36 Action Alternative would be up to 1.6°F and 2.0°F greater, respectively, than  
37 under the Second Basis of Comparison in June. As described above for the  
38 Sacramento River, Striped Bass, American Shad, and Hardhead can tolerate  
39 higher temperatures than salmonids. Therefore, it is unlikely that the slightly  
40 increased temperatures during some months under the No Action  
41 Alternative would have substantial adverse effects on these species in the  
42 American River.

1        *Changes in Position of X2*

2        The No Action Alternative would result in a more westward X2 position as  
3        compared to the Second Basis of Comparison during April and May, with similar  
4        values in June (Appendix 5A, Section C Table C-16-4). Based on Kimmerer  
5        (2002) and Kimmerer et al. (2009), this change in X2 would likely increase the  
6        survival index and the habitat index as measured by salinity for Striped Bass and  
7        abundance and habitat index for American Shad.

8        *Summary of Effects on Striped Bass, American Shad, and Hardhead*

9        In general, Striped Bass, American Shad, and Hardhead can tolerate higher  
10       temperatures than salmonids. Given the relatively minor changes in temperature  
11       and temperature threshold exceedance, and the inherent uncertainty associated  
12       with the resolution of the temperature model (average monthly outputs), it is  
13       likely that thermal conditions for and effects on Striped Bass, American Shad, and  
14       Hardhead in the Sacramento, Feather, and American rivers would be similar  
15       under the No Action Alternative and the Second Basis of Comparison. Overall,  
16       the No Action Alternative likely would be similar for Hardhead and have a  
17       slightly lower potential for adverse effects on Striped Bass and American Shad as  
18       compared to the Second Basis of Comparison, primarily due to the potential for  
19       increased survival during larval and juvenile life stages, and more favorable  
20       location of Spring X2 on average.

21       **9.4.3.1.3 Stanislaus River/Lower San Joaquin River**

22       *Fall-Run Chinook Salmon*

23       Changes in operations influence temperature and flow conditions that could affect  
24       fall-run Chinook Salmon in the Stanislaus River downstream of Goodwin Dam  
25       and in the San Joaquin River downstream of the Stanislaus River confluence, as  
26       measured at Vernalis. The following describes those changes and their  
27       potential effects.

28       *Changes in Water Temperature (Stanislaus River)*

29       Average monthly water temperatures in the Stanislaus River at Goodwin Dam  
30       under the No Action Alternative and Second Basis of Comparison generally  
31       would be similar (differences less than 0.5°F), with small differences in critical  
32       dry years when the No Action Alternative would 0.8°F and 1.3°F warmer on  
33       average than under the Second Basis of Comparison during June and September,  
34       respectively, and 0.7°F cooler in November (Appendix 6B, Table B-17-4).

35       Downstream at Orange Blossom Bridge, average monthly water temperatures in  
36       October under the No Action Alternative would be lower in all water year types  
37       than the Second Basis of Comparison by as much as 1.9°F. In most other months,  
38       water temperatures under the No Action Alternative and Second Basis of  
39       Comparison generally would be similar. An exception to this pattern occurs in  
40       April when average monthly water temperatures in all but wet water year types  
41       would be lower under the No Action Alternative by as much as about 1.2°F  
42       (Appendix 6B, Table B-18-4).

1 This temperature pattern would continue downstream to the confluence with the  
2 San Joaquin River, although temperatures would progressively increase, as would  
3 the magnitude of difference between the No Action Alternative and Second Basis  
4 of Comparison. Decreases in average monthly water temperatures in October and  
5 April would be more pronounced under the No Action Alternative, with average  
6 differences as much as 2.7°F in October and 2.0°F in April (Appendix 6B,  
7 Table B-19-4) relative to the Second Basis of Comparison. The magnitude of  
8 differences in average monthly water temperatures between the No Action  
9 Alternative and the Second Basis of Comparison in May and June also would  
10 increase relative to the upstream locations with average June water temperatures  
11 reaching 2.4°F warmer under the No Action Alternative in wet years.

12 Based on the life history timing for fall-run Chinook Salmon, the lower  
13 temperatures in October under the No Action Alternative may reduce the  
14 likelihood of adverse to fall-run Chinook Salmon spawning and egg incubation as  
15 compared to the Second Basis of Comparison.

16 *Changes in Exceedance of Water Temperature Thresholds (Stanislaus River)*

17 While specific water temperature thresholds for fall-run Chinook Salmon in the  
18 Stanislaus River are not established, temperatures generally considered suitable  
19 for fall-run Chinook Salmon spawning (56°F) would be exceeded in October and  
20 November approximately 30 percent of the time in the Stanislaus River at  
21 Goodwin Dam under the No Action Alternative (Appendix 6B, Figures B-17-1  
22 and B-17-2). Similar exceedances would occur under the Second Basis of  
23 Comparison, although slightly less frequently in November. Water temperatures  
24 for rearing from January to May generally would be below 56°F, except in May  
25 when average monthly water temperatures would reach about 60°F under both the  
26 No Action Alternative and the Second Basis of Comparison (Appendix 6B,  
27 Figure B-17-8).

28 Downstream at Orange Blossom Bridge, water temperatures suitable for fall-run  
29 Chinook Salmon spawning (56°F) would be exceeded frequently under both the  
30 No Action Alternative and Second Basis of Comparison during October and  
31 November. Under the No Action Alternative, average monthly water  
32 temperatures would exceed 56°F about 57 percent of the time in October  
33 (Appendix 6B, Figure B-18-1). This, however, would be about 28 percent less  
34 frequently than under the Second Basis of Comparison. In November, average  
35 monthly water temperatures would exceed 56°F about 33 percent of the time  
36 under the No Action Alternative, which would be about 5 percent more frequently  
37 than under the Second Basis of Comparison (Appendix 6B, Figure B-18-2).

38 From January through May, rearing fall-run Chinook Salmon would be subjected  
39 to average monthly water temperatures that exceed 56°F in March (less than  
40 10 percent of the time) and May (about 30 percent of the time) under the No  
41 Action Alternative which is about 10 percent more frequently in May than under  
42 the Second Basis of Comparison (Appendix 6B, Figure B-18-8).

1            *Changes in Egg Mortality (Stanislaus River)*

2 For fall-run Chinook Salmon in the Stanislaus River, the long-term average egg  
3 mortality rate is predicted to be around 7 percent, with higher mortality rates (in  
4 excess of 14 percent) occurring in critical dry years under the No Action  
5 Alternative. Overall, egg mortality in the Stanislaus River would be similar under  
6 the No Action Alternative and the Second Basis of Comparison (Appendix 9C,  
7 Table B-8).

8            *Changes in Delta Hydrodynamics*

9 San Joaquin River-origin fall-run Chinook Salmon smolts are most abundant in  
10 the Delta during the months of April, May and June. Near the Confluence of the  
11 San Joaquin River and the Mokelumne River, the median proportion of positive  
12 velocities was slightly greater under the No Action Alternative relative to the  
13 Second Basis of Comparison in April and May and similar in June  
14 (Appendix 9K). In Old River downstream of the facilities, the median proportion  
15 of positive velocities was substantially greater in April and May, but became  
16 more similar in June. In Old River upstream of the facilities, the median  
17 proportion of positive velocities was slightly to moderately greater for the No  
18 Action Alternative relative to the Second Basis of Comparison in April and May,  
19 respectively, and slightly lower in June. On the San Joaquin River downstream of  
20 the Head of Old River, the proportion of positive velocities was slightly to  
21 moderately lower under the No Action Alternative relative to the Second Basis  
22 of Comparison in April and May, respectively, whereas the values were similar  
23 in June.

24           *Changes in Junction Entrainment*

25 Median entrainment probabilities at the Head of Old River were much greater  
26 under the No Action Alternative relative to the Second Basis of Comparison  
27 during April and May. The median entrainment probability was similar under  
28 both scenarios in the month of June (Appendix 9L). At the Turner Cut junction,  
29 median entrainment probabilities under the No Action Alternative were slightly  
30 lower than the Second Basis of Comparison in June. During April and May,  
31 median entrainment probabilities were more divergent with moderately lower  
32 values for the No Action Alternative relative to the Second Basis of Comparison.  
33 Overall, entrainment was slightly lower at the Columbia Cut junction relative to  
34 Turner Cut, but patterns of entrainment between these two scenarios were similar.  
35 Patterns at the Middle River and Old River junctions were similar to those  
36 observed at Columbia and Turner Cut junctions.

37           *Changes in Fish Passage on the Stanislaus River*

38 The No Action Alternative includes the provision of passage at New Melones  
39 Dam for steelhead. The challenges and difficulties associated with providing fish  
40 passage upstream of Shasta and Folsom dams were briefly summarized  
41 previously, and the same considerations apply to passage upstream of New  
42 Melones Dam.

1 If a fish passage program could establish self-sustaining populations of spring-run  
2 Chinook Salmon and steelhead upstream of New Melones, it would contribute  
3 substantially to satisfaction of the spatial diversity viability standard. The passage  
4 program could also contribute to abundance and productivity, if average returns  
5 consistently exceeded 500 individuals. However, the passage program could also  
6 function as a population sink if fish transported above the reservoir achieved a  
7 cohort replacement rate of less than 1.

8 Insufficient information is available currently on the quantity, suitability, and  
9 accessibility of habitat upstream of New Melones. Given poor habitat data and  
10 the considerable technical uncertainties discussed previously, it is not possible to  
11 determine if (or how much) fish passage at New Melones Dam are likely to affect  
12 the status of Central Valley spring-run Chinook Salmon and steelhead  
13 populations.

14 While the purpose of the fish passage action is not intended to benefit fall-run  
15 Chinook Salmon, it could provide benefit if passage is provided for fall-run  
16 Chinook Salmon.

17 *Summary of Effects on Fall-Run Chinook Salmon*

18 The multiple model and analysis outputs described above characterize the  
19 anticipated conditions for fall-run Chinook Salmon and their response to change  
20 under the No Action Alternative as compared to the Second Basis of Comparison.  
21 In the Stanislaus River, the analysis of the effects of the No Action  
22 Alternative and Second Basis of Comparison for fall-run Chinook Salmon relied  
23 on the water temperature model output for the rivers at various locations  
24 downstream of Goodwin Dam. The temperature model outputs for each of the  
25 fall-run Chinook Salmon life stages suggest that thermal conditions and effects on  
26 fall-run Chinook Salmon in the Stanislaus River generally would be similar under  
27 both scenarios, although water temperatures could be somewhat more suitable for  
28 fall-run Chinook Salmon spawning/egg incubation under the No Action  
29 Alternative. This conclusion is supported by the water temperature threshold  
30 exceedance analysis that indicated that suitable water temperatures for fall-run  
31 Chinook Salmon spawning and egg incubation would be exceeded slightly more  
32 frequently in November, but substantially less frequently in October under the No  
33 Action Alternative. Suitable water temperatures for fall-run Chinook Salmon  
34 rearing would be exceeded somewhat more frequently under the No Action  
35 Alternative. Results of the analysis using Reclamation's salmon mortality model  
36 indicate that there would be little difference in fall-run Chinook Salmon egg  
37 mortality under the No Action Alternative and the Second Basis of Comparison.

38 Implementation of a fish passage project under the No Action Alternative,  
39 although intended to address the limited availability of suitable habitat for spring-  
40 run Chinook Salmon and steelhead in the Stanislaus River reaches downstream of  
41 Goodwin Dam, likely would provide some benefit to fall-run Chinook Salmon if  
42 passage for adult fall-run Chinook Salmon was provided and additional habitat  
43 could be accessed. Any potential benefit to fall-run Chinook Salmon is uncertain.  
44 Moreover, RPA actions intended to increase the efficiency of the Tracy and

1 Skinner Fish Collection Facilities could improve the overall salvage survival of  
2 fall-run Chinook Salmon.

3 The numerical model results for effects on fall-run Chinook Salmon under the No  
4 Action Alternative and Second Basis of Comparison do not definitively show  
5 distinct differences. Because the No Action Alternative has the potential for  
6 beneficial effects resulting from the RPA actions, it is concluded that the effects  
7 on fall-run Chinook Salmon would be less adverse under the No Action  
8 Alternative relative to the Second Basis of Comparison.

#### 9 *Steelhead*

10 Changes in operations that influence temperature and flow conditions in the  
11 Stanislaus River downstream of Goodwin Dam and the San Joaquin River  
12 downstream of the Stanislaus River confluence, as measured at Vernalis could  
13 affect steelhead. The following describes those changes and their potential  
14 effects.

#### 15 *Changes in Water Temperature (Stanislaus River)*

16 Average monthly water temperatures in the Stanislaus River at Goodwin Dam  
17 under the No Action Alternative and Second Basis of Comparison generally  
18 would be similar (differences less than 0.5°F), with small differences in critical  
19 dry years when water temperatures under the No Action Alternative would 0.8°F  
20 and 1.3°F warmer on average than under the Second Basis of Comparison during  
21 June and September, respectively, and 0.7°F cooler in November (Appendix 6B,  
22 Table B-17-4).

23 Downstream at Orange Blossom Bridge, average monthly water temperatures in  
24 October under the No Action Alternative would be lower than the Second Basis  
25 of Comparison in all water year types by as much as 1.9°F. In most other months,  
26 water temperatures under the No Action Alternative and Second Basis of  
27 Comparison generally would be similar, except in April when average monthly  
28 water temperatures would be lower under the No Action Alternative by as much  
29 as about 1.2°F in the drier years (Appendix 6B, Table B-18-4).

30 This temperature pattern would continue downstream to the confluence with the  
31 San Joaquin River, although temperatures would progressively increase, as would  
32 the magnitude of difference between the No Action Alternative and Second Basis  
33 of Comparison. Decreases in average monthly water temperatures in October and  
34 April would be more pronounced under the No Action Alternative, with average  
35 differences as much as 2.7°F (Appendix 6B, Table B-19-4) relative to the Second  
36 Basis of Comparison. The magnitude of differences in average monthly water  
37 temperatures between the No Action Alternative and the Second Basis of  
38 Comparison in May and June also would increase relative to the upstream  
39 locations with average June water temperatures reaching 2.4°F warmer under the  
40 No Action Alternative in wet years.

41 Overall, the temperature differences between the No Action Alternative and  
42 Second Basis of Comparison would be relatively minor (less than 0.5°F) and  
43 likely would have little effect on steelhead in the Stanislaus River. Based on the



1 life history timing for steelhead, the slightly higher temperatures in June and  
2 September of drier years under the No Action Alternative may increase the  
3 likelihood of adverse effects to steelhead rearing in the Stanislaus River; the lower  
4 temperatures in October under the No Action Alternative may reduce the  
5 likelihood of adverse effects on adult steelhead during their upstream migration.

6 *Changes in Exceedance of Water Temperature Thresholds (Stanislaus River)*

7 Average monthly water temperatures in the Stanislaus River at Orange Blossom  
8 Bridge would frequently exceed the temperature threshold (56°F) established for  
9 adult steelhead migration under both the No Action Alternative and Second Basis  
10 of Comparison during October and November. Under the No Action Alternative,  
11 average monthly water temperatures would exceed 56°F about 57 percent of the  
12 time in October which is about 28 percent less frequently than under the Second  
13 Basis of Comparison (Appendix 6B, Figure B-18-1). In November, average  
14 monthly water temperatures would exceed 56°F about 33 percent of the time  
15 under the No Action Alternative, which would be about 5 percent more frequently  
16 than under the Second Basis of Comparison (Appendix 6B, Figure B-18-2).

17 From January through May, the temperature threshold at Orange Blossom Bridge  
18 is 55°F, which is intended to support steelhead spawning. This threshold would  
19 not be exceeded under either the No Action Alternative or Second Basis of  
20 Comparison during January or February. From March through May, however,  
21 exceedances would occur under both the No action Alternative and Second Basis  
22 of Comparison, with the threshold most frequently exceeded (nearly half the time)  
23 under the No Action Alternative in May (Appendix 9N). Average monthly water  
24 temperatures under the No Action Alternative would exceed the threshold  
25 5 percent more frequently in March, 6 percent more frequently in May, and  
26 17 percent less frequently in April than under the Second Basis of Comparison.

27 From June through November, the temperature threshold of 65°F established to  
28 support steelhead rearing would be exceeded under both the No Action  
29 Alternative and Second Basis of Comparison in all months but November, and  
30 would exceed the threshold about 16 percent of the time in July under both the No  
31 Action Alternative and Second Basis of Comparison. The differences between  
32 the No Action Alternative and Second Basis of Comparison range from 1 percent  
33 less frequent exceedance in October to 4 percent more frequent exceedance in  
34 June under the No Action Alternative.

35 Average monthly water temperatures also would exceed the threshold (52°F)  
36 established for smoltification at Knights Ferry. At Goodwin Dam, about 4 miles  
37 upstream of Knights Ferry, average monthly water temperatures under the No  
38 Action Alternative would exceed 52°F in March, April, and May about 8 percent,  
39 33 percent, and 63 percent of the time, respectively. Water temperatures under  
40 the No Action Alternative would result in exceedances occurring about 1 to  
41 2 percent less frequently during the January through May period. Farther  
42 downstream at Orange Blossom Bridge, the temperature threshold for  
43 smoltification is higher (57°F) and would be exceeded less frequently. The  
44 magnitude of the exceedance also would be less. Average monthly water

1 temperatures under the No Action Alternative and the Second Basis of  
2 Comparison would not exceed the threshold during January through March. In  
3 April and May, exceedances of 2 percent and 18 percent would occur under the  
4 No Action Alternative, which represent a frequency of about 6 percent less than  
5 the Second Basis of Comparison in April and about an 8 percent higher frequency  
6 in May.

7 Overall, the differences in exceedance frequency between the No Action  
8 Alternative and Second Basis of Comparison would be relatively small, with the  
9 exception of substantial differences in the frequency of exceedances in October  
10 when the average monthly water temperatures under the No Action  
11 Alternative would exceed the threshold for adult steelhead migration about  
12 28 percent less frequently and in April during the spawning period when the  
13 exceedance frequency would be about 17 percent less. Given the frequency of  
14 exceedance under both the No Action Alternative and Second Basis of  
15 Comparison and the generally stressful temperature conditions in the river, the  
16 substantial differences (improvements) in October and April under the No Action  
17 Alternative suggest that there would be less potential to for adverse effects on  
18 steelhead under the No Action Alternative than under the Second Basis of  
19 Comparison. Even during months when the differences would be relatively small,  
20 the lower frequency of exceedances under the No Action Alternative suggest that  
21 there would be less potential to result in adverse effects on steelhead under the No  
22 Action Alternative than under the Second Basis of Comparison.

### 23 *Changes in Delta Hydrodynamics*

24 San Joaquin River-origin steelhead generally move through the Delta during  
25 spring; however, there is less information on their timing than there is for  
26 Chinook salmon. Thus, hydrodynamics in the entire January through June period  
27 have the potential to affect juvenile steelhead. For a description of potential  
28 hydrodynamic effects on steelhead, see the descriptions for fall-run Chinook  
29 Salmon in the San Joaquin River basin above.

### 30 *Summary of Effects on Steelhead*

31 The analysis of the effects of the No Action Alternative and Second Basis of  
32 Comparison for steelhead relied on the water temperature model output for the  
33 rivers at various locations downstream of Goodwin Dam. The temperature model  
34 outputs for each of the steelhead life stages suggest that thermal conditions and  
35 effects on steelhead generally would be similar under both scenarios, although  
36 water temperatures could be somewhat more suitable for steelhead rearing under  
37 the No Action Alternative. Water temperatures could be somewhat less suitable  
38 during the adult upstream migration period under the No Action relative to the  
39 Second Basis of Comparison. This conclusion is supported by the water  
40 temperature threshold exceedance analysis that indicated that the water  
41 temperature threshold for steelhead migration would be exceeded less frequently  
42 in October, but more frequently in November under the No Action Alternative.  
43 The water temperature threshold for steelhead spawning would also be exceeded  
44 less frequently under the No Action Alternative. The water temperature threshold  
45 for steelhead rearing generally would be exceeded more frequently under the No

1 Action Alternative, while the temperature thresholds for smoltification would be  
2 exceeded less frequently in most months.

3 Implementation of the fish passage program under the No Action  
4 Alternative intended to address the limited availability of suitable habitat for  
5 steelhead in the Stanislaus River reaches downstream of Goodwin Dam could  
6 provide a benefit to steelhead, however, the extent of benefit is uncertain. In  
7 addition, the potential effects of the No Action Alternative could be offset by the  
8 RPA actions intended to reduce predation risk on steelhead in the Stanislaus  
9 River, provide passage to upstream habitat, and to increase the efficiency of the  
10 Tracy and Skinner Fish Collection Facilities. The actions to augment spawning  
11 gravel in the Stanislaus River under the No Action Alternative also could benefit  
12 steelhead.

13 The numerical model results for effects on steelhead under the No Action  
14 Alternative and Second Basis of Comparison do not definitively show distinct  
15 differences. However, in consideration of the potentially beneficial effects  
16 resulting from the RPA actions under the No Action Alternative that are not  
17 included in the numerical models (see Appendix 5A, Section B), the No Action  
18 Alternative has a much greater potential to address the long-term sustainability of  
19 steelhead than does the Second Basis of Comparison. The No Action  
20 Alternative includes provisions for fish passage upstream of New Melones Dam  
21 to address long-term temperature increases associated with climate change. Even  
22 though the success of fish passage is uncertain, it is concluded that the potential  
23 for adverse effects on steelhead under the No Action Alternative would be clearly  
24 less than those under the Second Basis of Comparison, principally because the  
25 Second Basis of Comparison does not include a strategy to address water  
26 temperatures critical to steelhead sustainability over the long term with climate  
27 change by 2030.

### 28 *Reservoir Fishes*

29 The analysis of effects associated with changes in operation on reservoir fishes  
30 relied on evaluation of changes in available habitat (reservoir storage) and  
31 anticipated changes in black bass nesting success.

32 As described in Chapter 5, Surface Water Resources and Water Supplies, changes  
33 in CVP and SWP water supplies and operations under the No Action  
34 Alternative as compared to the Second Basis of Comparison would result in lower  
35 Storage levels in New Melones Reservoir under the No Action Alternative as  
36 compared to the Second Basis of Comparison, as summarized in Table 5.16, due  
37 to increased instream releases to support fish flows under the 2009 NMFS BO.

38 Storage in New Melones could be reduced up to around 10 percent in some  
39 months of some water year types. Additional information related to monthly  
40 reservoir elevations is provided in Appendix 5A, CalSim II and DSM2 Modeling.  
41 It is anticipated that aquatic habitat within New Melones is not limiting; however,  
42 storage volume is an indicator of how much habitat is available to fish species  
43 inhabiting these reservoirs. Therefore, the amount of habitat for reservoir fishes

1 could be reduced under the No Action Alternative as compared to the Second  
2 Basis of Comparison.

3 As shown in Appendix 9F, predicted survival in New Melones is higher than in  
4 the other reservoirs during May and June. For March, Largemouth Bass and  
5 Smallmouth Bass nest survival is predicted to be above 40 percent in all of the  
6 years simulated. For April, the likelihood that nest survival of Largemouth Bass  
7 and Smallmouth Bass is between 40 and 100 percent would be about 13 percent  
8 lower under the No Action Alternative than under the Second Basis of  
9 Comparison, but still would be relatively high (around 80 percent). For May, this  
10 pattern is reversed with the likelihood of high nest survival being similar under  
11 the No Action Alternative and the Second Basis of Comparison. For June, the  
12 likelihood of survival being greater than 40 percent for Largemouth Bass and  
13 Smallmouth Bass in New Melones is also higher (by about 8 percent) under the  
14 No Action Alternative as compared to the Second Basis of Comparison. For  
15 Spotted Bass, nest survival from March through June is anticipated to be near  
16 100 percent in every year under both the No Action Alternative and Second Basis  
17 of Comparison.

18 The somewhat lower likelihood of high nesting survival for Largemouth and  
19 Smallmouth Bass during April is not expected to adversely affect nesting success  
20 because the likelihood of successful nesting would be relatively high. Thus, it is  
21 concluded that effects on black bass nesting success would be similar under the  
22 No Action Alternative and the Second Basis of Comparison.

### 23 *Other species*

24 Changes in operations that influence temperature and flow conditions in the  
25 Stanislaus River downstream of Goodwin Dam and the San Joaquin River at  
26 Vernalis could affect other species such as lampreys, Hardhead, and Striped Bass.

27 As described above, average monthly water temperatures in the Stanislaus River  
28 at Goodwin Dam under the No Action Alternative and Second Basis of  
29 Comparison generally would be similar. Downstream at Orange Blossom Bridge,  
30 average monthly water temperatures in the November to March period under the  
31 No Action Alternative generally would be similar to, although somewhat higher  
32 than, under the Second Basis of Comparison, except in April when average  
33 monthly water temperatures in all water year types would be lower under the No  
34 Action Alternative. This temperature pattern would continue downstream to the  
35 confluence with the San Joaquin River, although temperatures would  
36 progressively increase, as would the magnitude of difference between the No  
37 Action Alternative and Second Basis of Comparison (Appendix 6B,  
38 Table B-19-1).

39 In general, lamprey species can tolerate higher temperatures than salmonids, up to  
40 around 72°F during their entire life history. Because lamprey ammocoetes remain  
41 in the river for several years, any substantial flow reductions or water temperature  
42 increases could result in adverse effects on larval lamprey. Given the relatively  
43 minor changes in water temperature and water temperature threshold exceedance,  
44 and the inherent uncertainty associated with the resolution of the temperature

1 model (average monthly outputs), it is likely that the potential to affect lamprey  
2 species in the Stanislaus and San Joaquin rivers would be similar under the No  
3 Action Alternative and the Second Basis of Comparison.

4 In general, Striped Bass and Hardhead also can tolerate higher temperatures than  
5 salmonids. Given the relatively minor changes in water temperature and water  
6 temperature threshold exceedance, the inherent uncertainty associated with the  
7 resolution of the temperature model (average monthly outputs), it is likely that the  
8 potential to affect Striped Bass and Hardhead in the Stanislaus and San Joaquin  
9 rivers would be similar under the No Action Alternative and the Second Basis of  
10 Comparison.

#### 11 **9.4.3.2 Alternative 1**

12 As described in Chapter 3, Description of Alternatives, Alternative 1 is identical  
13 to the Second Basis of Comparison. As described in Chapter 4, Approach to  
14 Environmental Analysis, Alternative 1 is compared to the No Action  
15 Alternative and the Second Basis of Comparison. However, because aquatic  
16 resource conditions under Alternative 1 are identical to aquatic resource  
17 conditions under the Second Basis of Comparison; Alternative 1 is only compared  
18 to the No Action Alternative.

#### 19 **9.4.3.2.1 Alternative 1 Compared to the No Action Alternative**

##### 20 *Trinity River Region*

##### 21 *Coho Salmon*

22 The analysis of effects associated with changes in operation on Coho Salmon was  
23 conducted using temperature model outputs for Lewiston Dam to anticipate the  
24 likely effects on conditions in the Trinity River downstream of Lewiston Dam for  
25 Coho Salmon.

26 Long-term average monthly water temperatures in the Trinity River at Lewiston  
27 Dam under Alternative 1 generally would be similar to the water temperatures  
28 that would occur under the No Action Alternative (Appendix 6B, Table B-1-1).  
29 Average monthly temperatures under Alternative 1 generally would be similar to  
30 those predicted under the No Action Alternative in most water year types, except  
31 from November through January in above- and below-normal water years when  
32 water temperatures under Alternative 1 could be up to 1.5°F cooler than under the  
33 No Action Alternative. In November of critical years water temperatures under  
34 Alternative 1 could be as much as 2.4°F warmer than under the No action  
35 Alternative (Appendix 6B, Table B-1-1). Average monthly water temperatures  
36 generally would be similar (less than 0.5°F differences) under Alternative 1 and  
37 the No Action Alternative from July through September, except in September of  
38 wet years when temperatures would be slightly (0.7°F) lower under Alternative 1.

39 The USFWS established a water temperature threshold of 56°F for Coho Salmon  
40 spawning in the reach of the Trinity River from Lewiston to the confluence with  
41 the North Fork Trinity River from October through December. Although not  
42 entirely reflective of water temperatures throughout the reach, the temperature

1 model provides average monthly water temperature outputs for releases from the  
2 Lewiston Dam, which may provide perspective on temperature conditions in the  
3 reach below. In October and November, average monthly water temperatures  
4 under both Alternative 1 and the No Action Alternative would exceed 56°F at  
5 Lewiston Dam in some years (Appendix 9N). Under Alternative 1, the threshold  
6 would be exceeded about 6 percent of the time in October, about 1 percent less  
7 frequently than under the No Action Alternative. In November, both scenarios  
8 would result in an exceedance frequency of about 2 percent. There would be no  
9 exceedance of the threshold in December under both the Alternative 1 and the No  
10 Action Alternative.

11 Overall, the temperature model outputs for each of the Coho Salmon life stages  
12 suggest that the temperature of water released at Lewiston Dam generally would  
13 be similar under both scenarios, although the exceedance of water temperature  
14 thresholds would be slightly less frequent (1 percent) under Alternative 1. The  
15 higher water temperatures in November of critical years (and lower temperatures  
16 in December) under Alternative 1 would likely have little effect on Coho Salmon  
17 as water temperatures in the Trinity River are typically low during this time  
18 period. Given the similarity of the results and the inherent uncertainty associated  
19 with the resolution of the temperature model (average monthly outputs),  
20 Alternative 1 and the No Action Alternative are likely to have similar effects on  
21 the Coho Salmon population in the Trinity River.

#### 22 *Spring-run Chinook Salmon*

23 The analysis of effects associated with changes in operation on spring-run  
24 Chinook Salmon was conducted using temperature model outputs for Lewiston  
25 Dam to anticipate the likely effects on conditions in the Trinity River downstream  
26 of Lewiston Dam.

27 As described above for Coho Salmon, the temperature differences between  
28 Alternative 1 and the No Action Alternative would be relatively minor (less than  
29 0.5°F) and likely would have little effect on spring-run Chinook Salmon in the  
30 Trinity River. The higher average monthly water temperatures (up to 2.4°F) in  
31 November of critical years (and lower temperatures in December) under  
32 Alternative 1 would likely have little effect on spring-run Chinook Salmon as  
33 water temperatures in the Trinity River are typically low during this time period.

34 Under both Alternative 1 and the No Action Alternative, average monthly water  
35 temperatures in the Trinity River at Lewiston Dam would infrequently (1 percent  
36 to 2 percent of the time) exceed 60°F, the threshold for spring-run Chinook  
37 Salmon holding. There would be no difference in the frequency of exceedance of  
38 the 60°F threshold under Alternative 1 as compared to the No Action Alternative.  
39 In September, however, the threshold for spawning (56°F) would be exceeded  
40 11 percent of the time under Alternative 1 which is about 2 percent more  
41 frequently than under the No Action Alternative.

42 Overall, the differences in the frequency of threshold exceedance between  
43 Alternative 1 and the No Action Alternative would be relatively minor, although  
44 temperature conditions under Alternative 1 could be slightly more likely to result

1 in adverse effects on spring-run Chinook Salmon spawning than under the No  
2 Action Alternative because of the increased frequency of exceedance of the 56°F  
3 threshold at Lewiston Dam in September.

4 The majority of spring-run Chinook Salmon in the Trinity River are produced in  
5 the South Fork Trinity watershed. Although the water temperatures under  
6 Alternative 1 could result in adverse effects on spring-run Chinook Salmon in the  
7 Trinity River, these effects would not occur in every year and are not anticipated  
8 to be substantial based on the relatively small differences water temperatures  
9 under Alternative 1 as compared to the No Action Alternative.

10 Overall, Alternative 1 is likely to have similar effects on the spring-run Chinook  
11 Salmon population in the Trinity River as compared to the No Action Alternative.  
12 However, implementation of the Hatchery Management Plan (RPA Action II.6.3)  
13 under the No Action Alternative could reduce the impacts of hatchery Chinook  
14 Salmon on natural spring-run Chinook Salmon in the Trinity River, and increase  
15 the genetic diversity and diversity of run-timing for these stocks relative to  
16 Alternative 1. Thus, given the relatively minor changes in water temperature and  
17 water temperature threshold exceedance, the inherent uncertainty associated with  
18 the resolution of the temperature model (average monthly outputs), and the  
19 uncertainty of the hatchery benefits, it is concluded that Alternative 1 and the No  
20 Action Alternative are likely to have similar effects on the spring-run Chinook  
21 Salmon in the Trinity River.

#### 22 *Fall-Run Chinook Salmon*

23 The analysis of effects associated with changes in operation on fall-run Chinook  
24 Salmon was conducted using temperature model outputs for Lewiston Dam to  
25 anticipate the likely effects on conditions in the Trinity River downstream of  
26 Lewiston Dam. In addition, the Reclamation Salmon Mortality Model was used  
27 to assess egg mortality.

28 As described above for Coho Salmon, the temperature differences between  
29 Alternative 1 and No Action Alternative would be relatively minor (less than  
30 0.5°F) and likely would have little effect on fall-run Chinook Salmon in the  
31 Trinity River. The higher water temperatures (as much as 2.4°F) in November of  
32 critical years (and lower temperatures in December) under Alternative 1 would  
33 likely have little effect on fall-run Chinook Salmon as water temperatures in the  
34 Trinity River are typically low during this time period.

35 The temperature threshold and months during which it applies for fall-run  
36 Chinook Salmon are the same as those for Coho Salmon. Under Alternative 1,  
37 the threshold would be exceeded about 6 percent of the time in October, about  
38 1 percent less frequently than under the No Action Alternative. In November,  
39 both conditions would result in an exceedance frequency of about 2 percent.  
40 There would be no exceedance of the threshold in December under both  
41 Alternative 1 and the No Action Alternative. Overall, the differences in the  
42 frequency of threshold exceedance between Alternative 1 and the No Action  
43 Alternative would be relatively minor. Temperature conditions under the  
44 Alternative 1 could be slightly less likely to result in adverse effects on fall-run

1 Chinook Salmon spawning than under the No Action Alternative because of the  
2 reduced frequency of exceedance of the 56°F threshold at Lewiston Dam in  
3 October. However, this would occur prior to the peak spawning period for  
4 fall-run Chinook Salmon.

5 The temperatures described above for the Trinity River downstream of Lewiston  
6 Dam are reflected in the analysis of egg mortality using the Reclamation salmon  
7 mortality model (Appendix 9C). For fall-run Chinook Salmon in the Trinity  
8 River, the long-term average egg mortality rate is predicted to be relatively low  
9 (around 4 percent), with higher mortality rates (nearly 15 percent) occurring in  
10 critical dry years under the No Action Alternative (Appendix 9C, Table B-1-5).  
11 Overall, egg mortality under Alternative 1 and the No Action Alternative would  
12 be similar in all water year types.

13 Although the combined analysis based on water temperature suggests that  
14 operations under Alternative 1 could be slightly less adverse than under the No  
15 Action Alternative, these effects would not occur in every year and are not  
16 anticipated to be substantial based on the relatively small differences in water  
17 temperatures (and similar egg mortality) between Alternative 1 and the No Action  
18 Alternative. In addition, implementation of the Hatchery Management Plan (RPA  
19 Action II.6.3) under the No Action Alternative could reduce the impacts of  
20 hatchery Chinook Salmon on natural fall-run Chinook Salmon in the Trinity  
21 River, and increase the genetic diversity and diversity of run-timing for these  
22 stocks relative to Alternative 1.

23 Overall, given the small differences in the numerical model results and the  
24 inherent uncertainty in the temperature model, as well as the potential for  
25 offsetting benefits associated with the Hatchery Management Plan, it is concluded  
26 that there would be no definitive difference in effects on fall-run Chinook Salmon  
27 between Alternative 1 and the No Action Alternative.

#### 28 *Steelhead*

29 The analysis of effects associated with changes in operation on steelhead relied on  
30 temperature model outputs for Lewiston Dam to anticipate the likely effects on  
31 conditions in the Trinity River downstream of Lewiston Dam.

32 Temperature differences between Alternative 1 and No Action Alternative would  
33 be relatively minor (less than 0.5°F) and likely would have little effect on  
34 steelhead in the Trinity River. The higher water temperatures (up to 2.4°F) in  
35 November of critical years (and lower temperatures in December) under  
36 Alternative 1 would likely have little effect on steelhead as water temperatures in  
37 the Trinity River are typically low during this time period.

38 The temperature threshold and months during which it applies for steelhead are  
39 the same as those described for Coho Salmon. Thus, the frequency of average  
40 monthly water temperatures in the Trinity River at Lewiston Dam exceeding the  
41 threshold of 56°F for steelhead would be the same as those described above for  
42 Coho Salmon. Water temperature conditions under Alternative 1 could be less  
43 likely to affect steelhead spawning than under the No Action Alternative because



1 of the slightly (1 percent) reduced frequency of exceedance of the 56°F threshold  
2 at Lewiston Dam in October. The biological significance of this difference,  
3 however, is uncertain.

4 Although the combined analysis based on water temperature suggests that  
5 operations under Alternative 1 could be slightly less adverse than under the No  
6 Action Alternative, these effects would not occur in every year and are not  
7 anticipated to be substantial based on the relatively small differences in water  
8 temperatures between Alternative 1 and the No Action Alternative. Overall,  
9 given these small differences in water temperatures and the inherent uncertainty  
10 in the temperature model, Alternative 1 and the No Action Alternative are likely  
11 to have similar effects on steelhead in the Trinity River.

#### 12 *Green Sturgeon*

13 The analysis of effects associated with changes in operation on Green Sturgeon  
14 relied on temperature model outputs for Lewiston Dam to anticipate the likely  
15 effects on conditions in the Trinity River downstream of Lewiston Dam.

16 Green Sturgeon spawn in the lower reaches of the Trinity River during April  
17 through June, and water temperatures above about 63°F are believed stressful to  
18 embryos (Van Eenennaam et al. 2005). Average monthly water temperature  
19 conditions during April through June in the Trinity River at Lewiston Dam under  
20 Alternative 1 would be similar to the temperatures under the No Action  
21 Alternative and would not exceed 58°F during this period. In addition, water  
22 temperatures in the reach of the river where Green Sturgeon spawn are likely  
23 controlled by other factors (e.g., ambient air temperatures and tributary inflows)  
24 more than water operations at Trinity and Lewiston dams.

25 Overall, given the similarities between average monthly water temperatures at  
26 Lewiston Dam under Alternative 1 and the No Action Alternative, it is likely that  
27 water temperature conditions for Green Sturgeon in the Trinity River or lower  
28 Klamath River and estuary would be similar under both scenarios.

#### 29 *Reservoir Fishes*

30 The analysis of effects associated with changes in operation on reservoir fishes  
31 relied on evaluation of changes in available habitat (reservoir storage) and  
32 anticipated changes in black bass nesting success.

33 Changes in CVP water supplies and operations under Alternative 1 as compared  
34 to the No Action Alternative would result in higher reservoir storage in Trinity  
35 Lake. Storage in Trinity Lake could increase by up to about 10 percent in some  
36 months of some water year types. Additional information related to monthly  
37 reservoir elevations is provided in Appendix 5A, CalSim II and DSM2 Modeling.

38 Using Trinity Lake storage as an indicator of habitat available to fish species  
39 inhabiting the reservoir, the amount of habitat for reservoir fishes would not be  
40 reduced under Alternative 1 as compared to the No Action Alternative.

1 As shown in Appendix 9F, nest survival in Trinity Lake is near 100 percent in  
2 March and April due to increasing reservoir elevations. For May, the likelihood  
3 of survival for Largemouth Bass in Trinity Lake being in the 40 to 100 percent  
4 range is slightly (about 2 percent) higher under Alternative 1 as compared to the  
5 No Action Alternative. For June, the likelihood of survival being greater than  
6 40 percent for Largemouth Bass is somewhat lower than in May and is slightly  
7 lower (about 2 percent) under Alternative 1 as compared to the No Action  
8 Alternative. For Spotted Bass, the likelihood of survival being greater than  
9 40 percent would be 100 percent in May under both Alternative 1 and the No  
10 Action Alternative. For June, Spotted Bass survival in Trinity Lake would be less  
11 than for May due to greater daily reductions in water surface elevation. The  
12 likelihood of survival being greater than 40 percent would be similar (near  
13 100 percent) under Alternative 1 and the No Action Alternative.

14 Overall, the comparison of storage and the analysis of nesting suggest that effects  
15 of Alternative 1 on reservoir fishes would be similar to those under the No Action  
16 Alternative.

#### 17 *Pacific Lamprey*

18 Little information is available on factors that influence populations of Pacific  
19 Lamprey in the Trinity River, but they are likely affected by many of the same  
20 factors as salmon and steelhead because of the parallels in their life cycles. On  
21 average, the temperature of water released at Lewiston Dam under Alternative 1  
22 generally would be similar to (less than 0.5°F differences) to those under the No  
23 Action Alternative. Given the similarities in water temperatures, it is likely that  
24 the effects on Pacific Lamprey would be similar under Alternative 1 and the No  
25 Action Alternative. This conclusion likely applies to other species of lamprey  
26 that inhabit the Trinity and lower Klamath rivers (e.g., River Lamprey).

#### 27 *Eulachon*

28 It is unclear whether this species has been extirpated from the Klamath River.  
29 Given that the highest increases in flow under Alternative 1 would be less than  
30 10 percent in the Trinity River (Appendix 5A), with a smaller relative change in  
31 the lower Klamath River and Klamath River estuary, and that water temperatures  
32 in the Klamath River are unlikely to be affected by changes upstream at Lewiston  
33 Dam, it is likely that Alternative 1 would have a similar potential to influence  
34 Eulachon in the Klamath River as the No Action Alternative.

#### 35 *Sacramento River System*

##### 36 *Winter-run Chinook Salmon*

37 Changes in operations that influence temperature and flow conditions in the  
38 Sacramento River downstream of Keswick Dam could affect winter-run Chinook  
39 Salmon. The following describes those changes and their potential effects.

##### 40 *Changes in Water Temperature*

41 Long-term average monthly water temperature in the Sacramento River at  
42 Keswick Dam under Alternative 1 would generally be similar to (less than 0.5°F  
43 difference) to water temperatures under the No Action Alternative. An exception

1 is during September and October of critical dry years when water temperatures  
2 could be up to 1.1°F and 0.8°F lower, respectively, under Alternative 1 as  
3 compared to the No Action Alternative and up to 1°F warmer in September of  
4 wetter years in some water year types(up to 0.3°F) (Appendix 6B, Table B-5-1).  
5 A similar pattern of changes in temperature generally would be exhibited  
6 downstream at Ball's Ferry, Jelly's Ferry, and Bend Bridge, with average monthly  
7 temperatures differences between the scenarios progressively decreasing, except  
8 in September (up to 2.8°F warmer at Bend Bridge) during wetter years under  
9 Alternative 1 (Appendix 6B, Table B-8-1).

10 Overall, the temperature differences between Alternative 1 and the No Action  
11 Alternative would be relatively minor (less than 0.5°F) and likely would have  
12 similar effects on winter-run Chinook Salmon in the Sacramento River.  
13 Spawning for winter-run Chinook Salmon in the Sacramento River takes place  
14 from mid-April to mid-August with incubation occurring over the same time  
15 period and extending into October. The somewhat lower water temperatures in  
16 September and October of critical dry years under the No Action  
17 Alternative could reduce the likelihood of adverse effects on winter-run Chinook  
18 Salmon egg incubation and fry rearing during this water year type. However, the  
19 increased water temperatures during this time period under Alternative 1 in wetter  
20 years could increase the likelihood of adverse effects on egg incubation relative to  
21 the No Action Alternative.

#### 22 *Changes in Exceedances of Water Temperature Thresholds*

23 With the exception of April, average monthly water temperatures from April to  
24 September under both Alternative 1 and the No Action Alternative would show  
25 exceedances of the water temperature threshold of 56°F established in the  
26 Sacramento River at Ball's Ferry for winter-run Chinook Salmon spawning and  
27 egg incubation (Appendix 9N). Under Alternative 1, the temperature threshold  
28 generally would be exceeded less frequently than under the No Action  
29 Alternative (by about 1 percent to 3 percent) in the April through August period,  
30 with the temperature threshold in September exceeded in 52 percent of the  
31 simulated years about 10 percent more frequently under Alternative 1 than the No  
32 Action Alternative (42 percent). Farther downstream at Bend Bridge, the  
33 frequency of exceedances would increase, with exceedances under both  
34 Alternative 1 and the No Action as Alternative as high as about 90 percent in  
35 some months. Under Alternative 1, temperature exceedances generally would be  
36 less frequent (by up to 8 percent) than under the No Action Alternative, with the  
37 exception of September, when threshold exceedances under Alternative 1 would  
38 be about 29 percent more frequent.

39 Overall, there would be substantial differences in the frequency of threshold  
40 exceedance between Alternative 1 and the No Action Alternative, particularly in  
41 September. Temperature conditions under Alternative 1 would reduce the  
42 likelihood of adverse effects on winter-run Chinook Salmon egg incubation than  
43 under the No Action Alternative because of the reduced frequency of exceedance  
44 of the 56°F threshold from April through August. However, the substantial

1 increase in the frequency of exceedance in September under Alternative 1 may  
2 increase the likelihood of adverse effects on winter-run Chinook Salmon egg  
3 incubation during this limited portion of the spawning and egg incubation period.

#### 4 *Changes in Egg Mortality*

5 The temperatures described above for the Sacramento River downstream of  
6 Keswick Dam are reflected in the analysis of egg mortality using the Reclamation  
7 salmon mortality model (Appendix 9C). For winter-run Chinook Salmon in the  
8 Sacramento River, the long-term average egg mortality rate is predicted to be  
9 relatively low (around 4 percent), with higher mortality rates (exceeding  
10 20 percent) occurring in critical dry years under Alternative 1. In critical dry  
11 years the average egg mortality rate would be 5.4 percent lower under  
12 Alternative 1 than under the No Action Alternative (Appendix 9C, Table B-4).  
13 Overall, winter-run Chinook Salmon egg mortality in the Sacramento River under  
14 Alternative 1 and the No Action Alternative would be similar, except in critical  
15 dry water years.

#### 16 *Changes in Weighted Usable Area*

17 As described above for the assessment methodology, Weighted Usable Area  
18 (WUA) is a function of flow, but the relationship is not linear due to differences  
19 in depths and velocities present in the wetted channel at different flows. Because  
20 the combination of depths, velocities, and substrates preferred by species and life  
21 stages varies, WUA values at a given flow can differ substantially for the life  
22 stages evaluated.

23 As an indicator of the amount of suitable spawning habitat for winter-run Chinook  
24 Salmon between Keswick Dam and Battle Creek, modeling results indicate that,  
25 in general, there would be similar amounts of spawning habitat available from  
26 May through September under Alternative 1 and the No Action  
27 Alternative (Appendix 9E).

28 Modeling results indicate that, in general, there would be similar amounts of  
29 suitable fry rearing habitat available from June through October under  
30 Alternative 1 and the No Action Alternative (Appendix 9E).

31 Similar to the results for fry rearing WUA, modeling results indicate that there  
32 would be similar amounts of suitable juvenile rearing habitat available during the  
33 juvenile rearing period from September through August under Alternative 1 and  
34 the No Action Alternative (Appendix 9E).

#### 35 *Changes in SALMOD Output*

36 SALMOD results indicate that potential juvenile production under Alternative 1  
37 would be the similar to the No Action Alternative (Appendix 9D, Table B-4-1).

#### 38 *Changes in Delta Passage Model Output*

39 The Delta Passage Model predicted similar estimates of annual Delta survival  
40 across the 81 water year time period for winter-run Chinook Salmon between  
41 Alternative 1 and the No Action Alternative (Appendix 9J). Median Delta  
42 survival would be 0.352 for Alternative 1 and 0.349 for the No Action  
43 Alternative.

1            *Changes in Oncorhynchus Bayesian Analysis Output*

2 Escapement of winter-run Chinook Salmon and Delta survival was modeled by  
3 the Oncorhynchus Bayesian Analysis (OBAN) model for winter-run Chinook  
4 salmon. Escapement was generally lower under Alternative 1 as compared to the  
5 No Action Alternative (Appendix 9I). The median abundance under Alternative 1  
6 was lower in 19 of the 22 years of simulation (1971 to 2002), and there was  
7 typically greater than a 25 percent chance that Alternative 1 values would be  
8 lower than under the No Action Alternative. Median delta survival was  
9 approximately 12 percent lower under Alternative 1 as compared to the No Action  
10 Alternative. However, the probability intervals indicated that no difference  
11 between scenarios was a likely outcome.

12            *Changes in Interactive Object-Oriented Simulation Output*

13 The IOS model predicted similar adult escapement trajectories for winter-run  
14 Chinook Salmon between Alternative 1 and the No Action Alternative across the  
15 81 water years (Appendix 9H). Under Alternative 1 median adult escapement  
16 was 4,042 and under the No Action Alternative, median escapement was 3,935.

17 Similar to adult escapement, the IOS model predicted similar egg survival time  
18 histories for winter-run Chinook Salmon between Alternative 1 and the No Action  
19 Alternative across the 81 water years (Appendix 9H). Under Alternative 1  
20 median egg survival was 0.987 and under the No Action Alternative median egg  
21 survival was 0.990.

22            *Changes in Delta Hydrodynamics*

23 Winter-run Chinook Salmon smolts are most abundant in the Delta during  
24 January, February and March. On the Sacramento River near the confluence of  
25 Georgiana Slough, the median proportion of positive velocities under  
26 Alternative 1 was indistinguishable from the No Action  
27 Alternative (Appendix 9K).

28            *Changes in Junction Entrainment*

29 Entrainment at Georgiana Slough was similar under both Alternative 1 and No  
30 Action Alternative during January, February and March when winter-run Chinook  
31 Salmon smolts are most abundant in the Delta (Appendix 9L).

32            *Changes in Salvage*

33 Salvage of Sacramento River-origin Chinook Salmon is predicted to be greater  
34 under Alternative 1 relative to No Action Alternative in every month  
35 (Appendix 9M). Winter-run Chinook Salmon smolts migrating through the Delta  
36 would be most susceptible in the months of January, February and March.  
37 Predicted values in January and February indicated a moderate increase in the  
38 proportion of fish salvaged under Alternative 1 relative to the No Action  
39 Alternative.

40            *Summary of Effects on Winter-Run Chinook Salmon*

41 The multiple model and analysis outputs described above characterize the  
42 anticipated conditions for winter-run Chinook Salmon and their response to  
43 change under Alternative 1 as compared to the No Action Alternative. For the

1 purpose of analyzing effects on winter-run Chinook Salmon and developing  
2 conclusions, greater reliance was placed on the outputs from the two life cycle  
3 models, IOS and OBAN because they each integrate the available information to  
4 produce single estimates of winter-run Chinook Salmon escapement. The output  
5 from IOS indicated that winter-run Chinook Salmon escapement would be similar  
6 under both scenarios, whereas the OBAN results indicated that escapement under  
7 Alternative 1 would be lower than under the No Action Alternative, although  
8 there would be some chance (less than a 25 percent) that escapement under the  
9 Alternative 1 could be greater than the No Action Alternative.

10 These model results suggest that effects on winter-run Chinook Salmon would be  
11 similar under both scenarios, with a small likelihood that winter-run Chinook  
12 Salmon escapement would be lower under Alternative 1 than under the No Action  
13 Alternative. This potential distinction between the two scenarios, however, may  
14 be offset or reversed by the benefits of implementation of fish passage under the  
15 No Action Alternative intended to address the limited availability of suitable  
16 habitat for winter-run Chinook Salmon in the Sacramento River reaches  
17 downstream of Keswick Dam. This potential beneficial effect and its magnitude  
18 would depend on the success of the fish passage program. In addition, RPA  
19 actions intended to increase the efficiency of the Tracy and Skinner Fish  
20 Collection Facilities could improve the overall salvage survival of winter-run  
21 Chinook Salmon.

22 Overall, the quantitative results from the numerical models suggest that operation  
23 under the Alternative 1 would be more likely to result in adverse effects on  
24 winter-run Chinook Salmon than would the No Action Alternative. In addition,  
25 the potentially beneficial effects resulting from the RPA actions under the No  
26 Action Alternative that are not included in the numerical models (see  
27 Appendix 5A, Section B) suggest that the No Action Alternative has a much  
28 greater potential to address the long-term sustainability of winter-run Chinook  
29 Salmon than does the Alternative 1. It is concluded that the potential for adverse  
30 effects on winter-run Chinook Salmon under Alternative 1 would be greater than  
31 those under the No Action Alternative, principally because Alternative 1 does not  
32 include fish passage to address water temperatures critical to winter-run Chinook  
33 Salmon sustainability over the long term with climate change by 2030.

#### 34 *Spring-run Chinook Salmon*

35 Changes in operations that influence temperature and flow conditions in the  
36 Sacramento River downstream of Keswick Dam, Clear Creek downstream of  
37 Whiskeytown Dam, and Feather River downstream of Oroville Dam could affect  
38 spring-run Chinook Salmon. The following describes those changes and their  
39 potential effects.

#### 40 *Changes in Water Temperature*

41 Changes in water temperature that could affect spring-run Chinook Salmon could  
42 occur in the Sacramento River, Clear Creek, and Feather River. The following  
43 describes temperature conditions in those water bodies.

1                    *Sacramento River*

2 Long-term average monthly water temperature in the Sacramento River at  
3 Keswick Dam under Alternative 1 would generally be similar (less than 0.5°F  
4 difference) to water temperatures under the No Action Alternative. An exception  
5 is during September and October of critical dry years when water temperatures  
6 could be up to 1.1°F and 0.8°F lower, respectively, under Alternative 1 as  
7 compared to the No Action Alternative and up to 1°F warmer in September of  
8 wetter years (Appendix 6B, Table B-5-1). A similar pattern of changes in  
9 temperature generally would be exhibited downstream at Ball's Ferry, Jelly's  
10 Ferry, Bend Bridge and Red Bluff, with average monthly temperature differences  
11 between scenarios progressively decreasing, except in September (up to 3.2°F  
12 warmer at Red Bluff) during wetter years (Appendix 6B, Table B-9-1).

13 Overall, the temperature differences between Alternative 1 and the No Action  
14 Alternative would be relatively minor (less than 0.5°F) and likely would have  
15 little effect on spring-run Chinook Salmon in the Sacramento River. The slightly  
16 lower water temperatures from October to December under Alternative 1 would  
17 likely have little effect on spring-run Chinook Salmon as water temperatures in  
18 the Sacramento River below Keswick Dam are typically low during this time  
19 period. The somewhat higher water temperatures in September of wetter years  
20 may increase the likelihood of adverse effects on spring-run Chinook Salmon  
21 spawning, although the decreased temperatures in September of critical dry years  
22 under Alternative 1 may reduce the likelihood of adverse effects on spring-run  
23 Chinook Salmon spawning in this water year type. There would be little  
24 difference in potential effects on spring-run Chinook Salmon holding over the  
25 summer due to the similar water temperatures during this time period under  
26 Alternative 1 and the No Action Alternative.

27                    *Clear Creek*

28 Average monthly water temperatures in Clear Creek at Igo under Alternative 1  
29 relative to the No Action Alternative are generally predicted to be similar (less  
30 than 0.5°F differences) from September through April and June through August  
31 from September through April and June through August (Appendix 6B,  
32 Table B-3-1). Average monthly water temperatures during May under  
33 Alternative 1 could be higher by up to 0.8°F than under the No Action  
34 Alternative. Overall, thermal conditions for spring-run Chinook Salmon in Clear  
35 Creek would be similar under Alternative 1 and the No Action Alternative.

36                    *Feather River*

37 Average monthly water temperature in the Feather River in the low flow channel  
38 generally were predicted to be similar (less than 0.5°F differences) under  
39 Alternative 1 and the No Action Alternative, except during November and  
40 December when average monthly water temperatures could be up to 1.4°F lower  
41 in some water year types (Appendix 6B, Table B-20-1). Average monthly water  
42 temperatures in September under Alternative 1 could be up to 1.3°F warmer than  
43 under the No Action Alternative in wetter years. Although temperatures in the  
44 river would become progressively higher in the downstream directions, the  
45 differences between Alternative 1 and No Action Alternative would exhibit a

1 similar pattern at the downstream locations (Robinson Riffle and Gridley Bridge),  
 2 with water temperature differences between Alternative 1 and the No Action  
 3 Alternative generally decreasing in most water year types. However, water  
 4 temperatures from July to September under Alternative 1 were predicted to be  
 5 somewhat (0.7°F to 1.6°F) warmer on average and up to 4.0°F warmer at the  
 6 confluence with the Sacramento River in wetter years (Appendix 6B,  
 7 Table B-23-1).

8 Overall, the temperature differences in the Feather River between Alternative 1  
 9 and the No Action Alternative would be relatively minor (less than 0.5°F) and  
 10 likely would have little effect on spring-run Chinook Salmon in the Feather River.  
 11 The slightly lower water temperatures in November and December under  
 12 Alternative 1 would likely have little effect on spring-run Chinook Salmon as  
 13 water temperatures in the Feather River are typically low during this time period.  
 14 The somewhat higher water temperatures in September of wetter years may  
 15 increase the likelihood of adverse effects on spring-run Chinook Salmon  
 16 spawning, although the decreased temperatures in September of critical dry years  
 17 under Alternative 1 may reduce the likelihood of adverse effects on spring-run  
 18 Chinook Salmon spawning in this water year type. There would be little  
 19 difference in potential effects on spring-run Chinook Salmon holding over the  
 20 summer due to the similar water temperatures during this time period under  
 21 Alternative 1 and the No Action Alternative.

#### 22 *Changes in Exceedances of Water Temperature Thresholds*

23 Changes in water temperature could result in the exceedance of established water  
 24 temperature thresholds for spring-run Chinook Salmon in the Sacramento River,  
 25 Clear Creek, and Feather River. The following describes the extent of water  
 26 temperature threshold exceedances for each of those water bodies.

#### 27 *Sacramento River*

28 Average monthly water temperatures under both Alternative 1 and No Action  
 29 Alternative would show exceedances of the water temperature threshold of 56°F  
 30 established in the Sacramento River at Red Bluff for spring-run Chinook Salmon  
 31 (egg incubation) in October, November, and again in April. The exceedances  
 32 would occur at the greatest frequency in October (79 percent of the time under  
 33 Alternative 1); under Alternative 1 the water temperature threshold would be  
 34 exceeded less frequently in November (7 percent of the time under Alternative 1)  
 35 and not exceeded at all from December through March (Appendix 9N). As water  
 36 temperatures warm in the spring, the thresholds would be exceeded in April by  
 37 15 percent under Alternative 1. In the months when the greatest frequency of  
 38 exceedances occur (October, November, and April), model results generally  
 39 indicate less frequent exceedances (by up to 4 percent in October) under  
 40 Alternative 1 than under the No Action Alternative. Temperature conditions in  
 41 the Sacramento River under Alternative 1 could be less likely to affect spring-run  
 42 Chinook Salmon egg incubation than under the No Action Alternative because of  
 43 the decreased frequency of exceedance of the 56°F threshold in October,  
 44 November, and April. However, this difference may be partially offset if water



1 temperature management and fish passage measures associated with 2009 NMFS  
2 BO RPA under the No Action Alternative are successful.

3 *Clear Creek*

4 Average monthly water temperatures under both Alternative 1 and No Action  
5 Alternative would not exceed the water temperature threshold of 60°F established  
6 in Clear Creek at Igo for spring-run Chinook Salmon pre-spawning and rearing in  
7 June through August. However, water temperatures under Alternative 1 and the  
8 No Action Alternative would exceed the water temperature threshold of 56°F  
9 established for spawning in September and October about 10 percent to  
10 15 percent of the time (Appendix 9N). Water temperatures under Alternative 1  
11 could exceed the threshold about 3 percent less frequently than under the No  
12 Action Alternative in September and about 2 percent less frequently in October  
13 (Appendix 9N). Temperature conditions in Clear Creek under Alternative 1 could  
14 be less likely to affect spring-run Chinook Salmon spawning than under the No  
15 Action Alternative because of the decreased frequency of exceedance of the 56°F  
16 threshold in September and October. However, this difference may be partially  
17 offset if the thermal stress reduction measures associated with 2009 NMFS BO  
18 RPA Action I.1.5 under the No Action Alternative are successful in improving  
19 water temperatures in Clear Creek.

20 *Feather River*

21 Average monthly water temperatures under both Alternative 1 and the No Action  
22 Alternative would exceed the water temperature threshold of 56°F established in  
23 the Feather River at Robinson Riffle for spring-run Chinook Salmon egg  
24 incubation and rearing during some months, particularly in October and  
25 November, and March and April, when temperature thresholds could be exceeded  
26 frequently (Appendix 9N). The frequency of exceedance was highest in October,  
27 a month in which average monthly water could get as high as about 68°F.  
28 However, water temperatures under Alternative 1 would exceed the spawning  
29 temperature threshold about 1 percent less frequently than under the No Action  
30 Alternative in October, November, and December, and about 2 percent more  
31 frequently in March.

32 The established water temperature threshold of 63°F for rearing during May  
33 through August would be exceeded often under both Alternative 1 and the No  
34 Action Alternative in May and June, but not at all in July and August. Water  
35 temperatures under Alternative 1 would exceed the rearing temperature threshold  
36 about 9 percent less frequently than under the No Action Alternative in May.  
37 Temperature conditions in the Feather River under Alternative 1 could be less  
38 likely to affect spring-run Chinook Salmon spawning and rearing than under the  
39 No Action Alternative because of the decreased frequency of exceedance of the  
40 water temperature thresholds.

41 *Changes in Egg Mortality*

42 These temperature differences described above are reflected in the analysis of egg  
43 mortality using the Reclamation salmon mortality model (Appendix 9C). For  
44 spring-run Chinook Salmon in the Sacramento River, the long-term average egg

1 mortality rate is predicted to be relatively high (exceeding 20 percent), with high  
2 mortality rates (exceeding 70 percent) occurring in critical dry years. In critical  
3 dry years the average egg mortality rate under Alternative 1 is predicted to be  
4 10.4 percent lower than under the No Action Alternative (Appendix 9C,  
5 Table B-3). Overall, spring-run Chinook Salmon egg mortality in the Sacramento  
6 River under Alternative 1 and the No Action Alternative would be similar, except  
7 in critical dry water years.

#### 8 *Changes in Weighted Usable Area*

9 Weighted usable area curves are available for spring-run Chinook Salmon in  
10 Clear Creek. As described above, flows in Clear Creek downstream of  
11 Whiskeytown Dam are not anticipated to differ under Alternative 1 relative to the  
12 No Action Alternative except in May due to the release of spring attraction flows  
13 in accordance with the 2009 NMFS BO under the No Action Alternative.  
14 Therefore, there would be no change in the amount of potentially suitable  
15 spawning and rearing habitat for spring-run Chinook Salmon (as indexed by  
16 WUA) available under Alternative 1 as compared to the No Action Alternative.

#### 17 *Changes in SALMOD Output*

18 SALMOD results indicate that potential spring-run juvenile production would be  
19 similar under Alternative 1 and the No Action Alternative except that production  
20 under Alternative 1 could be 12 percent higher than under the No Action  
21 Alternative in critical dry years (Appendix 9D, Table B-3-1).

#### 22 *Changes in Delta Passage Model Output*

23 The Delta Passage Model predicted similar estimates of annual Delta survival  
24 across the 81 water year time period for spring-run Chinook Salmon between  
25 Alternative 1 and the No Action Alternative (Appendix 9J). Median Delta  
26 survival was 0.286 for Alternative 1 and 0.296 for the No Action Alternative.

#### 27 *Changes in Delta Hydrodynamics*

28 Spring-run Chinook Salmon are most abundant in the Delta from March through  
29 May. Near the junction of Georgiana Slough, the median percent of time that  
30 velocity was positive was similar in March, April, and May for both scenarios. In  
31 Old River upstream of the facilities, the median percent of time with positive  
32 velocity was similar in March, slightly lower in April, and moderately lower in  
33 May under Alternative 1 relative to the No Action Alternative (Appendix 9K). In  
34 Old River downstream of the facilities the median percent of time with positive  
35 velocity was slightly lower in March and increasingly lower in April and May  
36 under Alternative 1 relative to No Action Alternative.

#### 37 *Changes in Junction Entrainment*

38 Entrainment at Georgiana Slough was similar under both Alternative 1 and No  
39 Action Alternative during March, April and May when spring run are most  
40 abundant in the Delta (Appendix 9L).

1            *Changes in Salvage*

2 Salvage of Sacramento River-origin Chinook Salmon is predicted to be higher  
3 under Alternative 1 relative to No Action Alternative in every month  
4 (Appendix 9M). Spring-run smolts migrating through the Delta would be most  
5 susceptible in the months of March April and May. Predicted values in April and  
6 May indicated a substantially larger fraction of fish salvaged under Alternative 1.  
7 Predicted salvage was more similar in March but still higher under Alternative 1  
8 than under the No Action Alternative.

9            *Summary of Effects on Spring-Run Chinook Salmon*

10 The multiple model and analysis outputs described above characterize the  
11 anticipated conditions for spring-run Chinook Salmon and their response to  
12 change under Alternative 1 and the No Action Alternative. For the purpose of  
13 analyzing effects on spring-run Chinook Salmon in the Sacramento River, greater  
14 reliance was placed on the outputs from the SALMOD model because it integrates  
15 the available information on temperature and flows to produce estimates of  
16 mortality for each life stage and an overall, integrated estimate of potential spring-  
17 run Chinook Salmon juvenile production. The output from SALMOD indicated  
18 that spring-run Chinook Salmon production in the Sacramento River would be  
19 similar under Alternative 1 and the No Action Alternative, although production  
20 under Alternative 1 could be over 10 percent greater than under the No Action  
21 Alternative in critical dry years. The analyses attempting to assess the effects on  
22 routing, entrainment, and salvage of juvenile salmonids in the Delta suggest that  
23 salvage (as an indicator of potential losses of juvenile salmon at the export  
24 facilities) of Sacramento River-origin Chinook Salmon is predicted to be higher  
25 under Alternative 1 relative to No Action Alternative in every month.

26 In Clear Creek and the Feather River, the analysis of the effects of Alternative 1  
27 and the No Action Alternative for spring-run Chinook Salmon relied on output  
28 from the WUA analysis and water temperature output for Clear Creek at Igo, and  
29 in the Feather River low flow channel and downstream of the Thermalito  
30 complex. The WUA analysis suggests that there would be little difference in the  
31 availability of spawning and rearing habitat in Clear Creek. The temperature  
32 model outputs suggest that thermal conditions and effects on each of the spring-  
33 run Chinook Salmon life stages generally would be similar under both scenarios  
34 in Clear Creek and the Feather River, although water temperatures could be  
35 somewhat more suitable for spring-run Chinook Salmon holding and  
36 spawning/egg incubation in the Feather River under Alternative 1. This  
37 conclusion is supported by the water temperature threshold exceedance analysis  
38 that indicated that water temperature thresholds for spawning and egg incubation  
39 would be exceeded slightly less frequently under Alternative 1 than under the No  
40 Action Alternative in Clear Creek and the Feather River. The water temperature  
41 threshold for rearing spring-run Chinook Salmon would also be exceeded slightly  
42 less frequently in the Feather River under Alternative 1. Because of the inherent  
43 uncertainty associated with the resolution of the temperature model (average  
44 monthly outputs), the slightly greater likelihood of exceeding water temperature  
45 thresholds under Alternative 1 could increase the potential for adverse effects on

1 the spring-run Chinook Salmon populations in the Feather River. Given the  
2 similarity of the results, Alternative 1 and the No Action Alternative are likely to  
3 have similar effects on the spring-run Chinook Salmon population in Clear Creek.

4 These model results suggest that overall, effects on spring-run Chinook Salmon  
5 could be slightly less adverse under Alternative 1 than the No Action Alternative.  
6 This potential distinction between the two scenarios, however, may be partially  
7 offset by the benefits of implementation of fish passage under the No Action  
8 Alternative intended to address the limited availability of suitable habitat for  
9 spring-run Chinook Salmon in the Sacramento River reaches downstream of  
10 Keswick Dam. This potential beneficial effect and its magnitude would depend  
11 on the success of the fish passage program. In addition, RPA actions intended to  
12 increase the efficiency of the Tracy and Skinner Fish Collection Facilities could  
13 improve the overall salvage survival of spring-run Chinook Salmon under the No  
14 Action Alternative.

15 Thus, it is concluded that the potential for adverse effects on spring-run Chinook  
16 Salmon under Alternative 1 would be greater than under the No Action  
17 Alternative, principally because Alternative 1 does not include a strategy to  
18 address water temperatures critical to spring-run Chinook Salmon sustainability  
19 over the long term with climate change by 2030.

#### 20 *Fall-Run Chinook Salmon*

21 Changes in operations that influence temperature and flow conditions in the  
22 Sacramento River downstream of Keswick Dam, Clear Creek downstream of  
23 Whiskeytown Dam, Feather River downstream of Oroville Dam and American  
24 River downstream of Nimbus could affect fall-run Chinook Salmon. The  
25 following describes those changes and their potential effects.

#### 26 *Changes in Water Temperature*

27 Changes in water temperature could affect fall-run Chinook Salmon in the  
28 Sacramento, Feather, and American rivers, and Clear Creek. The following  
29 describes temperature conditions in those water bodies.

#### 30 *Sacramento River*

31 Long-term average monthly water temperature in the Sacramento River at  
32 Keswick Dam under Alternative 1 would generally be similar (less than 0.5°F  
33 difference) to water temperatures under the No Action Alternative. An exception  
34 is during September and October of critical dry years when water temperatures  
35 could be up to 1.1°F and 0.8°F lower, respectively, under Alternative 1 as  
36 compared to the No Action Alternative and up to 1°F warmer in September of  
37 wetter years (Appendix 6B). A similar pattern in temperature differences  
38 generally would be exhibited at downstream locations along the Sacramento River  
39 (i.e., Ball's Ferry Jelly's Ferry, Bend Bridge, Red Bluff, Hamilton City, and  
40 Knights Landing), with temperature differences between scenarios at Knights  
41 Landing progressively increasing (up to 0.9°F cooler) in June and up to 4.6°F  
42 warmer in September during wetter years under Alternative 1 relative to the No  
43 Action Alternative.

1 Overall, the temperature differences between Alternative 1 and the No Action  
2 Alternative would be relatively minor (less than 0.5°F) and likely would have  
3 little effect on fall-run Chinook Salmon in the Sacramento River. The somewhat  
4 higher water temperatures in September of wetter years may increase the  
5 likelihood of adverse effects on early spawning fall-run Chinook Salmon under  
6 Alternative 1, although the reduced water temperatures in September of critical  
7 dry years under Alternative 1 may decrease the likelihood of adverse effects on  
8 fall-run Chinook Salmon spawning in this water year type.

9 *Clear Creek*

10 Average monthly water temperatures in Clear Creek at Igo under Alternative 1  
11 relative to the No Action Alternative are generally predicted to be similar (less  
12 than 0.5°F) from September through April and June through August  
13 (Appendix 6B, Table B-3-1). Average monthly water temperatures during May  
14 under Alternative 1 would be higher by up to 0.8°F than under the No Action  
15 Alternative. Average monthly temperatures at the confluence with the  
16 Sacramento River would exhibit a similar pattern, although temperatures in the  
17 creek would be slightly higher in general.

18 Under Alternative 1, temperature conditions at Igo would be similar to  
19 temperature conditions under the No Action Alternative. However, these  
20 temperature outputs represent conditions at Igo, a location upstream of most  
21 fall-run Chinook Salmon spawning and rearing. Water temperatures where most  
22 fall-run Chinook Salmon inhabit the creek would be somewhat higher as indicated  
23 by average monthly temperatures at the confluence with the Sacramento River,  
24 although these temperatures would be similar under Alternative 1 and the No  
25 Action Alternative. Overall, thermal conditions for fall-run Chinook Salmon in  
26 Clear Creek would be similar under Alternative 1 and the No Action Alternative.

27 *Feather River*

28 Average monthly water temperature in the Feather River in the low flow channel  
29 generally were predicted to be similar (less than 0.5°F differences) under  
30 Alternative 1 and the No Action Alternative, except during November and  
31 December when average monthly water temperatures could be up to 1.4°F lower  
32 in some water year types (Appendix 6B, Table B-20-1). Average monthly water  
33 temperatures in September under Alternative 1 could be up to 1.3°F warmer than  
34 under the No Action Alternative in wetter years. Although temperatures in the  
35 river would become progressively higher in the downstream directions, the  
36 differences between Alternative 1 and No Action Alternative would exhibit a  
37 similar pattern at the downstream locations (Robinson Riffle and Gridley Bridge),  
38 with water temperatures differences between Alternative 1 and the No Action  
39 Alternative generally decreasing in most water year types. However, water  
40 temperatures under Alternative 1 were predicted to be somewhat (0.7°F to 1.6°F)  
41 warmer on average and up to 4.0°F warmer at the confluence with the Sacramento  
42 River from July to September in wetter years (Appendix 6B, Table B-23-1).

1 Overall, the temperature differences in the Feather River between Alternative 1  
 2 and the No Action Alternative would be relatively minor (less than 0.5°F) and  
 3 likely would have little effect on fall-run Chinook Salmon in the Feather River.  
 4 The slightly lower water temperatures in November and December under  
 5 Alternative 1 would likely have little effect on fall-run Chinook Salmon as water  
 6 temperatures in the Feather River are typically low during this time period. The  
 7 somewhat higher water temperatures in September of wetter years may increase  
 8 the likelihood of adverse effects on early spawning fall-run Chinook Salmon,  
 9 although the decreased temperatures in September of critical dry years under  
 10 Alternative 1 may reduce the likelihood of adverse effects on fall-run Chinook  
 11 Salmon spawning in this water year type.

#### 12 *American River*

13 Long-term average monthly water temperatures in the American River at Nimbus  
 14 Dam under Alternative 1 generally would be similar (differences less than 0.5°F)  
 15 to the No Action Alternative, with the exception of during June and August, when  
 16 temperatures under Alternative 1 could be as much as 0.9°F lower in below  
 17 normal years (Appendix 6B, Table B-12-1). This pattern generally would persist  
 18 downstream to Watt Avenue and the mouth, although temperatures under  
 19 Alternative 1 would be up to 1.6°F and 2.0°F lower, respectively, than under the  
 20 No Action Alternative in June. In addition, average monthly water temperatures  
 21 at the mouth generally would be higher under Alternative 1 than the No Action  
 22 Alternative in September of wetter years when water temperatures under  
 23 Alternative 1 could be up to 1.7°F warmer (Appendix 6B, Table B-14-1).

24 Overall, the temperature differences in the American River between Alternative 1  
 25 and the No Action Alternative would be relatively minor (less than 0.5°F) and  
 26 likely would have little effect on fall-run Chinook Salmon in the American River.  
 27 The slightly lower water temperatures in June and August in some water year  
 28 types under Alternative 1 may decrease the likelihood of adverse effects on  
 29 fall-run Chinook Salmon rearing in the American River if they are present. The  
 30 slightly higher water temperatures during September under Alternative 1 would  
 31 have little effect on fall-run Chinook Salmon spawning in the American River  
 32 because most spawning occurs later in November.

#### 33 *Changes in Exceedances of Water Temperature Thresholds*

34 Changes in water temperature could result in the exceedance of water  
 35 temperatures that are protective of fall-run Chinook Salmon in the Sacramento  
 36 River, Clear Creek, Feather River, and American River. The following describes  
 37 the extent of those exceedances for each of those water bodies.

#### 38 *Sacramento River*

39 Average monthly water temperatures under both Alternative 1 and the No Action  
 40 Alternative indicate exceedances of the water temperature threshold of 56°F  
 41 established in the Sacramento River at Red Bluff for Chinook Salmon spawning  
 42 and egg incubation in October, November, and again in April. There would be no  
 43 exceedances of the threshold from December to March under both Alternative 1  
 44 and the No Action Alternative. In the months when the greatest frequency of

1 exceedances occur (October, November, and April), model results generally  
2 indicate less frequent exceedances (by up to 4 percent in October) under  
3 Alternative 1 than under the No Action Alternative. Temperature conditions in  
4 the Sacramento River under Alternative 1 could be less likely to affect fall-run  
5 Chinook Salmon spawning and egg incubation than under the No Action  
6 Alternative because of the reduced frequency of exceedance of the 56°F threshold  
7 in October, November, and April. However, this difference may be partially  
8 offset if water temperature management and fish passage measures associated  
9 with 2009 NMFS BO RPA under the No Action Alternative are successful.

10 *Clear Creek*

11 Fall-run Chinook Salmon spawning in lower Clear Creek typically occurs during  
12 October through December (USFWS 2015). Average monthly water  
13 temperatures at Igo during this period generally fall below 56°F, except in  
14 October. Under Alternative 1, the 56°F threshold would be exceeded in October  
15 about 10 percent of the time as compared to 12 percent under the No Action  
16 Alternative (Appendix 9N). At the confluence with the Sacramento River,  
17 average monthly water temperatures in October would be warmer, with the 56°F  
18 threshold exceeded slightly less frequently under Alternative 1 compared to the  
19 No Action Alternative (Appendix 6B, Figure B-4-1). During November and  
20 December, average monthly water temperatures generally would remain below  
21 56°F at both locations (Appendix 6B, Figure B-4-2 and B-4-3). Temperature  
22 conditions in Clear Creek under Alternative 1 could be less likely to affect  
23 fall-run Chinook Salmon spawning and egg incubation than under the No Action  
24 Alternative because of the reduced frequency of exceedance of the 56°F threshold  
25 in October.

26 For fall-run Chinook Salmon rearing (January through August), the average  
27 monthly temperatures at Igo would likely remain below the 60°F rearing  
28 threshold in all months. Downstream at the mouth of Clear Creek, average  
29 monthly water temperatures would exceed the 60°F threshold often during the  
30 summer, but the frequency of exceedance would be similar under Alternative 1  
31 and the No Action Alternative (Appendix 6B). Temperature conditions for fall-  
32 run Chinook Salmon rearing in Clear Creek would be similar under Alternative 1  
33 and the No Action Alternative.

34 *Feather River*

35 Average monthly water temperatures under both Alternative 1 and No Action  
36 Alternative would exceed the water temperature threshold of 56°F established in  
37 the Feather River at Gridley Bridge for fall-run Chinook Salmon spawning and  
38 egg incubation during some months, particularly in October, November, March,  
39 and April, when this temperature threshold would be exceeded frequently  
40 (Appendix 6B, Table B-22-4). The frequency of exceedance would be greatest in  
41 October, when average monthly temperatures under both Alternative 1 and the No  
42 Action Alternative would be above the threshold in nearly every year. The  
43 magnitude of the exceedances would be high as well, with average monthly  
44 temperatures in October reaching about 68°F. Similarly, the threshold would be  
45 exceeded under both Alternative 1 and the No Action Alternative about

1 85 percent of the time in April. The differences between Alternative 1 and the No  
 2 Action Alternative, however, would be relatively small, with water temperatures  
 3 under Alternative 1 generally exceeding the spawning temperature threshold  
 4 about 1-2 percent less frequently than under the No Action Alternative during the  
 5 October through April period. Temperature conditions in the Feather River under  
 6 Alternative 1 could be less likely to affect fall-run Chinook Salmon spawning and  
 7 egg incubation than under the No Action Alternative because of the reduced  
 8 frequency of exceedance of the 56°F threshold from October through April.

#### 9 *Changes in Egg Mortality*

10 Water temperatures influence the viability of incubating fall-run Chinook Salmon  
 11 eggs. The following describes the differences in egg mortality for the  
 12 Sacramento, Feather, and American rivers.

#### 13 *Sacramento River*

14 For fall-run Chinook Salmon in the Sacramento River, the long-term average egg  
 15 mortality rate is predicted to be around 17 percent, with higher mortality rates (in  
 16 excess of 35 percent) occurring in critical dry years under Alternative 1.  
 17 Predicted egg mortality would similar under Alternative 1 and the No Action  
 18 Alternative in all water year types (Appendix 9C, Table B-1).

#### 19 *Feather River*

20 For fall-run Chinook Salmon in the Feather River, the long-term average egg  
 21 mortality rate is predicted to be relatively low (around 7 percent), with higher  
 22 mortality rates (around 17 percent) occurring in critical dry years under  
 23 Alternative 1. Predicted egg mortality would similar under Alternative 1 and the  
 24 No Action Alternative in all water year types (Appendix 9C, Table B-7).

#### 25 *American River*

26 For fall-run Chinook Salmon in the American River, the predicted long-term  
 27 average egg mortality rate is predicted to range from approximately 22 to  
 28 25 percent in all water year types under Alternative 1. The predicted egg  
 29 mortality rate would similar under Alternative 1 and the No Action  
 30 Alternative (Appendix 9C, Table B-6).

#### 31 *Changes in Weighted Usable Area*

32 Weighted usable area, which is influenced by flow, is a measure of habitat  
 33 suitability. The following describes changes in WUA for fall-run Chinook  
 34 Salmon in the Sacramento, Feather, and American rivers and Clear Creek.

#### 35 *Sacramento River*

36 As an indicator of the amount of suitable spawning habitat for fall-run Chinook  
 37 Salmon between Keswick Dam and Battle Creek, modeling results indicate that,  
 38 in general, there would be greater amounts of spawning habitat available in  
 39 September and November under Alternative 1 as compared to the No Action  
 40 Alternative. Fall-run spawning WUA would be similar in October and December,  
 41 under Alternative 1 and the No Action Alternative (Appendix 9E, Table C-11-4).  
 42 The increase in long-term average spawning WUA during September (prior to the  
 43 peak spawning period) under Alternative 1 would be relatively large (more than



1 20 percent) and around 6 percent higher in November. November is during the  
2 peak spawning period for fall-run Chinook Salmon in the Sacramento River.  
3 Results for the reach from Battle Creek to Deer Creek show the same pattern for  
4 changes in WUA for spawning fall-run Chinook Salmon between Alternative 1  
5 and the No Action Alternative (Appendix 9E, Table C-10-4). Overall, spawning  
6 habitat availability would be somewhat higher under Alternative 1 relative to the  
7 No Action Alternative.

8 Modeling results indicate that, in general, the amount of suitable fry rearing  
9 habitat available from December to March under Alternative 1 would be similar  
10 to the amount of fry rearing habitat available under the No Action  
11 Alternative (Appendix 9E, Table C-12-4).

12 Similar to the results for fry rearing WUA, modeling results indicate that, there  
13 would be similar amounts of suitable juvenile rearing habitat available during the  
14 juvenile rearing period from February to June under Alternative 1 and the No  
15 Action Alternative (Appendix 9E, Table C-13-4).

16 *Clear Creek*

17 As described above, flows in Clear Creek downstream of Whiskeytown Dam are  
18 not anticipated to differ under Alternative 1 relative to the No Action  
19 Alternative except in May due to the release of spring attraction flows in  
20 accordance with the 2009 NMFS BO under the No Action Alternative. Therefore,  
21 there would be no change in the amount of potentially suitable spawning and  
22 rearing habitat for fall-run Chinook Salmon (as indexed by WUA) available under  
23 Alternative 1 as compared to the No Action Alternative.

24 *Feather River*

25 As described above, Flows in the low flow channel of the Feather River are not  
26 anticipated to differ under Alternative 1 relative to the No Action Alternative.  
27 Therefore, there would be no change in the amount of potentially suitable  
28 spawning habitat for fall-run Chinook Salmon (as indexed by WUA) available  
29 under Alternative 1 as compared to the No Action Alternative. The majority of  
30 spawning activity by fall-run Chinook Salmon in the Feather River occurs in this  
31 reach with a lesser amount of spawning occurring downstream of the  
32 Thermalito Complex.

33 Modeling results indicate that, in general, there would be greater amounts of  
34 spawning habitat available in September under Alternative 1 as compared to the  
35 No Action Alternative; fall-run Chinook Salmon spawning WUA would be  
36 similar in October and November (the peak spawning months) and in December  
37 (after the peak spawning period) for fall-run Chinook Salmon in this reach  
38 (Appendix 9E, Table C-24-4). The increase in long-term average spawning WUA  
39 during September (prior to the peak spawning period) under Alternative 1 would  
40 be relatively large (more than 15 percent). Overall, spawning habitat availability  
41 would be similar under Alternative 1 and the No Action Alternative.

1 *American River*

2 Modeling results indicate that, in general, there would be similar amounts of  
3 spawning habitat available for fall-run Chinook Salmon in the American River  
4 from October through December under Alternative 1 as compared to the No  
5 Action Alternative (Appendix 9E, Table C-25-4).

6 *Changes in SALMOD Output*

7 SALMOD results indicate that pre-spawning mortality of fall-run Chinook  
8 Salmon eggs would be approximately 16 percent lower under Alternative 1,  
9 primarily due to reduced summer temperatures. Flow-related fall-run Chinook  
10 Salmon egg mortality would be increased by 8 percent under Alternative 1  
11 compared to the No Action Alternative. Conversely, temperature-related egg  
12 mortality would be 11 percent lower under Alternative 1 (Appendix 9D,  
13 Table B-1-4). Flow (habitat)-related fry mortality would be similar under  
14 Alternative 1 and the No Action Alternative. Temperature-related juvenile  
15 mortality would be approximately 21 percent lower under Alternative 1, while  
16 flow (habitat)-related mortality would be similar under Alternative 1 and the No  
17 Action Alternative. Overall, potential fall-run juvenile production would be  
18 similar under Alternative 1 and the No Action Alternative, but up to 12 percent  
19 greater than under the No Action Alternative in critical dry years (Appendix 9D,  
20 Table B-1-1).

21 *Changes in Delta Passage Model Output*

22 The Delta Passage Model predicted similar estimates of annual Delta survival  
23 across the 81 water year time period for fall-run between Alternative 1 and the No  
24 Action Alternative (Appendix 9J). Median Delta survival was 0.245 for  
25 Alternative 1 and 0.248 for the No Action Alternative.

26 *Changes in Delta Hydrodynamics*

27 Fall-run Chinook Salmon smolts are most abundant in the Delta during the  
28 months of April, May and June. At the junction of Georgiana Slough and the  
29 Sacramento River, median percent of time with positive velocity was similar  
30 under both Alternative 1 and No Action Alternative in the months of April, May  
31 and June (Appendix 9K). Near the confluence of the San Joaquin River and the  
32 Mokelumne River, the median proportion of positive velocities was slightly lower  
33 under Alternative 1 relative to No Action Alternative in April and May and  
34 similar in June. In Old River downstream of the facilities, the median proportion  
35 of positive velocities was substantially lower in April and May under  
36 Alternative 1 relative to No Action Alternative but became more similar in June  
37 (Appendix 9K). In Old River upstream of the facilities, the median proportion of  
38 positive velocities was slightly to moderately lower for Alternative 1 relative to  
39 No Action Alternative in April and May, respectively and slightly higher in June  
40 (Appendix 9K). On the San Joaquin River downstream of the Head of Old River,  
41 the median proportion of positive velocities was slightly to moderately higher  
42 under Alternative 1 relative to No Action Alternative in April and May,  
43 respectively, whereas the values were similar in June (Appendix 9K).

1                    *Changes in Junction Entrainment*

2    Entrainment at Georgiana Slough was similar under both Alternative 1 and the No  
3    Action Alternative in most months but was slightly higher under Alternative 1 in  
4    the month of June (Appendix 9L). Median entrainment probabilities at the Head  
5    of Old River were much lower under Alternative 1 relative to the No Action  
6    Alternative during April and May. The median entrainment probability was  
7    similar under both alternatives in the month of June. At the Turner Cut junction,  
8    median entrainment probabilities under Alternative 1 were slightly higher than  
9    under the No Action Alternative in June. During April and May, median  
10    entrainment probabilities were more divergent with moderately higher values for  
11    Alternative 1 relative to No Action Alternative. Overall, entrainment was slightly  
12    lower at the Columbia Cut junction relative to Turner Cut but patterns of  
13    entrainment between the two alternatives were similar. Patterns in entrainment  
14    probabilities at the Middle River and Old River junctions were similar to those  
15    observed at Columbia and Turner Cut junctions.

16                    *Changes in Salvage*

17    Salvage of Sacramento River-origin Chinook Salmon is predicted to be greater  
18    under Alternative 1 relative to No Action Alternative in every month  
19    (Appendix 9M). Fall-run smolts migrating through the Delta would be most  
20    susceptible in the months of April, May and June. Predicted values in April and  
21    May indicated a substantially increased fraction of fish salvaged under  
22    Alternative 1 relative to No Action Alternative. Predicted salvage was more  
23    similar in March but still higher under Alternative 1.

24                    *Summary of Effects on Fall-Run Chinook Salmon*

25    The multiple model and analysis outputs described above characterize the  
26    anticipated conditions for fall-run Chinook Salmon and their response to change  
27    under Alternative 1 and the No Action Alternative. For the purpose of analyzing  
28    effects on fall-run Chinook Salmon in the Sacramento River, greater reliance was  
29    placed on the outputs from the SALMOD model because it integrates the  
30    available information on temperature and flows to produce estimates of mortality  
31    for each life stage and an overall, integrated estimate of potential fall-run Chinook  
32    Salmon juvenile production. The output from SALMOD indicated that fall-run  
33    Chinook Salmon production would be similar in most water year types under  
34    Alternative 1 than under the No Action Alternative, and up to 12 percent greater  
35    than under the No Action Alternative in critical dry years.

36    The analyses attempting to assess the effects on routing, entrainment, and salvage  
37    of juvenile salmonids in the Delta suggest that salvage (as an indicator of  
38    potential losses of juvenile salmon at the export facilities) of Sacramento River-  
39    origin Chinook Salmon is predicted to be higher under Alternative 1 relative to  
40    No Action Alternative in every month.

41    In Clear Creek and the Feather and American rivers, the analysis of the effects of  
42    Alternative 1 and the No Action Alternative for fall-run Chinook Salmon relied  
43    on the WUA analysis for habitat and water temperature model output for the  
44    rivers at various locations downstream of the CVP and SWP facilities. The WUA

1 analysis indicated that the availability of spawning and rearing habitat in Clear  
2 Creek and spawning habitat in the Feather and American rivers would be similar  
3 under Alternative 1 and the No Action Alternative. The temperature model  
4 outputs for each of the fall-run Chinook Salmon life stages suggest that thermal  
5 conditions and effects on fall-run Chinook Salmon in all of these streams  
6 generally would be similar under both scenarios. The water temperature threshold  
7 exceedance analysis that indicated that the water temperature thresholds for  
8 fall-run Chinook Salmon spawning and egg incubation would be exceeded  
9 slightly less frequently in the Feather River and Clear Creek under Alternative 1  
10 and could reduce the potential for adverse effects on the fall-run Chinook Salmon  
11 populations in Clear Creek and the Feather River. Results of the analysis using  
12 Reclamation's salmon mortality model indicate that there would be little  
13 difference in fall-run Chinook Salmon egg mortality under Alternative 1 and the  
14 No Action Alternative.

15 These model results suggest that overall, effects on fall-run Chinook Salmon  
16 could be slightly less adverse under Alternative 1 than the No Action Alternative,  
17 with a small likelihood that fall-run Chinook Salmon production would be higher  
18 under Alternative 1 due to increased production potential in critical dry years.  
19 This potential distinction between the two scenarios, however, may be partially  
20 balanced by the benefits of implementation of fish passage under the No Action  
21 Alternative intended to address the limited availability of suitable habitat for  
22 winter-run and spring-run Chinook Salmon in the Sacramento River reaches  
23 downstream of Keswick Dam. This potential benefit, however, would only apply  
24 if passage is provided for adult fall-run Chinook Salmon that allows access to  
25 additional habitat. In addition, RPA actions under the No Action  
26 Alternative intended to increase the efficiency of the Tracy and Skinner Fish  
27 Collection Facilities could improve the overall salvage survival of fall-run  
28 Chinook Salmon.

29 The results of the numerical models suggest that Alternative 1 is less likely to  
30 result in adverse effects on fall-run Chinook Salmon than the No Action  
31 Alternative. However, discerning a meaningful difference between these two  
32 scenarios based on the quantitative results is not possible because of the similarity  
33 in results (generally differences less than 5 percent) and the inherent uncertainty  
34 of the models. In addition, adverse effects of the No Action Alternative could be  
35 balanced by the potentially beneficial effects resulting from the RPA actions  
36 evaluated qualitatively for the No Action Alternative. Overall, given the small  
37 differences in the numerical model results and the inherent uncertainty in the  
38 temperature model, as well as the potential for benefits associated with the RPA  
39 actions under the No Action Alternative, it is concluded that there would be no  
40 definitive difference in effects on fall-run Chinook Salmon between Alternative 1  
41 and the No Action Alternative.

#### 42 *Late Fall-Run Chinook Salmon*

43 Changes in operations that influence temperature and flow conditions in the  
44 Sacramento River downstream of Keswick Dam could affect late fall-run Chinook  
45 Salmon. The following describes those changes and their potential effects.

1                    *Changes in Water Temperature*

2 Long-term average monthly water temperature in the Sacramento River at  
3 Keswick Dam under Alternative 1 would generally be similar (less than 0.5°F  
4 difference) to water temperatures under the No Action Alternative. An exception  
5 is during September and October of critical dry years when water temperatures  
6 could be up to 1.1°F and 0.8°F lower, respectively, under Alternative 1 as  
7 compared to the No Action Alternative and up to 1°F warmer in September of  
8 wetter years (Appendix 6B, Table 5-5-1). A similar pattern in temperature  
9 differences generally would be exhibited at downstream locations along the  
10 Sacramento River (i.e., Ball's Ferry, Jelly's Ferry, Bend Bridge, Red Bluff,  
11 Hamilton City, and Knights Landing), with temperature differences between  
12 scenarios in June at Knights Landing progressively increasing (up to 0.9°F cooler)  
13 in June and up to 4.6°F warmer in September during wetter years under  
14 Alternative 1 relative to the No Action Alternative.

15 Overall, the temperature differences between Alternative 1 and the No Action  
16 Alternative would be relatively minor (less than 0.5°F) and likely would have  
17 little effect on late fall-run Chinook Salmon in the Sacramento River. The  
18 likelihood of adverse effects on late fall-run Chinook Salmon spawning and egg  
19 incubation would be similar under Alternative 1 and the No Action  
20 Alternative due to similar water temperatures during the January to May time  
21 period. Because late fall-run Chinook Salmon have an extended rearing period,  
22 the similar water temperatures during the summer under Alternative 1 and the No  
23 Action Alternative would have similar effects on rearing fry and juvenile late  
24 fall-run Chinook Salmon in the Sacramento River. The higher water temperatures  
25 under Alternative 1 in September of wetter years may increase the likelihood of  
26 adverse effects on fry and juvenile late fall-run Chinook Salmon in the  
27 Sacramento River during this limited time period.

28                    *Changes in Exceedances of Water Temperature Thresholds*

29 Average monthly water temperatures under both Alternative 1 and the No Action  
30 Alternative indicate exceedances of the water temperature threshold of 56°F  
31 established in the Sacramento River at Red Bluff for Chinook Salmon spawning  
32 and egg incubation in October, November, and again in April. There would be no  
33 exceedances of the threshold from December to March under both Alternative 1  
34 and the No Action Alternative. In April, model results indicate that water  
35 temperatures under Alternative 1 would exceed the threshold about 2 percent less  
36 frequently than under the No Action Alternative. Temperature conditions in the  
37 Sacramento River under Alternative 1 could be slightly less likely to result in  
38 adverse effects on late fall-run Chinook Salmon spawning and egg incubation  
39 than under the No Action Alternative because of the reduced frequency of  
40 exceedance of the 56°F threshold in April.

41                    *Changes in Egg Mortality*

42 For late fall-run Chinook Salmon in the Sacramento River, the long-term average  
43 egg mortality rate is predicted to range from approximately 2 to nearly 5 percent  
44 in all water year types under Alternative 1. Overall, egg mortality would be

1 similar under Alternative 1 and the No Action Alternative (Appendix 9C,  
2 Table B-2).

3 *Changes in Weighted Usable Area*

4 Modeling results indicate that there would be similar amounts of spawning habitat  
5 available for late fall-run Chinook Salmon in the Sacramento River from January  
6 through April under Alternative 1 and the No Action Alternative (Appendix 9E,  
7 Table C-14-4). Modeling results also indicate that there would be similar  
8 amounts of suitable late fall-run Chinook Salmon fry rearing habitat available  
9 from April to June under Alternative 1 and the No Action  
10 Alternative (Appendix 9E, Table C-15-4).

11 A substantial fraction of late fall run Chinook Salmon juveniles oversummer in  
12 the Sacramento River before emigrating, which allows them to avoid predation  
13 through both their larger size and greater swimming ability. One implication of  
14 this life history strategy is that rearing habitat is most likely the limiting factor for  
15 late-fall-run Chinook Salmon, especially if availability of cool water determines  
16 the downstream extent of spawning habitat for late-fall-run salmon. Modeling  
17 results indicate that, there would generally be similar amounts of suitable juvenile  
18 rearing habitat available from December through August under Alternative 1 and  
19 the No Action Alternative. There could be an increase in the amount of late fall-  
20 run Chinook Salmon juvenile rearing WUA in September and November of up to  
21 15 percent (Appendix 9E, Table C-16-4). Overall, late fall-run juvenile rearing  
22 habitat availability would be similar under Alternative 1 and the No Action  
23 Alternative.

24 *Changes in SALMOD Output*

25 SALMOD results indicate that potential juvenile production would be similar  
26 under Alternative 1 and the No Action Alternative (Appendix 9D, Table B-2-1).

27 *Changes in Delta Passage Model Output*

28 For late fall-run Chinook Salmon, through-Delta survival was predicted to be  
29 slightly lower under Alternative 1 relative to the No Action Alternative for all  
30 81 years simulated by the Delta Passage Model (Appendix 9J). Median Delta  
31 survival across all years was 0.199 for Alternative 1 and 0.244 for the No Action  
32 Alternative.

33 *Changes in Delta Hydrodynamics*

34 The late fall run Chinook migration period overlaps with winter-run. See the  
35 section on hydrodynamic analysis for winter run Chinook Salmon for potential  
36 effects on late fall-run Chinook Salmon.

37 *Changes in Junction Entrainment*

38 Entrainment probabilities for late fall-run Chinook Salmon are assumed to mimic  
39 that of winter-run Chinook Salmon due to the overlap in timing. See the section  
40 on winter-run Chinook Salmon entrainment for potential effects on late fall-run  
41 Chinook Salmon.

1            *Changes in Salvage*

2 Salvage of late fall-run Chinook Salmon is assumed to mimic that of winter-run  
3 Chinook Salmon due to the overlap in timing. See the section on winter-run  
4 Chinook Salmon entrainment for potential effects on late fall-run Chinook  
5 Salmon.

6            *Summary of Effects on Late Fall-Run Chinook Salmon*

7 The multiple model and analysis outputs described above characterize the  
8 anticipated conditions for late fall-run Chinook Salmon and their response to  
9 change under Alternative 1 and the No Action Alternative. For the purpose of  
10 analyzing effects on late fall-run Chinook Salmon and developing conclusions,  
11 greater reliance was placed on the outputs from the SALMOD model because it  
12 integrates the available information on temperature and flows to produce  
13 estimates of mortality for each life stage and an overall, integrated estimate of  
14 potential fall-run Chinook Salmon juvenile production. The output from  
15 SALMOD indicated that late fall-run Chinook Salmon production would be  
16 similar under Alternative 1 and the No Action Alternative. The analyses  
17 attempting to assess the effects on routing, entrainment, and salvage of juvenile  
18 salmonids in the Delta suggest that salvage (as an indicator of potential losses of  
19 juvenile salmon at the export facilities) of Sacramento River-origin Chinook  
20 Salmon is predicted to be higher under Alternative 1 relative to No Action  
21 Alternative in every month. Actions under the No Action Alternative intended to  
22 increase the efficiency of the Tracy and Skinner Fish Collection Facilities could  
23 improve the overall salvage survival of late fall-run Chinook Salmon.

24 Although survival in the Delta may be lower, given the similarity in the  
25 SALMOD outputs, it is likely that Alternative 1 and the No Action  
26 Alternative would have similar effects on fall-run Chinook Salmon.

27            *Steelhead*

28 Changes in operations that influence temperature and flow conditions that could  
29 affect steelhead. The following describes those changes and their potential  
30 effects.

31            *Changes in Water Temperature*

32 Changes in water temperature could affect steelhead in the Sacramento, Feather,  
33 and American rivers, and Clear Creek. The following describes temperature  
34 conditions in those water bodies.

35            *Sacramento River*

36 Long-term average monthly water temperature in the Sacramento River at  
37 Keswick Dam under Alternative 1 would generally be similar (less than 0.5°F  
38 difference) to water temperatures under the No Action Alternative. An exception  
39 is during September and October of critical dry years when water temperatures  
40 could be up to 1.1°F and 0.8°F lower, respectively, under Alternative 1 as  
41 compared to the No Action Alternative and up to 1°F warmer in September of  
42 wetter years (Appendix 6B, Table 5-5-1). A similar pattern of changes in  
43 temperature generally would be exhibited downstream at Ball's Ferry, Jelly's

1 Ferry, Bend Bridge and Red Bluff, with average monthly temperature differences  
2 between scenarios progressively decreasing, except in September (up to a 3.2°F  
3 warmer at Red Bluff) during wetter years (Appendix 6B, Table B-9-1).

4 Overall, the temperature differences between Alternative 1 and the No Action  
5 Alternative would be relatively minor (less than 0.5°F) and likely would have  
6 little effect on steelhead in the Sacramento River. Based on the life history timing  
7 for steelhead, the slightly lower water temperatures in September and October of  
8 drier years under Alternative 1 may reduce the likelihood of adverse effects on  
9 steelhead adults migrating upstream in the Sacramento River. The higher water  
10 temperatures in September of wetter years under Alternative 1 may increase the  
11 likelihood of adverse effects on steelhead migration compared to the No Action  
12 Alternative.

13 *Clear Creek*

14 Average monthly water temperatures in Clear Creek at Igo under Alternative 1 are  
15 generally predicted to be similar to (less than 0.5°F differences) water  
16 temperatures under the No Action Alternative from September through April and  
17 June through August (Appendix 6B, Table B-3-1). Average monthly water  
18 temperatures during May under Alternative 1 could be higher by up to 0.8°F than  
19 under the No Action Alternative in all water year types. Overall, thermal  
20 conditions for steelhead in Clear Creek would be similar under Alternative 1 and  
21 the No Action Alternative.

22 *Feather River*

23 Average monthly water temperature in the Feather River in the low flow channel  
24 generally were predicted to be similar (less than 0.5°F differences) under  
25 Alternative 1 and the No Action Alternative, except during November and  
26 December when average monthly water temperatures could be up to 1.4°F lower  
27 in some water year types (Appendix 6B, Table B-20-1). Average monthly water  
28 temperatures in September under Alternative 1 could be up to 1.3°F warmer than  
29 under the No Action Alternative in wetter years. Although temperatures in the  
30 river generally become progressively higher in the downstream direction, the  
31 differences between Alternative 1 and the No Action Alternative exhibit a similar  
32 pattern at the downstream locations (Robinson Riffle and Gridley Bridge), with  
33 water temperature differences between Alternative 1 and the No Action  
34 Alternative generally decreasing in most water year types. Water temperatures  
35 under Alternative 1 are predicted to be somewhat (0.7°F to 1.6°F) warmer on  
36 average and up to 4.0°F warmer at the confluence with Sacramento River from  
37 July to September in wetter years than under the No Action Alternative.

38 Overall, the temperature differences in the Feather River between Alternative 1  
39 and the No Action Alternative would be relatively minor (less than 0.5°F) and  
40 likely would have little effect on steelhead in the Feather River. The slightly  
41 lower water temperatures in November and December under Alternative 1 would  
42 likely have little effect on adult steelhead migration as water temperatures in the  
43 Feather River are typically low during this time period. The somewhat higher  
44 water temperatures in September of wetter years may increase the likelihood of



1 adverse effects on adult steelhead migrating upstream and juveniles rearing in the  
2 Feather River, although the decreased temperatures in September of critical dry  
3 years under Alternative 1 may decrease the likelihood of adverse effects on  
4 migrating and rearing steelhead in this water year type.

5 *American River*

6 Average monthly water temperatures in the American River at Nimbus Dam  
7 under Alternative 1 generally would be similar (differences less than 0.5°F) to the  
8 No Action Alternative, with the exception of during June and August, when  
9 temperatures under Alternative 1 could be as much as 0.9°F lower in below  
10 normal years. This pattern generally would persist downstream to Watt Avenue  
11 and the mouth, although temperatures under Alternative 1 would be up to 1.6°F  
12 and 2.0°F lower, respectively, than under the No Action Alternative in June. In  
13 addition, average monthly water temperatures at the mouth generally would be  
14 higher under Alternative 1 than the No Action Alternative in September of wetter  
15 years when water temperatures under Alternative 1 could be up to 1.7°F warmer.

16 Overall, the temperature differences between Alternative 1 and the No Action  
17 Alternative would be relatively minor (less than 0.5°F) and likely would have  
18 little effect on steelhead in the American River. The slightly cooler water  
19 temperatures in June and August under Alternative 1 may reduce the likelihood of  
20 adverse effects on steelhead rearing in the American River compared to the No  
21 Action Alternative.

22 *Changes in Exceedances of Water Temperature Thresholds*

23 Changes in water temperature could result in the exceedance of established water  
24 temperature thresholds for steelhead in the Sacramento River, Clear Creek, and  
25 Feather River. The following describes the extent of those exceedance for each of  
26 those streams.

27 *Sacramento River*

28 Steelhead spawning in the mainstem Sacramento River generally occurs in the  
29 upper reaches from Keswick Dam downstream to near Balls Ferry, with most  
30 spawning concentrated near Redding. Most steelhead, however, spawn in  
31 tributaries to the Sacramento River. Spawning generally takes place in the  
32 January through March period when water temperatures in the river generally do  
33 not exceed 52°F under either Alternative 1 or the No Action Alternative. While  
34 there are no established temperature thresholds for steelhead rearing in the  
35 mainstem Sacramento River, average monthly temperatures when fry and juvenile  
36 steelhead are in the river would generally remain below 56°F at Balls Ferry  
37 except in August and September when this water temperature would be exceeded  
38 30 to 40 percent of the time under both the No Action Alternative and Second  
39 Basis of Comparison. However, water temperatures in the Sacramento River at  
40 Balls Ferry would exceed 56°F about 10 percent more often in September under  
41 Alternative 1. Overall, thermal conditions for steelhead in the Sacramento River  
42 would be similar under Alternative 1 and the No Action Alternative.

1                    *Clear Creek*

2 While there are no established temperature thresholds for steelhead spawning in  
3 Clear Creek, average monthly water temperatures in the river generally would not  
4 exceed 48°F during the spawning period (December to April) under Alternative 1  
5 and the No Action Alternative. Similarly, while there are no established  
6 temperature thresholds for steelhead rearing in Clear Creek, average monthly  
7 temperatures in most months of the year would not exceed 56°F at Igo under both  
8 alternatives. Overall, thermal conditions for steelhead in Clear Creek would be  
9 similar under Alternative 1 and the No Action Alternative.

10                    *Feather River*

11 Average monthly water temperatures under both Alternative 1 and the No Action  
12 Alternative would on occasion exceed the water temperature threshold of 56°F  
13 established in the Feather River at Robinson Riffle for steelhead spawning and  
14 incubation during some months, particularly in October and November, and  
15 March and April, when temperature thresholds could be exceeded frequently  
16 (Appendix 9N). There would be a 1 percent exceedance of the 56°F threshold in  
17 December under the No Action Alternative and no exceedances of the 56°F  
18 threshold from December through February under Alternative 1. However, the  
19 differences in the frequency of exceedance between Alternative 1 and No Action  
20 Alternative during March and April would be relatively small with water  
21 temperatures under Alternative 1 exceeding the threshold about 2 percent more  
22 frequently in March (20 percent) and the same exceedance frequency (75 percent)  
23 as the No Action Alternative in April.

24 The established water temperature threshold of 63°F for rearing from May  
25 through August would be exceeded often under both Alternative 1 and the No  
26 Action Alternative in May and June, but not at all in July and August. Water  
27 temperatures under Alternative 1 would exceed the rearing temperature threshold  
28 about 9 percent less frequently than under the No Action Alternative in May, but  
29 no more frequently in June. Temperature conditions in the Feather River under  
30 Alternative 1 could be less likely to affect steelhead spawning and rearing than  
31 under the No Action Alternative because of the reduced frequency of exceedance  
32 of the 56°F spawning threshold in March and the increased frequency of  
33 exceedance of the 63°F rearing threshold in May.

34                    *American River*

35 In the American River, the water temperature threshold for steelhead rearing  
36 (May through October) is 65°F at the Watt Avenue Bridge. Average monthly  
37 water temperatures would exceed this threshold often under both Alternative 1  
38 and No Action Alternative, especially in the July through September period when  
39 the threshold is exceeded nearly all of the time. In addition, the magnitude of the  
40 exceedance would be high, with average monthly water temperatures sometimes  
41 higher than 76°F. The differences in exceedance frequency between Alternative 1  
42 and No Action Alternative, however, would be relatively small and only occur in  
43 June (1 percent more frequent exceedance under Alternative 1), and in September,  
44 when average monthly water temperatures under Alternative 1 would exceed 65°F

1 about 7 percent more frequently than under the No Action Alternative.  
2 Temperature conditions in the American River under Alternative 1 could be more  
3 likely to result in adverse effects on steelhead rearing than under the No Action  
4 Alternative because of the increased frequency of exceedance of the 65°F rearing  
5 threshold.

6 *Changes in Weighted Usable Area*

7 The following describes changes in WUA for steelhead in the Sacramento,  
8 Feather, and American rivers and Clear Creek.

9 *Sacramento River*

10 Modeling results indicate that, in general, there would be similar amounts of  
11 suitable steelhead spawning habitat available from December through March  
12 under Alternative 1 and the No Action Alternative (Appendix 9E, Table C-20-4).

13 *Clear Creek*

14 As described above, flows in Clear Creek downstream of Whiskeytown Dam are  
15 not anticipated to differ under Alternative 1 relative to the No Action  
16 Alternative except in May due to the release of spring attraction flows in  
17 accordance with the 2009 NMFS BO under the No Action Alternative. Therefore,  
18 there would be no change in the amount of potentially suitable spawning and  
19 rearing habitat for steelhead (as indexed by WUA) available under Alternative 1  
20 as compared to the No Action Alternative.

21 *Feather River*

22 Flows in the low flow channel of the Feather River are not anticipated to differ  
23 under Alternative 1 relative to the No Action Alternative. Therefore, there would  
24 be no change in the amount of potentially suitable spawning habitat for steelhead  
25 (as indexed by WUA) available under Alternative 1 as compared to the No Action  
26 Alternative. The majority of spawning activity by steelhead in the Feather River  
27 occurs in this reach with a lesser amount of spawning occurring downstream of  
28 the Thermalito Complex.

29 Modeling results indicate that, in general, there would be similar amounts of  
30 spawning habitat for steelhead in the Feather River downstream of Thermalito  
31 available from December through April under Alternative 1 and the No Action  
32 Alternative (Appendix 9E, Table C-22-4).

33 *American River*

34 Modeling results indicate that, in general, there would be similar amounts of  
35 spawning habitat for steelhead in the American River downstream of Nimbus  
36 Dam available from December through April under Alternative 1 and the No  
37 Action Alternative.

38 *Summary of Effects on Steelhead*

39 The multiple model and analysis outputs described above characterize the  
40 anticipated conditions for steelhead and their response to change under  
41 Alternative 1 and the No Action Alternative. The analysis of the effects of  
42 Alternative 1 and the No Action Alternative for steelhead relied on the WUA

1 analysis for habitat and water temperature model output for the rivers at various  
2 locations downstream of the CVP and SWP facilities.

3 The WUA analysis indicated that the availability of steelhead spawning and  
4 rearing habitat in Clear Creek and steelhead spawning habitat in the Sacramento,  
5 Feather and American rivers would be similar under Alternative 1 and the No  
6 Action Alternative. The temperature model outputs for each of the steelhead life  
7 stages suggest that thermal conditions and effects on steelhead in all of these  
8 streams generally would be similar under both scenarios. This conclusion is  
9 supported by the water temperature threshold exceedance analysis that indicated  
10 that the water temperature thresholds for steelhead spawning and egg incubation  
11 would be exceeded less frequently in the Feather River under Alternative 1. The  
12 water temperature threshold for steelhead rearing would also be exceeded less  
13 frequently in the Feather River and could reduce the potential for adverse effects  
14 on the steelhead population in the Feather River.

15 The numerical model results suggest that overall, effects on steelhead could be  
16 slightly less adverse under Alternative 1 than the No Action Alternative,  
17 particularly in the Feather River. Implementation of the fish passage program  
18 under the No Action Alternative intended to address the limited availability of  
19 suitable habitat for steelhead in the Sacramento River reaches downstream of  
20 Keswick Dam and in the American River could provide a benefit to Central  
21 Valley steelhead in the Sacramento and American rivers. This is particularly  
22 important in light of anticipated increases in water temperature associated with  
23 climate change in 2030. In addition to fish passage, preparation and  
24 implementation of an HGMP for steelhead at the Nimbus Fish Hatchery and  
25 actions under the No Action Alternative intended to increase the efficiency of the  
26 Tracy and Skinner Fish Collection Facilities could benefit steelhead under the No  
27 Action Alternative in comparison to Alternative 1. Thus, on balance and over the  
28 long term, the adverse effects on steelhead under Alternative 1 would be greater  
29 than those under the No Action Alternative.

### 30 *Green Sturgeon*

31 The effects on Green Sturgeon were analyzed by comparing changes in water  
32 temperature and the frequency of temperature threshold exceedance between  
33 Alternative 1 and the No Action Alternative. In addition, potential effects on  
34 Green Sturgeon during the Delta portion of their life cycle were evaluated based  
35 on changes in Delta outflow. The effects are described and summarized below.

### 36 *Changes in Water Temperature*

37 The effects of Alternative 1 compared to the No Action Alternative on Green  
38 Sturgeon were analyzed based on water temperature model outputs and  
39 comparisons of the frequency of water temperature threshold exceedances in the  
40 Sacramento and Feather rivers.

### 41 *Sacramento River*

42 As described previously, long-term average monthly water temperature in the  
43 Sacramento River at Keswick Dam under Alternative 1 would generally be  
44 similar (less than 0.5°F difference) to water temperatures under the No Action

1 Alternative An exception is during September and October of critical dry years  
2 when water temperatures could be up to 1.1°F and 0.8°F lower, respectively,  
3 under Alternative 1 as compared to the No Action Alternative and up to 1°F  
4 warmer in September of wetter years (Appendix 6B). A similar pattern in  
5 temperature differences generally would be exhibited at downstream locations  
6 along the Sacramento River (i.e., Ball's Ferry Jelly's Ferry, Bend Bridge, Red  
7 Bluff, Hamilton City, and Knights Landing), with temperature differences  
8 between scenarios at Knights Landing progressively increasing (up to 0.9°F  
9 cooler) in June and up to 4.6°F warmer in September during wetter years under  
10 Alternative 1 relative to the No Action Alternative.

11 Overall, the temperature differences between Alternative 1 and the No Action  
12 Alternative would be relatively minor (less than 0.5°F) and likely would have  
13 little effect on Green Sturgeon. Increased temperatures in September are likely  
14 not to be lethal, but may increase growth of juvenile green sturgeon if food was  
15 not limiting.

16 *Feather River*

17 Average monthly water temperature in the Feather River in the low flow channel  
18 generally were predicted to be similar (less than 0.5°F differences) under  
19 Alternative 1 and the No Action Alternative, except during November and  
20 December when average monthly water temperatures would be up to 1.4°F lower  
21 in some water year types (Appendix 6B, Table B-20-1). Average monthly water  
22 temperatures in September under Alternative 1 could be up to 1.3°F warmer than  
23 under the No Action Alternative in wetter years.

24 Although temperatures in the river would become progressively higher in the  
25 downstream directions, the differences between Alternative 1 and the No Action  
26 Alternative would exhibit a similar pattern at the downstream locations (Robinson  
27 Riffle and Gridley Bridge), with temperatures differences between Alternative 1  
28 and the No Action Alternative generally decreasing in most water year types.  
29 However, water temperatures under Alternative 1 were predicted to be somewhat  
30 (0.7°F to 1.6°F) warmer on average and up to 4.0°F warmer at the confluence  
31 with the Sacramento River from July to September in wetter years (Appendix 6B,  
32 Table B-23-1).

33 Overall, the temperature differences between Alternative 1 and the No Action  
34 Alternative would be relatively minor (less than 0.5°F) and likely would have  
35 little effect on Green Sturgeon in the Feather River.

36 *Changes in Exceedances of Water Temperature Thresholds*

37 Changes in water temperature could result in the exceedance of established water  
38 temperature thresholds for Green Sturgeon in the Sacramento and Feather rivers.  
39 The following describes the extent of those exceedance for each of those rivers.

40 *Sacramento River*

41 Average monthly water temperatures in the Sacramento River at Bend Bridge  
42 under both Alternative 1 and the No Action Alternative would exceed the water  
43 temperature threshold of 63°F established for Green Sturgeon larval rearing in

1 August and September, with exceedances under Alternative 1 occurring about  
2 6 percent of the time in August and about 10 percent of the time in September.  
3 This is 1 to 2 percent less frequent than under the No Action Alternative.  
4 Average monthly water temperatures at Bend Bridge could exceed the threshold  
5 by up to 10 degrees (reaching 73°F) during this period. Temperature conditions  
6 in the Sacramento River under Alternative 1 could be less likely to result in  
7 adverse effects on Green Sturgeon rearing than under the No Action  
8 Alternative because of the reduced frequency of exceedance of the 63°F threshold  
9 in August and September.

#### 10 *Feather River*

11 Average monthly water temperatures in the Feather River at Gridley Bridge under  
12 both Alternative 1 and No Action Alternative would exceed the water temperature  
13 threshold of 64°F established for Green Sturgeon spawning, incubation, and  
14 rearing in May, June, and September; no exceedances under either scenarios  
15 would occur in July and August. The frequency of exceedances would be high,  
16 with water temperatures under both Alternative 1 and No Action  
17 Alternative exceeding the threshold in June nearly 100 percent of the time. The  
18 magnitude of the exceedance also would be substantial, with average monthly  
19 water temperatures higher than 72°F in June, and higher than 75°F in July and  
20 August. Water temperatures under Alternative 1 would exceed the threshold  
21 during May about 9 percent less frequently than the No Action Alternative and  
22 about 35 percent more frequently in September. Temperature conditions in the  
23 Feather River under Alternative 1 could be less likely to result in adverse effects  
24 on Green Sturgeon rearing than under the No Action Alternative because of the  
25 reduced frequency of exceedance of the 64°F threshold in May. The increase in  
26 exceedance frequency in September under Alternative 1 may have little effect on  
27 rearing Green Sturgeon as many juvenile sturgeon may have migrated  
28 downstream to the lower Sacramento River and Delta by this time.

#### 29 *Changes in Delta Outflow*

30 As described in Appendix 9P, mean (March to July) Delta outflow was used an  
31 indicator of potential year class strength and the likelihood of producing a strong  
32 year class of sturgeon. The median value over the 82-year CalSim II modeling  
33 period of mean (March to July) Delta outflow was predicted to be 12 percent  
34 lower under Alternative 1 than under the No Action Alternative. In addition, the  
35 likelihood of mean (March to July) Delta outflow exceeding the threshold of  
36 50,000 cfs was the same under both alternatives.

#### 37 *Summary of Effects on Green Sturgeon*

38 The temperature model outputs for the Sacramento and Feather rivers suggest that  
39 thermal conditions and effects on Green Sturgeon in the Sacramento and Feather  
40 rivers generally would be slightly less adverse under Alternative 1. This  
41 conclusion is supported by the water temperature threshold exceedance analysis  
42 that indicated that the water temperature thresholds for Green Sturgeon spawning,  
43 incubation, and rearing would be exceeded less frequently under Alternative 1 in  
44 the Sacramento River. The water temperature threshold for Green Sturgeon

1 spawning, incubation, and rearing would also be exceeded less frequently during  
2 some months in the Feather River, but would be exceeded more frequently in  
3 September under Alternative 1 and could reduce the potential for adverse effects  
4 on Green Sturgeon in the Sacramento and Feather rivers relative to the No Action  
5 Alternative. The analysis based on Delta outflows suggests that Alternative 1  
6 provides lower mean (March to July) outflows which could result in weaker year  
7 classes of juvenile sturgeon relative to the No Action Alternative. In addition,  
8 actions under the No Action Alternative intended to increase the efficiency of the  
9 Tracy and Skinner Fish Collection Facilities could improve the overall salvage  
10 survival of green sturgeon. However, early life stage survival in the natal rivers is  
11 crucial in development of a strong year class. Therefore, based primarily on the  
12 analysis of water temperatures, Alternative 1 could be less likely to result in  
13 adverse effects on Green Sturgeon than the No Action Alternative.

14 *White Sturgeon*

15 Changes in water temperature conditions in the Sacramento River would be the  
16 same as those described above for Green Sturgeon in the Sacramento River.  
17 Overall, the temperature differences between Alternative 1 and the No Action  
18 Alternative would be relatively minor (less than 0.5°F) and likely would have  
19 little effect on White Sturgeon in the Sacramento River.

20 The water temperature threshold established for White Sturgeon spawning and  
21 egg incubation in the Sacramento River at Hamilton City is 61°F from March  
22 through June. Although there would be no exceedances of the threshold in March  
23 and April, water temperatures under both Alternative 1 and No Action  
24 Alternative would exceed this threshold in May and June. The average monthly  
25 water temperatures in May under Alternative 1 would exceed this threshold about  
26 49 percent of the time (about 6 percent less frequently than under the No Action  
27 Alternative). In June, the average monthly water temperature under Alternative 1  
28 would exceed the threshold about 74 percent of the time (about 13 percent less  
29 frequently than under the No Action Alternative). Average monthly water  
30 temperatures during May and June under Alternative 1 would as high as about  
31 64°F, which is below the 68°F threshold considered lethal for White Sturgeon  
32 eggs. Temperature conditions in the Sacramento River under Alternative 1 could  
33 be less likely to result in adverse effects on White Sturgeon rearing than under the  
34 No Action Alternative because of the reduced frequency of exceedance of the  
35 61°F threshold in May and June.

36 Changes in Delta outflows would be the same as those described above for Green  
37 Sturgeon. Mean (March to July) Delta outflow was predicted to be 12 percent  
38 lower under Alternative 1 than under the No Action Alternative. In addition, the  
39 likelihood of mean (March to July) Delta outflow exceeding the threshold of  
40 50,000 cfs was the same under both alternatives.

41 Overall, the temperature model outputs suggest that thermal conditions and  
42 effects on White Sturgeon in the Sacramento River generally would be slightly  
43 less adverse under Alternative 1. The analysis based on Delta outflows suggests  
44 that Alternative 1 provides lower mean (March to July) outflows which could

1 result in weaker year classes of juvenile Green Sturgeon relative to the No Action  
2 Alternative. However, early life stage survival in the natal rivers is crucial in  
3 development of a strong year class. Therefore, based primarily on the analysis of  
4 water temperatures, Alternative 1 could be less likely to result in adverse effects  
5 on White Sturgeon than the No Action Alternative.

#### 6 *Delta Smelt*

7 The potential for effects on Delta Smelt resulting from Alternative 1 as compared  
8 to the No Action Alternative were analyzed using changes in proportional  
9 entrainment and fall abiotic habitat index values.

10 As described in Appendix 9G, a proportional entrainment regression model  
11 (based on Kimmerer 2008, 2011) was used to simulate adult Delta Smelt  
12 entrainment, as influenced by OMR flow in December through March. Results  
13 indicate that the percentage of entrainment of migrating and spawning adult Delta  
14 Smelt under Alternative 1 would be 9 percent (long term average percent  
15 entrainment). Percent entrainment of adult Delta Smelt under Alternative 1 would  
16 be similar to results under the No Action Alternative.

17 As described in Appendix 9G, a proportional entrainment regression model  
18 (based on Kimmerer 2008) was used to simulate larval and early juvenile Delta  
19 Smelt entrainment, as influenced by OMR flow and location of X2 in March  
20 through June. Results indicate that the percentage of entrainment of larval and  
21 early juvenile Delta Smelt under Alternative 1 would be 15.5 percent, long-term  
22 average, and highest entrainment of 23.6 percent under Critical water year  
23 conditions. Percent entrainment of larval and early juvenile Delta Smelt under  
24 Alternative 1 would be higher than results under the No Action Alternative, by up  
25 to 9.4 percent. Under the No Action Alternative, the long term average percent  
26 entrainment would be 8.6 percent, and highest entrainment would occur under  
27 Critical water year conditions, at 19.3 percent.

28 The predicted location of Fall X2 position (in September through December) is  
29 used as an indicator of fall abiotic habitat index for Delta Smelt. Feyrer et al.  
30 (2010) used X2 location as an indicator of the extent of habitat available with  
31 suitable salinity for the rearing of older juvenile delta smelt. Feyrer et al. (2010)  
32 concluded that when X2 is located downstream (west) of the confluence of the  
33 Sacramento and San Joaquin Rivers, at a distance of 70 to 80 km from the Golden  
34 Gate Bridge, there is a larger area of suitable habitat. The overlap of the low  
35 salinity zone (or X2) with the Suisun Bay/Marsh results in a two-fold increase in  
36 the habitat index (Feyrer et al. 2010). The average September through December  
37 X2 position in km was used to evaluate the fall abiotic habitat availability for  
38 delta smelt under the Alternatives. X2 values simulated in the CalSim II model  
39 for each Alternative were averaged over September through December, and  
40 compared.

41 Alternative 1 does not include the operations related to the 2008 USFWS BO  
42 RPA Component 3 (Action 4), Fall X2 requirement while the No Action  
43 Alternative includes it. Therefore, the average September through December X2  
44 position under Alternative 1 would be eastward by over 6 km compared to the No



1 Action Alternative during the wetter years. In the drier years September through  
2 December average X2 position is similar under both scenarios.

3 Overall, Alternative 1 likely would have adverse effects on Delta Smelt, as  
4 compared to the No Action Alternative, primarily due to the potential for  
5 increased percentage entrainment during larval and juvenile life stages, and less  
6 favorable location of Fall X2 in wetter years, and on average. Given the current  
7 condition of the Delta Smelt population, even small differences between  
8 alternatives may be important.

9 *Longfin Smelt*

10 The effects of the Alternative 1 as compared to the No Action Alternative were  
11 analyzed based on the direction and magnitude of OMR flows during the period  
12 (December through June) when adult, larvae, and young juvenile Longfin Smelt  
13 are present in the Delta in the vicinity of the export facilities (Appendix 5A). The  
14 analysis was augmented with calculated Longfin Smelt abundance index values  
15 (Appendix 9G) per Kimmerer et al. (2009), which is based on the assumptions  
16 that lower X2 values reflect higher flows and that transporting Longfin Smelt  
17 farther downstream leads to greater Longfin Smelt survival. The index value  
18 indicates the relative abundance of Longfin Smelt and not the calculated  
19 population.

20 The OMR flows would generally be negative in all months under Alternative 1,  
21 with the long-term average ranging from -3,700 to -7,400 cfs from December  
22 through June (Appendix 5A). The OMR flows generally would be more negative  
23 during this time period under Alternative 1 as compared to the No Action  
24 Alternative. The greatest differences between alternatives would be in April and  
25 May, where long-term average OMR flows would be negative under Alternative 1  
26 and positive under the No Action Alternative (Appendix 5A, Table C-17-4). The  
27 increase in the magnitude of negative flows, with negative flows in April and  
28 May, under Alternative 1 as compared to the No Action Alternative could  
29 increase the potential for entrainment of Longfin Smelt at the export facilities.

30 Under Alternative 1, Longfin Smelt abundance index values range from 947  
31 under critical water year conditions to a high of 15,822 under wet water year  
32 conditions, with a long-term average value of 7,257. Under the No Action  
33 Alternative, Longfin Smelt abundance index values range from 1,147 under  
34 critical water year conditions to a high of 16,635 under wet water year conditions,  
35 with a long-term average value of 7,951.

36 Results indicate that the Longfin Smelt abundance index values would be lower in  
37 every water year type under Alternative 1 than they would be under the No Action  
38 Alternative, with a long-term average index for Alternative 1 that is almost  
39 10 percent lower than the long-term average index for the No Action Alternative.  
40 For below normal, dry, and critical water years, the Longfin Smelt abundance  
41 index values would be over 20 percent lower under Alternative 1 than they would  
42 be under the No Action Alternative, with the greatest difference (26.2 percent)  
43 predicted under dry conditions. Based on the Longfin Smelt abundance indices,

1 Alternative 1 likely would have adverse effects on Longfin Smelt, as compared to  
2 the No Action Alternative.

3 Overall, based on the increase in frequency and magnitude of negative OMR  
4 flows and the lower Longfin Smelt abundance index values, especially in dry and  
5 critical years, potential adverse effects on the Longfin Smelt population under  
6 Alternative 1 likely would be greater than under the No Action Alternative.

#### 7 *Sacramento Splittail*

8 Under Alternative 1, flows entering the Yolo Bypass generally would be higher  
9 than under the No Action Alternative from December through March, especially  
10 during wetter years (Appendix 5A, Table C-26-1). These increases would occur  
11 during periods of relatively high flow in the bypass, and could slightly increase  
12 the area of inundation. Thus, Alternative 1 could result in a slight increase in  
13 spawning habitat for Sacramento Splittail as a result of the increased area of  
14 potential habitat (inundation). Given the relatively minor changes in flows into  
15 the Yolo Bypass, and the inherent uncertainty associated with the resolution of the  
16 CalSim II model (average monthly outputs), it is concluded that there would be no  
17 definitive difference in effects on Sacramento Splittail between Alternative 1 and  
18 the No Action Alternative.

#### 19 *Reservoir Fishes*

20 The analysis of effects associated with changes in operation on reservoir fishes  
21 relied on evaluation of changes in available habitat (reservoir storage) and  
22 anticipated changes in black bass nesting success.

#### 23 *Changes in Available Habitat (Storage)*

24 Changes in CVP and SWP water supplies and operations under Alternative 1 as  
25 compared to the No Action Alternative generally would result in higher reservoir  
26 storage in CVP and SWP reservoirs in the Central Valley Region. Storage levels  
27 in Shasta Lake, Lake Oroville, and Folsom Lake would be higher under  
28 Alternative 1 as compared to the No Action Alternative, as summarized in Tables  
29 5.12 through 5.14, in the fall and winter months due to the inclusion of Fall X2  
30 criteria under the No Action Alternative.

31 The highest increases in Shasta Lake and Lake Oroville storage could be in excess  
32 of 20 percent. Storage in Folsom Lake and New Melones could be increased by  
33 up to around 10 percent in some months of some water year types. Additional  
34 information related to monthly reservoir elevations is provided in Appendix 5A,  
35 CalSim II and DSM2 Modeling. It is anticipated that aquatic habitat within the  
36 CVP and SWP water supply reservoirs is not limiting; however, storage volume is  
37 an indicator of how much habitat is available to fish species inhabiting these  
38 reservoirs. Therefore, the amount of habitat for reservoir fishes could increase  
39 under Alternative 1 as compared to the No Action Alternative.

#### 40 *Changes in Black Bass Nesting Success*

41 As shown in Appendix 9F, black bass nest survival in CVP and SWP reservoirs is  
42 anticipated to be near 100 percent in March and April due to increasing reservoir  
43 elevations. For May and June, the likelihood of nest survival for Largemouth

1 Bass in Shasta Lake being in the 40 to 100 percent range is similar under  
2 Alternative 1 and the No Action Alternative; however, nest survival of greater  
3 than 40 percent is likely only in about 20 percent of the years evaluated. The  
4 likelihood of high nest survival for Smallmouth Bass in Shasta Lake exhibits  
5 nearly the same pattern. For Spotted Bass, the likelihood of nest survival being  
6 greater than 40 percent is high (nearly 100 percent) from March to May under  
7 both Alternative 1 and the No Action Alternative. For June, Spotted Bass nest  
8 survival would be less than for May due to greater daily reductions in water  
9 surface elevation as Shasta Lake is drawn down. The likelihood of nest survival  
10 being greater than 40 percent is about 10 percent less under Alternative 1 as  
11 compared to the No Action Alternative.

12 For May and June, the likelihood of nest survival for Largemouth Bass in Lake  
13 Oroville being in the 40 to 100 percent range is somewhat (4 to 10 percent) lower  
14 under Alternative 1 than under the No Action Alternative. However, in June, nest  
15 survival of greater than 40 percent is likely only in about 35 percent of the years  
16 evaluated under Alternative 1. The likelihood of high nest survival for  
17 Smallmouth Bass in Lake Oroville exhibits nearly the same pattern. For Spotted  
18 Bass, the likelihood of nest survival being greater than 40 percent is high (over  
19 90 percent) in May under both Alternative 1 and the No Action Alternative with  
20 the likelihood of greater than 40 percent survival being similar under  
21 Alternative 1 and the No Action Alternative. For June, Spotted Bass nest survival  
22 would be less than for May due to greater daily reductions in water surface  
23 elevation as Lake Oroville is drawn down. The likelihood of survival being  
24 greater than 40 percent is substantially lower (nearly 20 percent) under  
25 Alternative 1 as compared to the No Action Alternative.

26 Black bass nest survival in Folsom Lake is near 100 percent in March, April, and  
27 May due to increasing reservoir elevations. For June, the likelihood of nest  
28 survival for Largemouth Bass and Smallmouth Bass in Folsom Lake being in the  
29 40 to 100 percent range is about 5 percent lower under Alternative 1 than the No  
30 Action Alternative. For Spotted Bass, nest survival for June would be less than  
31 for May due to greater daily reductions in water surface elevation. However, the  
32 likelihood of survival being greater than 40 percent is around 5 percent lower  
33 under Alternative 1 as compared to the No Action Alternative.

34 *Summary of Effects on Reservoir Fishes*

35 The analysis of the effects of Alternative 1 and the No Action Alternative for  
36 reservoir fish relied on CalSim II output for reservoir storage levels and water  
37 surface elevation changes as described in Appendix 9F. As described above,  
38 reservoir storage is anticipated to be increased under Alternative 1 relative to the  
39 No Action Alternative and this increase could affect the amount of warm and cold  
40 water habitat available within the reservoirs. However, it is unlikely that aquatic  
41 habitat within the CVP and SWP water supply reservoirs is limiting.

42 The analysis of black bass nest survival based on changes in water surface  
43 elevation during the spawning period indicated that the likelihood of high  
44 (>40 percent) nest survival in most of the reservoirs would be similar in March,  
45 April, and May under Alternative 1 and the No Action Alternative, but somewhat

1 lower in June. Most black bass spawning likely occurs prior to June, such that  
2 drawdowns during June would likely affect only a small proportion of the  
3 spawning population. Thus, it is concluded that effects on black bass nesting  
4 success would be similar under Alternative 1 and the No Action Alternative.

#### 5 *Pacific Lamprey*

6 Little information is available on factors that influence populations of Pacific  
7 Lamprey in the Sacramento River, but they are likely affected by many of the  
8 same factors as salmon and steelhead because of the parallels in their life cycles.

#### 9 *Changes in Water Temperature*

10 The following describes anticipated changes in average monthly water  
11 temperature in the Sacramento, Feather, and American rivers and the potential for  
12 those changes to affect Pacific Lamprey.

#### 13 *Sacramento River*

14 Long-term average monthly water temperature in the Sacramento River at  
15 Keswick Dam under Alternative 1 would generally be similar (less than 0.5°F  
16 difference) to water temperatures under the No Action Alternative. An exception  
17 is during September and October of critical dry years when water temperatures  
18 could be up to 1.1°F and 0.8°F lower, respectively, under Alternative 1 as  
19 compared to the No Action Alternative and up to 1°F warmer in September of  
20 wetter years (Appendix 6B, Table 5-5-1). A similar temperature pattern generally  
21 would be exhibited downstream at Ball's Ferry, Jelly's Ferry, and Bend Bridge,  
22 with average monthly temperatures increasing in a downstream direction and  
23 temperature differences between scenarios progressively decreasing except in  
24 September (up to 2.8°F warmer) at Bend Bridge) during wetter years under  
25 Alternative 1. Due to the similarity of water temperatures under Alternative 1 and  
26 the No Action Alternative from January through the summer, there would be little  
27 difference in potential effects on Pacific Lamprey adults during their migration,  
28 holding, and spawning periods.

#### 29 *Feather River*

30 Long-term average monthly water temperature in the Feather River in the low  
31 flow channel generally were predicted to be similar (less than 0.5°F differences)  
32 under Alternative 1 and the No Action Alternative, except during November and  
33 December when average monthly water temperatures would be up to 1.4°F lower  
34 in some water year types (Appendix 6B, Table B-20-1). Average monthly water  
35 temperatures in September under Alternative 1 generally could be up to 1.3°F  
36 higher than under the No Action Alternative in wetter years. Although  
37 temperatures in the river would become progressively higher in the downstream  
38 directions, the differences in water temperatures between Alternative 1 and the No  
39 Action Alternative would exhibit a similar pattern at the downstream locations  
40 (Robinson Riffle and Gridley Bridge), with water temperature differences  
41 between Alternative 1 and the No Action Alternative generally decreasing in most  
42 water year types. However, water temperatures from July to September under  
43 Alternative 1 could be somewhat (0.7°F to 1.6°F) warmer on average and up to  
44 4.0°F warmer at the confluence with Sacramento River in wetter years.

1 Due to the similarity of water temperatures under Alternative 1 and the No Action  
2 Alternative from January through the summer, there would be little difference in  
3 potential effects on Pacific Lamprey adults during their migration, holding, and  
4 spawning periods under Alternative 1 and the No Action Alternative.

5 *American River*

6 Average monthly water temperatures in the American River at Nimbus Dam  
7 under Alternative 1 generally would be similar (differences less than 0.5°F) to the  
8 No Action Alternative, with the exception of during June and August, when water  
9 temperatures under Alternative 1 could be as much as 0.9°F lower in below  
10 normal years. This pattern generally would persist downstream to Watt Avenue  
11 and the mouth, although temperatures under Alternative 1 would be up to 1.6°F  
12 and 2.0°F lower, respectively, than under the No Action Alternative in June. In  
13 addition, average monthly water temperatures at the mouth generally would be  
14 higher under Alternative 1 than the No Action Alternative in September of wetter  
15 years when water temperatures under Alternative 1 could be up to 1.7°F warmer.  
16 Due to the similarity of water temperatures under Alternative 1 and the No Action  
17 Alternative from January through the summer, there would be little difference in  
18 potential effects on Pacific Lamprey adults during their migration, holding, and  
19 spawning periods.

20 *Summary of Effects on Pacific Lamprey*

21 In general, Pacific Lamprey can tolerate higher temperatures than salmonids, up  
22 to around 72°F during their entire life history. Based on the similar water  
23 temperatures during their spawning and incubation period under Alternative 1, it  
24 is likely that conditions for and effects on Pacific Lamprey in the Sacramento,  
25 Feather, and American rivers would be similar under Alternative 1 and the No  
26 Action Alternative. This conclusion likely applies to other species of lamprey  
27 that inhabit these rivers (e.g., River Lamprey).

28 *Striped Bass, American Shad, and Hardhead*

29 Changes in operations influence temperature and flow conditions that could affect  
30 Striped Bass, American Shad, and Hardhead. The following describes those  
31 changes and their potential effects.

32 *Changes in Water Temperature*

33 Changes in water temperature that affect Striped Bass, American Shad, and  
34 Hardhead could occur in the Sacramento, Feather, and American rivers. The  
35 following describes temperature conditions in those water bodies.

36 *Sacramento River*

37 Long-term average monthly water temperatures in the Sacramento River at  
38 Keswick Dam under Alternative 1 would generally be similar (less than 0.5°F  
39 difference) to water temperatures under the No Action Alternative. An exception  
40 is during September and October of critical dry years when water temperatures  
41 could be up to 1.1°F and 0.8°F lower, respectively, under Alternative 1 as  
42 compared to the No Action Alternative and up to 1°F warmer in September of  
43 wetter years (Appendix 6B, Table 5-5-1). A similar water temperature pattern

1 generally would be exhibited downstream at Ball's Ferry, Jelly's Ferry, and Bend  
2 Bridge, with average monthly water temperatures increasing in a downstream  
3 direction and temperature differences between scenarios progressively increasing  
4 (up to 0.9°F cooler) in June and up to 4.6°F warmer in September during the  
5 wetter years under Alternative 1 relative to the No Action Alternative. In general,  
6 Striped Bass, American Shad, and Hardhead can tolerate higher temperatures than  
7 salmonids. Therefore, it is unlikely that the slightly reduced temperatures during  
8 some months would have adverse effects on these species.

#### 9 *Feather River*

10 Average monthly water temperature in the Feather River in the low flow channel  
11 generally were predicted to be similar (less than 0.5°F differences) under  
12 Alternative 1 and the No Action Alternative, except during November and  
13 December when average monthly water temperatures would be up to 1.4°F lower  
14 in some water year types (Appendix 6B, Table B-20-1). Average monthly water  
15 temperatures in September under Alternative 1 could be up to 1.3°F warmer than  
16 under the No Action Alternative in the wetter years. Although temperatures in the  
17 river would become progressively lower in the downstream directions, the  
18 differences between Alternative 1 and No Action Alternative would exhibit a  
19 similar pattern at the downstream locations (Appendix 6B, Table B-23-1). As  
20 described above for the Sacramento River, Striped Bass, American Shad, and  
21 Hardhead can tolerate higher temperatures than salmonids. Therefore, it is  
22 unlikely that the slightly reduced temperatures during some months would have  
23 adverse effects on these species in the Feather River.

#### 24 *American River*

25 Average monthly water temperatures in the American River at Nimbus Dam  
26 under Alternative 1 generally would be similar (differences less than 0.5°F) to the  
27 No Action Alternative, with the exception of during June and August, when  
28 differences under Alternative 1 could be as much as 0.9°F lower in below normal  
29 years. This pattern generally would persist downstream to Watt Avenue and the  
30 mouth, although temperatures under Alternative 1 would be up to 1.6°F and 2.0°F  
31 lower, respectively, than under the No Action Alternative in June. As described  
32 above for the Sacramento River, Striped Bass, American Shad, and Hardhead can  
33 tolerate higher temperatures than salmonids. Therefore, it is unlikely that the  
34 slightly reduced temperatures during some months would have adverse effects on  
35 these species in the American River.

#### 36 *Changes in Position of X2*

37 Alternative 1 would result in a more eastward X2 position as compared to the No  
38 Action Alternative during April and May, with similar values in June  
39 (Appendix 5A, Section C Table C-16-1). Based on Kimmerer (2002) and  
40 Kimmerer et al. (2009), this change in X2 would likely reduce the survival index  
41 and the habitat index as measured by salinity for Striped Bass and abundance and  
42 habitat index for American Shad.

1            *Summary of Effects on Striped Bass, American Shad, and Hardhead*

2 In general, Striped Bass, American Shad, and Hardhead can tolerate higher  
3 temperatures than salmonids. Based on the similar water temperatures during  
4 their spawning and incubation period under Alternative 1, it is likely that thermal  
5 conditions for and effects on Striped Bass, American Shad, and Hardhead in the  
6 Sacramento, Feather, and American rivers would be similar under Alternative 1  
7 and the No Action Alternative. Overall, however, Alternative 1 likely would have  
8 slightly greater potential for adverse effects on Striped Bass and American Shad  
9 as compared to the No Action Alternative, primarily due to the potential for  
10 reduced survival during larval and juvenile life stages, and less favorable location  
11 of Spring X2 on average.

12 *Stanislaus River/Lower San Joaquin River*

13            *Fall-Run Chinook Salmon*

14 Changes in operations influence temperature and flow conditions that could affect  
15 fall-run Chinook Salmon in the Stanislaus River downstream of Goodwin Dam  
16 and in the San Joaquin River below Vernalis. The following describes those  
17 changes and their potential effects.

18            *Changes in Water Temperature (Stanislaus River)*

19 Average monthly water temperatures in the Stanislaus River at Goodwin Dam  
20 under Alternative 1 and the No Action Alternative generally would be similar  
21 (differences less than 0.5°F), with small differences in critical dry years when  
22 Alternative 1 would 0.8°F and 1.3°F cooler on average than under the No Action  
23 Alternative during June and September, respectively, and 0.7°F warmer in  
24 November (Appendix 6B, Table B-1-1).

25 Downstream at Orange Blossom Bridge, average monthly water temperatures in  
26 October under Alternative 1 would be higher in all water year types than under  
27 the No Action Alternative by as much as 1.9°F. In most other months, water  
28 temperatures under Alternative 1 and the No Action Alternative generally would  
29 be similar. An exception to this pattern occurs in April when average monthly  
30 water temperatures in all water year types would be higher under Alternative 1 by  
31 as much as about 1.2°F (Appendix 6B, Table B-18-1).

32 This water temperature pattern would continue downstream to the confluence  
33 with the San Joaquin River, although temperatures would progressively increase,  
34 as would the magnitude of difference between Alternative 1 and No Action  
35 Alternative. Increases in average monthly water temperatures in October and  
36 April would be more pronounced under Alternative 1, with average differences as  
37 much as 2.7°F in October and 2.0 F in April (Appendix 6B, Table B-19-1)  
38 relative to the No Action Alternative. The magnitude of differences in average  
39 monthly water temperatures between Alternative 1 and the No Action  
40 Alternative in May and June also would increase relative to the upstream  
41 locations with average June water temperatures being 2.4°F cooler under  
42 Alternative 1 in wet years.

1 Based on the life history timing for fall-run Chinook Salmon, the higher water  
 2 temperatures in October under Alternative 1 may increase the likelihood of  
 3 adverse effects on fall-run Chinook Salmon spawning and egg incubation as  
 4 compared to the No action Alternative.

5 *Changes in Exceedance of Water Temperature Thresholds Appendix*

6 While specific water temperature thresholds for fall-run Chinook Salmon in the  
 7 Stanislaus River are not established, temperatures generally considered suitable  
 8 for fall-run Chinook Salmon spawning (56°F) would be exceeded in October and  
 9 November about 30 and 25 percent of the time, respectively at Goodwin Dam  
 10 under Alternative 1 (Appendix 6B, Figures B-17-1 and B-17-2). Similar  
 11 exceedances would occur under the No Action Alternative, although slightly more  
 12 frequently in November. Water temperatures for rearing generally would be  
 13 below 56°F, except in May when average monthly water temperatures would  
 14 reach about 60°F under both Alternative 1 and the No action  
 15 Alternative (Appendix 6B, Figure B-17-8).

16 Downstream at Orange Blossom Bridge, water temperatures suitable for fall-run  
 17 Chinook Salmon spawning (56°F) would be exceeded frequently under both  
 18 Alternative 1 and the No Action Alternative during October and November.  
 19 Under Alternative 1, average monthly water temperatures would exceed 56°F  
 20 about 85 percent of the time in October. This, would be about 28 percent more  
 21 frequently than under the No Action Alternative. In November, average monthly  
 22 water temperatures would exceed 56°F about 28 percent of the time under  
 23 Alternative 1, which would be about 5 percent less frequent than under the No  
 24 Action Alternative (Appendix 6B, Figure B-18-2).

25 From January through May, rearing fall-run Chinook Salmon would be subjected  
 26 to average monthly water temperatures that exceed 56° in March (less than  
 27 10 percent of the time) and May (about 20 percent of the time) under  
 28 Alternative 1, which is about 10 percent less frequently than under the No Action  
 29 Alternative in May (Appendix 6B, Figure B-18-8).

30 *Changes in Egg Mortality (Stanislaus River)*

31 For fall-run Chinook Salmon in the Stanislaus River, the long-term average egg  
 32 mortality rate is predicted to be around 7 percent, with higher mortality rates (in  
 33 excess of 15 percent) occurring in critical dry years under Alternative 1. Overall,  
 34 egg mortality in the Stanislaus River would be similar under Alternative 1 and the  
 35 No Action Alternative (Appendix 9C, Table B-1).

36 *Changes in Delta Hydrodynamics*

37 San Joaquin River-origin fall-run Chinook Salmon smolts are most abundant in  
 38 the Delta during the months of April, May and June. Near the confluence of the  
 39 San Joaquin River and the Mokelumne River, the median proportion of positive  
 40 velocities was slightly lower under Alternative 1 relative to the No Action  
 41 Alternative in April and May and similar in June (Appendix 9K). In Old River  
 42 downstream of the facilities, the median proportion of positive velocities was  
 43 substantially lower in April and May under Alternative 1 relative to No Action



1 Alternative but became more similar in June. In Old River upstream of the  
2 facilities, the median proportion of positive velocities was slightly to moderately  
3 lower for Alternative 1 relative to No Action Alternative in April and May,  
4 respectively and moderately lower in June. On the San Joaquin River  
5 downstream of the Head of Old River, the median proportion of positive  
6 velocities was slightly to moderately higher under Alternative 1 relative to No  
7 Action Alternative in April and May, respectively, whereas values were similar  
8 in June.

9 *Changes in Junction Entrainment*

10 Median entrainment probabilities at the Head of Old River were much lower  
11 under Alternative 1 relative to the No Action Alternative during April and May.  
12 The median entrainment probability was similar under both alternatives in the  
13 month of June (Appendix 9L). At the Turner Cut junction, median entrainment  
14 probabilities under Alternative 1 were slightly higher than under the No Action  
15 Alternative in June. During April and May, entrainment probabilities were more  
16 divergent with moderately higher values for Alternative 1 relative to No Action  
17 Alternative. Overall, entrainment was slightly lower at the Columbia Cut junction  
18 relative to Turner Cut but patterns of entrainment between these two alternatives  
19 were similar. Patterns at the Middle River and Old River junctions were similar  
20 to those observed at Columbia and Turner Cut junctions.

21 *Summary of Effects on Fall-Run Chinook Salmon*

22 In the Stanislaus River, the analysis of the effects of Alternative 1 and the No  
23 Action Alternative for fall-run Chinook Salmon relied on the water temperature  
24 model output for the rivers at various locations downstream of Goodwin Dam.  
25 The temperature model outputs for each of the fall-run Chinook Salmon life  
26 stages suggest that thermal conditions and effects on fall-run Chinook Salmon in  
27 the Stanislaus River generally would be similar under both scenarios, although  
28 water temperatures could be somewhat less suitable for fall-run Chinook Salmon  
29 spawning/egg incubation under Alternative 1. This conclusion is supported by the  
30 water temperature threshold exceedance analysis that indicated that suitable water  
31 temperatures for fall-run Chinook Salmon spawning and egg incubation would be  
32 exceeded slightly less frequently in November, but substantially more frequently  
33 in October under Alternative 1. Suitable water temperatures for fall-run Chinook  
34 Salmon rearing would be exceeded somewhat less frequently under Alternative 1.  
35 Results of the analysis using Reclamation's salmon mortality model indicate that  
36 there would be little difference in fall-run Chinook Salmon egg mortality under  
37 Alternative 1 and the No Action Alternative.

38 Implementation of a fish passage project under the No Action Alternative,  
39 although intended to address the limited availability of suitable habitat for  
40 steelhead in the Stanislaus River reaches downstream of Goodwin Dam, could  
41 provide some benefit to fall-run Chinook Salmon if passage for adult fall-run  
42 Chinook Salmon was provided and additional habitat could be accessed. Any  
43 potential benefit to fall-run Chinook Salmon under the No Action Alternative  
44 relative to Alternative 1 is uncertain. The potential benefits of actions under the  
45 No Action Alternative intended to increase the efficiency of the Tracy and

1 Skinner Fish Collection Facilities could improve the overall salvage survival of  
2 fall-run Chinook Salmon relative to Alternative 1.

3 The results of the numerical models suggest that Alternative 1 is less likely to  
4 result in adverse effects on fall-run Chinook Salmon than the No Action  
5 Alternative. However, discerning a meaningful difference between these two  
6 scenarios based on the quantitative results is not possible because of the similarity  
7 in results (generally differences less than 5 percent) and the inherent uncertainty  
8 of the models. In addition, adverse effects of the No Action Alternative could be  
9 balanced by the potentially beneficial effects resulting from the RPA actions  
10 evaluated qualitatively for the No Action Alternative. Overall, given the small  
11 differences in the numerical model results and the inherent uncertainty in the  
12 temperature model, as well as the potential for benefits associated with the RPA  
13 actions under the No Action Alternative, it is concluded that there would be no  
14 definitive difference in effects on fall-run Chinook Salmon between Alternative 1  
15 and the No Action Alternative.

### 16 *Steelhead*

17 Changes in operations that influence temperature and flow conditions in the  
18 Stanislaus River downstream of Goodwin Dam and the San Joaquin River below  
19 Vernalis could affect steelhead. The following describes those changes and their  
20 potential effects.

#### 21 *Changes in Water Temperature (Stanislaus River)*

22 Average monthly water temperatures in the Stanislaus River at Goodwin Dam  
23 under Alternative 1 and the No Action Alternative generally would be similar  
24 (differences less than 0.5°F), with small differences in critical dry years when  
25 water temperatures under Alternative 1 would 0.8°F and 1.3°F cooler on average  
26 than under the No Action Alternative during June and September, respectively,  
27 and 0.7°F warmer in November (Appendix 6B, Table B-17-1).

28 Downstream at Orange Blossom Bridge, average monthly water temperatures in  
29 October under Alternative 1 would be higher in all water year types than the No  
30 Action Alternative by as much as 1.9°F. In most other months, water  
31 temperatures under Alternative 1 and the No Action Alternative generally would  
32 be similar (less than 0.5°F differences), except in April when average monthly  
33 water temperatures in all water year types would be higher under Alternative 1 by  
34 as much as about 1.2°F in the drier years (Appendix 6B, Table B-18-1).

35 This water temperature pattern would continue downstream to the confluence  
36 with the San Joaquin River, although temperatures would progressively increase,  
37 as would the magnitude of difference between Alternative 1 and the No Action  
38 Alternative. Increases in average monthly water temperatures in October and  
39 April would be more pronounced under Alternative 1, with average differences as  
40 much as 2.7°F (Appendix 6B, Table B-19-1) relative to the No Action  
41 Alternative. The magnitude of differences in average monthly water temperatures  
42 between Alternative 1 and the No Action Alternative in May and June also would

1 increase relative to the upstream locations with average June water temperatures  
2 being 2.4°F cooler under Alternative 1 in wet years.

3 Overall, the water temperature differences between Alternative 1 and the No  
4 Action Alternative would be relatively minor (less than 0.5°F) and likely would  
5 have little effect on steelhead in the Stanislaus River. Based on the life history  
6 timing for steelhead, the slightly lower temperatures in June and September of  
7 drier years under Alternative 1 may decrease the likelihood of adverse effects to  
8 steelhead rearing in the Stanislaus River; the higher temperatures in October  
9 under Alternative 1 may increase the likelihood of adverse effects on adult  
10 steelhead during their upstream migration.

11 *Changes in Exceedance of Water Temperature Thresholds*  
12 *(Stanislaus River)*

13 Average monthly water temperatures in the Stanislaus River at Orange Blossom  
14 Bridge would frequently exceed the temperature threshold (56°F) established for  
15 adult steelhead migration under both Alternative 1 and No Action  
16 Alternative during October and November. Under Alternative 1, average monthly  
17 water temperatures would exceed 56°F about 85 percent of the time in October  
18 which is about 28 percent more frequently than under the No Action  
19 Alternative (Appendix 6B, Figure B-18-1). In November, average monthly water  
20 temperatures would exceed 56°F about 28 percent of the time under Alternative 1,  
21 which would be about 5 percent less frequent than under the No Action  
22 Alternative (Appendix 6B, Figure B-18-2).

23 From January through May, the temperature threshold at Orange Blossom Bridge  
24 is 55°F, which is intended to support steelhead spawning. This threshold would  
25 not be exceeded under either Alternative 1 or No Action Alternative during  
26 January or February. From March through May, however, exceedances would  
27 occur under both Alternative 1 and the No Action Alternative in each month, with  
28 the threshold most frequently exceeded (43 percent) under Alternative 1 in May  
29 (Appendix 9N). Water temperatures under Alternative 1 would exceed the  
30 threshold 5 percent less frequently in March, 6 percent less frequently in May,  
31 and 17 percent more frequently in April than under the No Action Alternative.

32 From June through November, the temperature threshold of 65°F established to  
33 support steelhead rearing would be exceeded by both Alternative 1 and No Action  
34 Alternative in all months but November, and would exceed the threshold by  
35 16 percent of the time in July under both Alternative 1 and the No Action  
36 Alternative. The differences between Alternative 1 and the No Action  
37 Alternative range from 1 percent less frequent exceedance in October to 4 percent  
38 more frequent exceedance in June under the No Action Alternative.

39 Average monthly water temperatures also would exceed the threshold (52°F)  
40 established for smoltification at Knights Ferry. At Goodwin Dam, about 4 miles  
41 upstream of Knights Ferry, average monthly water temperatures under  
42 Alternative 1 would exceed 52°F in March, April, and May about 9 percent,  
43 31 percent, and 66 percent of the time, respectively. Water temperatures under

1 Alternative 1 would result in exceedances occurring about 1 to 2 percent more  
2 frequently during the January through May period. Farther downstream at Orange  
3 Blossom Bridge, the temperature threshold for smoltification is higher (57°F) and  
4 would be exceeded less frequently. The magnitude of the exceedance also would  
5 be less. Average monthly water temperatures under Alternative 1 and the No  
6 Action Alternative would not exceed the threshold during January through March.  
7 In April and May, exceedances of 8 percent and 10 percent would occur under  
8 Alternative 1, which represent a frequency of about 6 percent more than the No  
9 Action Alternative in April and about an 8 percent lower frequency in May.

10 Overall, the differences in exceedance frequency between Alternative 1 and the  
11 No Action Alternative would be relatively small, with the exception of substantial  
12 differences in the frequency of exceedances in October when the average monthly  
13 water temperatures under Alternative 1 would exceed the threshold for adult  
14 steelhead migration about 28 percent more frequently and in April during the  
15 spawning period when the exceedance frequency would be about 17 percent  
16 more. Given the frequency of exceedance under both Alternative 1 and No  
17 Action Alternative and the generally stressful temperature conditions in the river,  
18 the substantial differences in October and April under Alternative 1 suggest that  
19 there would be more potential to result in adverse effects on steelhead under  
20 Alternative 1 than under the No Action Alternative. Even during months when  
21 the differences would be relatively small, the slightly higher frequency of  
22 exceedances under Alternative 1 suggest that there would be more potential to  
23 result in adverse effects on steelhead under Alternative 1 than under the No  
24 Action Alternative.

#### 25 *Changes in Delta Hydrodynamics*

26 San Joaquin River-origin steelhead generally move through the Delta during  
27 spring; however, there is less information on their timing relative to Chinook  
28 Salmon. Thus, hydrodynamics in the entire January through June period have the  
29 potential to affect juvenile steelhead. For a description of potential hydrodynamic  
30 effects on steelhead, see the descriptions for winter-run Chinook Salmon in the  
31 Sacramento Basin and fall-run Chinook Salmon in the San Joaquin River  
32 basin above.

#### 33 *Summary of Effects on Steelhead*

34 The analysis of the effects of Alternative 1 and the No Action Alternative for  
35 steelhead relied on the water temperature model output for the rivers at various  
36 locations downstream of Goodwin Dam. The temperature model outputs for each  
37 of the steelhead life stages suggest that thermal conditions and effects on  
38 steelhead in all of these streams generally would be similar under both scenarios,  
39 although water temperatures could be somewhat less suitable for steelhead rearing  
40 under Alternative 1. Water temperatures could be somewhat more suitable during  
41 the adult upstream migration period under Alternative 1 than the No Action  
42 Alternative. This conclusion is supported by the water temperature threshold  
43 exceedance analysis that indicated that the water temperature threshold for  
44 steelhead migration would be exceeded substantially more frequently on October,  
45 but somewhat more frequently in November under Alternative 1. The water

1 temperature threshold for steelhead spawning would also be exceeded  
2 substantially more frequently in May, but somewhat less frequently in other  
3 months under Alternative 1. The water temperature threshold for steelhead  
4 rearing generally would be exceeded less frequently under Alternative 1 while the  
5 temperature thresholds for smoltification would be exceeded more frequently in  
6 most months.

7 The differences in the magnitude and frequency of exceedance of suitable  
8 temperatures for the various lifestages under Alternative 1 could affect the  
9 potential for adverse effects on the steelhead populations in the Stanislaus River.  
10 However, the direction and magnitude of this effect is uncertain. Implementation  
11 of the fish passage program under the No Action Alternative intended to address  
12 the limited availability of suitable habitat for steelhead in the Stanislaus River  
13 reaches downstream of Goodwin Dam could provide a benefit to Central Valley  
14 steelhead in the Stanislaus River. This is particularly important in light of  
15 anticipated increases in water temperature associated with climate change in  
16 2030. Thus, it is concluded that the potential for adverse effects on steelhead  
17 under Alternative 1 would be greater, principally because Alternative 1 does not  
18 include fish passage to address water temperatures critical to steelhead  
19 sustainability over the long term with climate change by 2030.

#### 20 *White Sturgeon*

21 Evidence of White Sturgeon spawning has been recorded in the San Joaquin River  
22 upstream of the confluence with the Stanislaus River. While flows in the San  
23 Joaquin River upstream of the Stanislaus River are expected to be similar under all  
24 alternatives, flow contributions from the Stanislaus River could influence water  
25 temperatures in the San Joaquin River where White Sturgeon eggs or larvae may  
26 occur during the spring and early summer. The magnitude of influence on water  
27 temperature would depend on the proportional flow contribution of the Stanislaus  
28 River and the temperatures in both the Stanislaus and San Joaquin rivers. The  
29 potential for an effect on White Sturgeon eggs and larvae would be influenced by  
30 the proportion of the population occurring in the San Joaquin River. In  
31 consideration of this uncertainty, it is not possible to distinguish potential effects  
32 on White Sturgeon between alternatives.

#### 33 *Reservoir Fishes*

34 The analysis of effects associated with changes in operation on reservoir fishes  
35 relied on evaluation of changes in available habitat (reservoir storage) and  
36 anticipated changes in black bass nesting success.

37 Changes in CVP and SWP water supplies and operations under Alternative 1 as  
38 compared to the No Action Alternative would result in higher storage levels in  
39 New Melones Reservoir under Alternative 1 as compared to the No Action  
40 Alternative, as summarized in Table 5.16, due to lower instream releases to  
41 support fish flows under Alternative 1.

42 Storage in New Melones could be increased by up to around 10 percent in some  
43 months of some water year types under Alternative 1 compared to the No Action  
44 Alternative. Additional information related to monthly reservoir elevations is

1 provided in Appendix 5A, CalSim II and DSM2 Modeling. Assuming that  
2 storage volume is an indicator of how much habitat is available to fish species  
3 inhabiting the reservoir, the amount of habitat for reservoir fishes could be  
4 increased under Alternative 1 as compared to the No Action Alternative.

5 As shown in Appendix 9F, Largemouth Bass and Smallmouth Bass nest survival  
6 is anticipated to always be above 40 percent under both Alternative 1 and the No  
7 Action Alternative in March. For April, the likelihood that nest survival of  
8 Largemouth Bass and Smallmouth Bass is between 40 and 100 percent is  
9 reasonably high (nearly 80 percent), although about 13 percent higher under  
10 Alternative 1 as compared to the No Action Alternative. For May, nest survival is  
11 anticipated to be similar under Alternative 1 and the No Action Alternative. For  
12 June, the likelihood of survival being greater than 40 percent for Largemouth  
13 Bass and Smallmouth Bass in New Melones Reservoir is about 8 percent lower  
14 under Alternative 1 as compared to the No Action Alternative. For Spotted Bass,  
15 nest survival from March through June is anticipated to be near 100 percent in  
16 every year under both Alternative 1 and No Action Alternative. Most black bass  
17 spawning likely occurs prior to June, such that drawdowns during June would  
18 likely affect only a small proportion of the spawning population. Thus, it is  
19 concluded that effects on black bass nesting success would be similar under  
20 Alternative 1 and the No Action Alternative.

#### 21 *Other species*

22 Changes in operations that influence temperature and flow conditions in the  
23 Stanislaus River downstream of Keswick Dam and the San Joaquin River at  
24 Vernalis could affect other species such as lampreys, Hardhead, and Striped Bass.

25 As described above, average monthly water temperatures in the Stanislaus River  
26 at Goodwin Dam under Alternative 1 and No Action Alternative generally would  
27 be similar. Downstream at Orange Blossom Bridge, average monthly water  
28 temperatures in the November to March period under Alternative 1 generally  
29 would be similar to, although somewhat lower than, under the No Action  
30 Alternative. In April and October, average monthly water temperatures in all  
31 water year types would be higher under Alternative 1 and in September, water  
32 temperatures would be lower under Alternative 1 compared to the No Action  
33 Alternative. This temperature pattern would continue downstream to the  
34 confluence with the San Joaquin River, although temperatures would  
35 progressively increase, as would the magnitude of difference between  
36 Alternative 1 and No Action Alternative (Appendix 6B, Table B-19-1).

37 In general, lamprey species can tolerate higher temperatures than salmonids, up to  
38 around 72°F during their entire life history. Because lamprey ammocoetes remain  
39 in the river for several years, any substantial flow reductions or temperature  
40 increases could result in adverse effects on larval lamprey. Given the similar  
41 flows and temperatures during their spawning and incubation period, it is likely  
42 that the potential to affect lamprey species in the Stanislaus and San Joaquin  
43 rivers would be similar under Alternative 1 and the No Action Alternative.

1 In general, Striped Bass and Hardhead also can tolerate higher temperatures than  
2 salmonids. Given the similar temperatures during their spawning and incubation  
3 period, it is likely that the potential to affect Striped Bass and Hardhead in the  
4 Stanislaus and San Joaquin rivers would be similar under Alternative 1 and the  
5 No Action Alternative.

6 *San Francisco Bay Area Region*

7 *Killer Whale*

8 Southern Resident killer whales (Southern Residents) are thought to rely heavily  
9 upon salmon as their main source of prey (about 96 percent of their diet)  
10 throughout the areas and times for which reliable data on prey consumption are  
11 available (Ford and Ellis 2006). Studies have indicated that Chinook Salmon  
12 generally constitute a large percentage of the Southern Resident salmon diet, with  
13 some indications that Chinook Salmon are strongly preferred at certain times in  
14 comparison to other salmonids (Ford and Ellis 2006; Hanson et al. 2007). Results  
15 have also suggested that Chinook Salmon from ESUs from California to British  
16 Columbia are being consumed by Southern Residents (Hanson et al. 2007).

17 Best available data on the abundance and composition of Central Valley Chinook  
18 Salmon indicates that approximately 75 percent of all Central Valley-origin  
19 Chinook Salmon available for consumption by Southern Residents are produced  
20 by Central Valley fall-run Chinook Salmon hatcheries (Palmer-Zwhalen and  
21 Kormos 2012; Table 9). Most Central Valley hatchery fall-run Chinook Salmon  
22 production is released directly into San Francisco Bay, and thus bypass potential  
23 impacts from water project operations. Even where there might be a nexus with  
24 water project operations, the purpose of Central Valley fall-run Chinook Salmon  
25 hatchery programs is to produce large numbers of fish independent of freshwater  
26 conditions. Since fall-run Chinook Salmon hatcheries came on-line more than  
27 forty years ago, the only period of exceptionally low returns was principally  
28 attributed to unusual ocean conditions (Lindley et al. 2007).

29 Ocean commercial and recreational fisheries annually harvest hundreds of  
30 thousands of Chinook salmon. The Northwest Region of NMFS (NMFS 2009c)  
31 used a model that estimates prey reduction associated with the salmon fishery and  
32 which considers the metabolic requirements of Southern Residents and the  
33 remaining levels of prey availability. Their analysis concluded that the salmon  
34 fishery was not likely to result in jeopardy for Southern Residents. Given  
35 conclusions from NMFS (2009c), and the fact that at least 75 percent of fall-run  
36 Chinook Salmon available for Southern Residents are produced by Central Valley  
37 hatcheries, it is likely that Central Valley fall-run Chinook Salmon as a prey base  
38 for killer whales would not be appreciably affected by any of the alternatives.

39 **9.4.3.2.2 Alternative 1 Compared to the Second Basis of Comparison**

40 As described in Chapter 3, Description of Alternatives, Alternative 1 is identical  
41 to the Second Basis of Comparison.

1    **9.4.3.3    Alternative 2**

2    The CVP and SWP operations under Alternative 2 are identical to the CVP and  
3    SWP operations under the No Action Alternative, as described in Chapter 3,  
4    Description of Alternatives. Alternative 2 would not include implementation of  
5    fish passage actions under the 2009 NMFS BO. As described in Chapter 4,  
6    Approach to Environmental Analysis, Alternative 2 is compared to the No Action  
7    Alternative and the Second Basis of Comparison.

8    **9.4.3.3.1    Alternative 2 Compared to the No Action Alternative**

9    *Trinity River Region*

10   The CVP and SWP operations under Alternative 2 are identical to the CVP and  
11   SWP operations under the No Action Alternative. Therefore, fish and aquatic  
12   resources conditions at Trinity Lake and along the Trinity River and lower  
13   Klamath River under Alternative 2 would be the same as under the No Action  
14   Alternative.

15   *Central Valley Region*

16   The CVP and SWP operations under Alternative 2 are identical to the CVP and  
17   SWP operations under the No Action Alternative. Therefore, physical conditions  
18   that affect aquatic resources under Alternative 2 would be the same as under the  
19   No Action Alternative. However, salmonid survival could be less under  
20   Alternative 2 due to the lack of fish passage actions to move fish to portions of the  
21   Sacramento, American, and Stanislaus rivers that would provide cooler  
22   temperatures for spawning and rearing under the No Action Alternative. In  
23   addition, Alternative 2 would not include various actions that would occur under  
24   the No Action Alternative intended to benefit salmonids and sturgeon, such as  
25   structural improvements for temperature control on the American River; gravel  
26   augmentation, floodplain restoration and inundation flows, and freshwater  
27   migratory habitat restoration in the Stanislaus River; and measures to increase the  
28   efficiency of the Tracy and Skinner Fish Collection Facilities. Thus, it is  
29   concluded that the potential for adverse effects on salmonids and sturgeon under  
30   Alternative 2 would be greater than under the No Action Alternative.

31   *San Francisco Bay Area Region*

32    *Killer Whale*

33   It is unlikely that the Chinook Salmon prey base of killer whales, supported  
34   heavily by hatchery production of fall-run Chinook Salmon, would be appreciably  
35   affected by any of the alternatives.

36   **9.4.3.3.2    Alternative 2 Compared to the Second Basis of Comparison**

37    *Trinity River Region*

38   The CVP and SWP operations under Alternative 2 are identical to the CVP and  
39   SWP operations under the No Action Alternative. Therefore, changes in aquatic  
40   resources at Trinity Lake and along the Trinity River and lower Klamath River  
41   under Alternative 2 as compared to the Second Basis of Comparison would be the



1 same as the impacts described in Section 10.4.4.1, No Action  
2 Alternative Compared to the Second Basis of Comparison.

3 *Central Valley Region*

4 The CVP and SWP operations under Alternative 2 are identical to the CVP and  
5 SWP operations under the No Action Alternative. Therefore, changes in physical  
6 conditions that affect aquatic resources in the Central Valley Region under  
7 Alternative 2 as compared to the Second Basis of Comparison would be the same  
8 as the impacts described for the No Action Alternative Compared to the Second  
9 Basis of Comparison. Actions to provide fish passage to portions of the  
10 Sacramento, American, and Stanislaus rivers upstream of their dams would not be  
11 undertaken under Alternative 2 or the Second Basis of Comparison.

12 *San Francisco Bay Area Region*

13 *Killer Whale*

14 As described above for the comparison of Alternative 1 to the No Action  
15 Alternative, it is unlikely that the Chinook Salmon prey base of killer whales,  
16 supported heavily by hatchery production of fall-run Chinook Salmon, would be  
17 appreciably affected by any of the alternatives.

18 **9.4.3.4 Alternative 3**

19 As described in Chapter 3, Description of Alternatives, CVP and SWP operations  
20 under Alternative 3 are similar to the Second Basis of Comparison with modified  
21 OMR flow criteria and New Melones Reservoir operations. Alternative 3 also  
22 includes the following items that are not included in the No Action Alternative or  
23 the Second Basis of Comparison and would affect fish and aquatic resources.

- 24 • Implement predator control programs for black bass, Striped Bass, and  
25 Sacramento Pikeminnow to protect salmonids and Delta Smelt as follows:
  - 26 – Black bass catch limit changed to allow catch of 12-inch fish with a bag  
27 limit of 10
  - 28 – Striped Bass catch limit changed to allow catch of 12-inch fish with a bag  
29 limit of 5
  - 30 – Establish a Sacramento Pikeminnow sport-fishing reward program with a  
31 8-inch limit at \$2/fish
- 32 • Establish a trap and haul program for juvenile salmonids entering the Delta  
33 from the San Joaquin River in March through June as follows:
  - 34 – Begin operation of downstream migrant fish traps upstream of the Head of  
35 Old River on the San Joaquin River
  - 36 – “Barge” all captured juvenile salmonids through the Delta, release at  
37 Chipps Island.
  - 38 – Tag subset of fish in order to quantify effectiveness of the program
  - 39 – Attempt to capture 10 percent to 20 percent of out-migrating juvenile  
40 salmonids

- 1 • Work with Pacific Fisheries Management Council, CDFW, and NMFS to  
2 minimize harvest mortality of natural origin Central Valley Chinook Salmon,  
3 including fall-run Chinook Salmon, by evaluating and modifying ocean  
4 harvest for consistency with Viable Salmonid Population Standards; including  
5 harvest management plan to show that abundance, productivity, and diversity  
6 (age-composition) are not appreciably reduced.

7 As described in Chapter 4, Approach to Environmental Analysis, Alternative 3 is  
8 compared to the No Action Alternative and the Second Basis of Comparison.

#### 9 **9.4.3.4.1 Alternative 3 Compared to the No Action Alternative**

##### 10 *Trinity River Region*

##### 11 *Coho Salmon*

12 The analysis of effects associated with changes in operation on Coho Salmon was  
13 conducted using temperature model outputs for Lewiston Dam to anticipate the  
14 likely effects on conditions in the Trinity River downstream of Lewiston Dam for  
15 Coho Salmon.

16 Long-term average monthly water temperatures in the Trinity River at Lewiston  
17 Dam under Alternative 3 generally would be similar to the temperatures that  
18 would occur under the No Action Alternative (Appendix 6B, Table B-1-2). An  
19 exception occurs during November when long-term average water temperatures  
20 are increased by 3.3°F under Alternative 3 relative to the No Action Alternative in  
21 critical years. In addition, water temperatures under Alternative 3 could be as  
22 much as 1.5°F cooler than under the No Action Alternative in December of below  
23 normal years. Overall, the temperature differences between Alternative 3 and the  
24 No Action Alternative would be relatively minor and likely would have little  
25 effect on Coho Salmon in the Trinity River. The higher water temperatures in  
26 November of critical years and lower temperatures in December of below normal  
27 years under Alternative 3 would likely have little effect on Coho Salmon as water  
28 temperatures in the Trinity River are typically low during this time period.

29 The USFWS established a water temperature threshold of 56°F for Coho Salmon  
30 spawning in the reach of the Trinity River from Lewiston to the confluence with  
31 the North Fork Trinity River from October through December. Although not  
32 entirely reflective of water temperatures throughout the reach, the temperature  
33 model provides average monthly water temperature outputs for Lewiston Dam,  
34 which may provide perspective on temperature conditions in the reach below.  
35 Under Alternative 3, the spawning temperature threshold would be exceeded  
36 about 6 percent of the time in October, about 2 percent less frequently than under  
37 the No Action Alternative. In November, average water temperatures under  
38 Alternative 3 would not exceed the threshold, whereas average monthly water  
39 temperatures the No Action Alternative would exceed the threshold about  
40 2 percent of the time. The threshold would not be exceeded in December under  
41 either scenario (Appendix 9N).

1 Overall, the temperature model outputs for each of the Coho Salmon life stages  
2 suggest that the temperature of water released at Lewiston Dam generally would  
3 be similar under both scenarios, although the exceedance of water temperature  
4 thresholds would be less frequent under Alternative 3. Given the similarity of the  
5 results and the inherent uncertainty associated with the resolution of the  
6 temperature model (average monthly outputs), it is concluded that Alternative 3  
7 and the No Action Alternative are likely to have similar effects on the Coho  
8 Salmon population in the Trinity River.

9 *Spring-run Chinook Salmon*

10 The analysis of effects associated with changes in operation on spring-run  
11 Chinook Salmon was conducted using temperature model outputs for Lewiston  
12 Dam to anticipate the likely effects on conditions in the Trinity River downstream  
13 of Lewiston Dam.

14 As described above for Coho Salmon, the differences in long-term average  
15 monthly water temperatures between Alternative 3 and the No Action  
16 Alternative would be relatively minor (less than 0.5°F) and likely would have  
17 little effect on spring-run Chinook Salmon in the Trinity River. The substantially  
18 higher (3.3°F) water temperatures in November of critical dry years and lower (by  
19 1.5°F) in December of below normal years under Alternative 3 would likely have  
20 little effect on spring-run Chinook Salmon as water temperatures in the Trinity  
21 River are typically low during this time period.

22 In July, water temperatures in the Trinity River at Lewiston Dam would not  
23 exceed the 60°F threshold for spring-run Chinook Salmon holding under  
24 Alternative 3, although this threshold would be exceeded 1 percent of the time  
25 under the No Action Alternative. Under both Alternative 3 and the No Action  
26 Alternative, average monthly water temperatures in the Trinity River at Lewiston  
27 Dam would exceed 60°F two percent of the time in August. In September, the  
28 threshold for spawning (56°F) would be exceeded under both scenarios about  
29 9 percent of the time. Overall, the differences in the frequency of threshold  
30 exceedance between Alternative 3 and the No Action Alternative would be  
31 relatively minor. However, temperature conditions under Alternative 3 could be  
32 slightly less likely to affect spring-run Chinook Salmon holding than under the No  
33 Action Alternative because of the reduced frequency of exceedance of the 60°F  
34 threshold at Lewiston Dam in July.

35 The majority of spring-run Chinook Salmon in the Trinity River are produced in  
36 the South Fork Trinity watershed. Although the water temperature and flow  
37 changes could have slight beneficial effects on spring-run Chinook Salmon in the  
38 Trinity River, these effects would not occur in every year and are not anticipated  
39 to be substantial based on the relatively small differences in flows and water  
40 temperatures under Alternative 3 as compared to the No Action Alternative.

41 Overall, Alternative 3 is likely to have similar effects on the spring-run Chinook  
42 Salmon population in the Trinity River as compared to the No Action Alternative.  
43 However, the implementation of the Hatchery Management Plan (RPA  
44 Action II.6.3) under the No Action Alternative could reduce the impacts of

1 hatchery Chinook Salmon on natural spring-run Chinook Salmon in the Trinity  
2 River, and increase the genetic diversity and diversity of run-timing for these  
3 stocks relative to Alternative 3.

4 *Fall-Run Chinook Salmon*

5 The analysis of effects associated with changes in operation on fall-run Chinook  
6 Salmon was conducted using temperature model outputs for Lewiston Dam to  
7 anticipate the likely effects on conditions in the Trinity River downstream of  
8 Lewiston Dam. The Reclamation Salmon Survival Model also was applied to  
9 assess changes in egg mortality.

10 As described above for Coho Salmon, the temperature differences between  
11 Alternative 3 and No Action Alternative would be relatively minor (less than  
12 0.5°F) and likely would have little effect on fall-run Chinook Salmon in the  
13 Trinity River. The higher water temperatures (as much as 3.3°F) in November of  
14 critical years (and lower temperatures in December) under Alternative 3 would  
15 likely have little effect on fall-run Chinook Salmon as water temperatures in the  
16 Trinity River are typically low during this time period.

17 The temperature threshold and months during which it applies for fall-run  
18 Chinook Salmon are the same as those for Coho Salmon. Under Alternative 3,  
19 the 56°F threshold for fall-run Chinook Salmon spawning would be exceeded  
20 about 6 percent of the time in October, about 2 percent less frequently than under  
21 the No Action Alternative. In November and December, average water  
22 temperatures under Alternative 3 would not exceed the threshold, whereas  
23 average monthly water temperatures the No Action Alternative would exceed the  
24 threshold about 2 percent of the time in November, with no exceedances in  
25 December. Overall, the differences in the frequency of threshold exceedance  
26 between Alternative 3 and the No Action Alternative would be relatively minor.  
27 Temperature conditions under the Alternative 3 could be slightly less likely to  
28 affect fall-run Chinook Salmon spawning than under the No Action  
29 Alternative because of the slightly reduced frequency of exceedance of the 56°F  
30 threshold at Lewiston Dam in October. However, this would occur prior to the  
31 peak spawning period (November-December) for fall-run Chinook Salmon.

32 The temperatures described above for the Trinity River downstream of Lewiston  
33 Dam are reflected in the analysis of egg mortality using the Reclamation model  
34 (Appendix 9C). For fall-run Chinook Salmon in the Trinity River, the long-term  
35 average egg mortality rate is predicted to be relatively low (around 4 percent),  
36 with higher mortality rates (over 10 percent) occurring in critical dry years under  
37 Alternative 3 (Appendix 9C, Table B-5). Overall, egg mortality under  
38 Alternative 3 and the No Action Alternative would be similar in all water year  
39 types.

40 Although the water temperature and flow changes suggest a lower potential for  
41 adverse effects on fall-run Chinook Salmon in the Trinity River, these effects  
42 would not occur in every year and are not anticipated to be substantial based on  
43 the relatively small differences in flows and water temperatures (and similar egg  
44 mortality) under Alternative 3 as compared to the No Action Alternative.

1 Overall, Alternative 3 is likely to have similar effects on fall-run Chinook Salmon  
2 in the Trinity River as compared to the No Action Alternative. However, the  
3 implementation of the Hatchery Management Plan (RPA Action II.6.3) under the  
4 No Action Alternative could reduce the impacts of hatchery Chinook Salmon on  
5 natural fall-run Chinook Salmon in the Trinity River, and increase the genetic  
6 diversity and diversity of run-timing for these stocks relative to Alternative 3.

7 *Steelhead*

8 The analysis of effects associated with changes in operation on steelhead was  
9 conducted using temperature model outputs for Lewiston Dam to anticipate the  
10 likely effects on conditions in the Trinity River downstream of Lewiston Dam.

11 As described above for Coho Salmon, the temperature differences between  
12 Alternative 3 and No Action Alternative would be relatively minor (less than  
13 0.5°F) and likely would have little effect on steelhead in the Trinity River. In  
14 critical dry years, increased water temperatures in November under Alternative 3  
15 could increase the likelihood of adverse effects on migrating adult steelhead,  
16 although water temperatures are relatively low at this time of year.

17 The temperature threshold and months during which it applies for steelhead are  
18 the same as those for Coho Salmon. Overall, the differences in the frequency of  
19 threshold exceedance between Alternative 3 and the No Action Alternative would  
20 be relatively minor and are unlikely to affect steelhead spawning in the Trinity  
21 River. While average monthly temperatures would be similar overall, the slight  
22 reduction in the frequency of threshold exceedance provided by Alternative 3  
23 during warm periods in October and November suggest that temperature  
24 conditions under Alternative 3 could be slightly less likely to affect steelhead than  
25 under the No Action Alternative.

26 Although water temperatures under Alternative 3 suggest a slightly lower  
27 potential for adverse effects on steelhead in the Trinity River, the relatively small  
28 differences in flows and water temperatures under Alternative 3 as compared to  
29 the No Action Alternative would likely have similar effects on steelhead in the  
30 Trinity River as compared to the No Action Alternative.

31 *Green Sturgeon*

32 Changes in operations that influence temperature and flow conditions in the  
33 Trinity River downstream of Lewiston Dam could influence Green Sturgeon. The  
34 following describes those changes and their potential effects.

35 As described in the Affected Environment, Green Sturgeon spawn in the lower  
36 reaches of the Trinity River during April through June, and water temperatures  
37 above about 63°F are believed stressful to embryos (Van Eenennaam et al. 2005).  
38 Average monthly water temperature conditions during April through June in the  
39 Trinity River at Lewiston Dam under Alternative 3 are similar and do not exceed  
40 58°F during this period. Water temperatures in the downstream reaches where  
41 Green Sturgeon spawn would be higher, although temperature conditions likely  
42 would be controlled by other factors (e.g., ambient air temperatures and tributary  
43 inflows) rather than water operations at Trinity and Lewiston dams. Therefore,

1 given the similarities between average monthly water temperatures at Lewiston  
2 Dam under Alternative 3 and the No Action Alternative, it is likely that  
3 temperature conditions for Green Sturgeon in the Trinity River and lower  
4 Klamath River and estuary would be similar under both scenarios.

#### 5 *Reservoir Fishes*

6 The analysis of effects associated with changes in operation on reservoir fishes  
7 relied on evaluation of changes in available habitat (reservoir storage) and  
8 anticipated changes in black bass nesting success.

9 Changes in CVP water supplies and operations under Alternative 3 as compared  
10 to the No Action Alternative would result in higher reservoir storage in Trinity  
11 Lake. Storage in Trinity Lake could be increased up to around 10 percent in some  
12 months of some water year types. Additional information related to monthly  
13 reservoir elevations is provided in Appendix 5A, CalSim II and DSM2 Modeling.

14 Aquatic habitat in Trinity Lake may not be limiting; however, storage volume is  
15 an indicator of how much habitat is available to fish species inhabiting these  
16 reservoirs. Therefore, the amount of habitat for reservoir fishes could be  
17 increased somewhat under Alternative 3 as compared to the No Action  
18 Alternative.

19 Results of the bass nesting success analysis are presented in Appendix 9F,  
20 Reservoir Fish Analysis Documentation. Bass nest survival in Trinity Lake is  
21 predicted to be near 100 percent in March and April due to increasing reservoir  
22 elevations. For May, the likelihood of survival for Largemouth and Smallmouth  
23 Bass in Trinity Lake being in the 40 to 100 percent range would be similar under  
24 Alternative 3 and the No Action Alternative. For June, the likelihood of survival  
25 being greater than 40 percent for Largemouth and Smallmouth Bass would be  
26 somewhat lower than in May and would be similar under Alternative 3 and the No  
27 Action Alternative. For Spotted Bass, the likelihood of survival being greater  
28 than 40 percent would be 100 percent in May under both Alternative 3 and the No  
29 Action Alternative. For June, Spotted Bass survival in Trinity Lake would be less  
30 than for May due to greater daily reductions in water surface elevation. The  
31 likelihood of survival being greater than 40 percent would be similar (near  
32 100 percent) under Alternative 3 and the No Action Alternative.

33 Overall, the comparison of storage and the analysis of nesting suggest that effects  
34 of Alternative 3 on reservoir fishes would be similar to those under the No Action  
35 Alternative.

#### 36 *Pacific Lamprey*

37 Little information is available on factors that influence populations of Pacific  
38 Lamprey in the Trinity River, but they are likely affected by many of the same  
39 factors as salmon and steelhead because of the parallels in their life cycles. On  
40 average, the temperature of water released at Lewiston Dam under Alternative 3  
41 would be similar to (within 0.5°F) (Appendix 6B). The highest increases in flow  
42 would be less than 10 percent in the Trinity River, with a smaller relative increase  
43 in the lower Klamath River and Klamath River estuary (Appendix 5A).

1 Overall, it is likely that effects on Pacific Lamprey would be similar under both  
2 Alternative 3 and the No Action Alternative. This conclusion likely also applies  
3 to other species of lamprey that inhabit the Trinity and lower Klamath rivers  
4 (e.g., River Lamprey).

5 *Eulachon*

6 It is uncertain whether Eulachon has been extirpated from the Klamath River.  
7 Given that the highest increases in flow would be less than 10 percent in the  
8 Trinity River (Appendix 5A), with a smaller relative increase in the lower  
9 Klamath River and Klamath River estuary, and that water temperatures in the  
10 Klamath River (Appendix 6B) would be unlikely to be affected by changes  
11 upstream at Lewiston Dam, it is likely that Alternative 3 would have a similar  
12 potential to influence Eulachon in the Klamath River as the No Action  
13 Alternative.

14 *Sacramento River System*

15 *Winter-run Chinook Salmon*

16 Changes in operations that influence temperature and flow conditions in the  
17 Sacramento River downstream of Keswick Dam could affect winter-run Chinook  
18 Salmon. The following describes those changes and their potential effects.

19 *Changes in Water Temperature*

20 Average monthly water temperature in the Sacramento River at Keswick Dam  
21 under Alternative 3 generally would be similar to (less than 0.5°F difference)  
22 water temperatures under the No Action Alternative during most months of the  
23 year (Appendix 6B, Table B-5-2). In September, average water temperatures in  
24 wetter years could be increased by up to 0.8°F and decreased by up to 1.2°F in  
25 critical years. A similar temperature pattern generally would be exhibited  
26 downstream at Ball's Ferry, Jelly's Ferry, and Bend Bridge, with average monthly  
27 temperatures progressively increasing in the downstream direction (e.g., average  
28 difference of about 2°F between Keswick Dam and Bend Bridge) (Appendix 6B,  
29 Table B-8-2). The water temperature differences between Alternative 3 and the  
30 No Action Alternative in September of wetter years would increase to as high as  
31 2.6°F warmer under Alternative 3, while the differences in drier years could reach  
32 1.0°F cooler in September of drier years.

33 Overall, the temperature differences between Alternative 3 and the No Action  
34 Alternative would be relatively minor (less than 0.5°F) and likely would have  
35 little effect on winter-run Chinook Salmon in the Sacramento River. The  
36 increased water temperatures in September of wetter years under Alternative 3  
37 could increase the likelihood of adverse effects on winter-run Chinook Salmon  
38 egg incubation and fry rearing during this water year type. The slightly lower  
39 water temperatures in September of drier years under Alternative 3 could reduce  
40 the likelihood of adverse effects on winter-run Chinook Salmon fry rearing in or  
41 outmigrating from the Sacramento River. There would be little difference in  
42 potential effects on spawning of winter-run Chinook Salmon due to the similar

1 water temperatures during the April to June time period under Alternative 3 as  
2 compared to the No Action Alternative.

3 *Changes in Exceedances of Water Temperature Thresholds*

4 With the exception of April, average monthly water temperatures under both  
5 Alternative 3 and the No Action Alternative would show exceedances of the water  
6 temperature threshold of 56°F established in the Sacramento River at Ball's Ferry  
7 for winter-run Chinook Salmon spawning and egg incubation in every month,  
8 with exceedances under both as high as about 49 percent and 42 percent,  
9 respectively, in some months. Under Alternative 3, the temperature threshold  
10 generally would be exceeded less frequently than it would under the No Action  
11 Alternative (by about 2 percent to 4 percent) in June through August, with the  
12 temperature threshold in September exceeded about 6 percent more frequently  
13 under Alternative 3 than the No Action Alternative. Farther downstream at Bend  
14 Bridge, the frequency of exceedances would increase, with exceedances under  
15 both Alternative 3 and the No Action Alternative as high as nearly 90 percent in  
16 some months. Under Alternative 3, temperature exceedances generally would be  
17 less frequent (by up to 8 percent) than under the No Action Alternative, with the  
18 exception of September, when exceedances under Alternative 3 would be about  
19 26 percent more frequent.

20 Overall, there would be substantial differences in the frequency of threshold  
21 exceedance between Alternative 3 and the No Action Alternative, particularly in  
22 September. While temperature conditions under Alternative 3 could be less likely  
23 to affect winter-run Chinook Salmon egg incubation than under the No Action  
24 Alternative because of the reduced frequency of exceedance of the 56°F threshold  
25 from April through August, the substantial increase in the frequency of  
26 exceedance in September under Alternative 3 may increase the likelihood of  
27 adverse effects on winter-run Chinook Salmon egg incubation during this limited  
28 portion of the spawning and egg incubation period.

29 *Changes in Egg Mortality*

30 The temperatures described above for the Sacramento River downstream of  
31 Keswick Dam are reflected in the analysis of egg mortality using Reclamation's  
32 salmon mortality model (Appendix 9C). For winter-run Chinook Salmon in the  
33 Sacramento River, the long-term average egg mortality rate is predicted to be  
34 relatively low (around 5 percent), with higher mortality rates (exceeding  
35 25 percent) occurring in critical dry years under Alternative 3. In critical dry  
36 years the average egg mortality rate would be 6 percent less than under the No  
37 Action Alternative (Appendix 9C, Table B-4). Overall, winter-run Chinook  
38 Salmon egg mortality in the Sacramento River under Alternative 3 and the No  
39 Action Alternative would be similar, except in critical dry water years.

40 *Changes in Weighted Usable Area*

41 As an indicator of the amount of suitable spawning habitat for winter-run Chinook  
42 Salmon between Keswick Dam and Battle Creek, modeling results indicate that,  
43 in general, there would be similar amounts of spawning habitat available from  
44 April through August under Alternative 3 as compared to the No Action



1 Alternative (Appendix 9E, Weighted Usable Area Analysis). Modeling results  
2 also indicate that, in general, there would be similar amounts of suitable fry  
3 rearing habitat available from June through October under Alternative 3. Similar  
4 to the results for fry rearing WUA, modeling results indicate that there would be  
5 similar amounts of suitable juvenile rearing habitat available during the juvenile  
6 rearing period from July to May under Alternative 3 and the No Action  
7 Alternative.

8 *Changes in SALMOD Output*

9 SALMOD results indicate that potential juvenile production would be similar  
10 under Alternative 3 as compared to the No Action Alternative (Appendix 9D,  
11 Table B-4-6).

12 *Changes in Delta Passage Model Output*

13 The Delta Passage Model predicted similar estimates of annual Delta survival  
14 across the 81-year time period for winter-run Chinook Salmon between  
15 Alternative 3 and the No Action Alternative (Appendix 9J). Median Delta  
16 survival would be 0.354 for Alternative 3 and 0.349 for the No Action  
17 Alternative.

18 *Changes in Delta Hydrodynamics*

19 Winter-run Chinook Salmon smolts are most abundant in the Delta during  
20 January, February, and March. On the Sacramento River near the confluence of  
21 Georgiana Slough, the median proportion of positive velocities under  
22 Alternative 3 was indistinguishable from the No Action  
23 Alternative (Appendix 9K). On the San Joaquin River near the Mokelumne River  
24 confluence, the median proportion of positive velocities would be  
25 indistinguishable between these two alternatives. In Old River downstream of the  
26 facilities, the median proportion of positive velocities would be similar under  
27 Alternative 3 and the No Action Alternative in January, February, and March. In  
28 Old River upstream of the facilities, the median proportion of positive velocities  
29 also would be similar under Alternative 3 and the No Action Alternative in these  
30 months. On the San Joaquin River downstream of Head of Old River, the percent  
31 of positive velocities would be similar under both alternatives in January,  
32 February and March.

33 *Changes in Junction Entrainment*

34 For all junctions examined, entrainment probabilities for both scenarios would be  
35 similar under Alternative 3 and the No Action Alternative from January through  
36 March (Appendix 9L).

37 *Changes in Salvage*

38 Salvage of Sacramento River-origin Chinook Salmon is predicted to be similar  
39 under Alternative 3 relative to No Action Alternative during the three months  
40 when winter-run Chinook Salmon are most abundant in the Delta (January,  
41 February, March; (Appendix 9M).

1            *Changes in Oncorhynchus Bayesian Analysis Output*

2    Escapement of winter-run Chinook Salmon and Delta survival was modeled by  
 3    the Oncorhynchus Bayesian Analysis (OBAN) model for winter-run Chinook  
 4    salmon. Escapement was generally lower under Alternative 3 as compared to the  
 5    No Action Alternative (Appendix 9I). The median abundance under Alternative 3  
 6    was higher in only 5 of the 22 years of simulation (1971 to 2002), and there was  
 7    typically greater than a 25 percent chance that Alternative 3 values would be  
 8    lower than under the No Action Alternative. Median delta survival was  
 9    consistently lower (by approximately 7 percent) under Alternative 3 as compared  
 10   to the No Action Alternative. However, the probability intervals indicated that no  
 11   difference between scenarios was a likely outcome. Thus delta survival was not  
 12   responsible for the temporal patterns in relative escapement. Since the ocean  
 13   conditions were equivalent across scenarios, the differences under Alternative 3  
 14   were likely due to differences in survival in the life stages upstream of the delta  
 15   (i.e., due to differences in temperature and flow at Bend Bridge).

16           *Changes in Interactive Object-Oriented Simulation Output*

17    The IOS model predicted similar adult escapement trajectories for winter-run  
 18    Chinook Salmon between Alternative 3 and the No Action Alternative across the  
 19    81 years (Appendix 9H). Under Alternative 3 median adult escapement was  
 20    4,025 and under the No Action Alternative, median escapement was 3,935.

21    Similar to adult escapement, the IOS model predicted similar egg survival time  
 22    trajectories for winter-run Chinook Salmon between Alternative 3 and No Action  
 23    Alternative across the 81 water years. Under Alternative 3 median egg survival  
 24    was 0.987 and under the No Action Alternative median egg survival was 0.990.

25           *Changes in Predator Management*

26    The fish predator assemblage of the Delta is dominated by invasive predators,  
 27    with the exception of the Sacramento Pikeminnow (Brown and Michniuk 2007;  
 28    Nobriga and Feyrer 2007, National Research Council 2010; Cavallo et al. 2012,  
 29    NRC 2012, Brown 2013). With the exception of Striped Bass, there is little  
 30    population-level information for fish predators including Largemouth Bass and  
 31    Sacramento Pikeminnow and there is even less information for Smallmouth Bass  
 32    and White and Channel Catfish (Grossman et al. 2013). It is important to note  
 33    that, in addition to predation by native and non-native fishes, there has been  
 34    extensive modification of the hydrology, loss of tidal freshwater wetlands,  
 35    increases in non-native submerged aquatic vegetation such as *Egeria densa*, and  
 36    other effects of human population growth within the Delta, which also  
 37    undoubtedly influence the survival of salmonids in the Delta (Brown and  
 38    Michniuk 2007; National Research Council 2010, 2012).

39    Bowen et al. (2009 and 2010) describe salmonid behavior in the vicinity of the  
 40    Head of Old River Barrier and predation from the release point upstream at  
 41    Durham Ferry. Predation in this short reach seemed to be increased during the  
 42    lower flows in 2009 and during later release in 2010. While this two year study  
 43    observed a variable and negative relationship between flow and survival past a  
 44    Head of Old River Barrier, there remains uncertainty in this due to the actual

1 barrier structures implemented and how they affected predator habitat in this  
2 reach.

3 Although it is well documented that Striped Bass can feed heavily on juvenile  
4 salmon and steelhead in the rivers, as they migrate seaward, many of the salmon  
5 eaten are likely to be hatchery-reared fish; juveniles from natural spawning may  
6 be more wary and encounter lower predation rates. It is thought that predation on  
7 hatchery-reared juveniles may buffer wild fish from such predation (Moyle and  
8 Bennett 2010). Much of the predation on juvenile salmon seems to take in place  
9 in conjunction with artificial structures and release practices. These include  
10 releases of fish from hatcheries and those trucked to the estuary from the export  
11 facilities in the south Delta (DWR 2010).

12 In general, Striped Bass are opportunistic predators that tend to forage on  
13 whatever prey are most abundant, from benthic invertebrates to their own young  
14 to juvenile salmon and American Shad (Stevens 1966, Moyle 2002, Nobriga and  
15 Feyrer 2008). Striped Bass are unlikely to be a major predator of Delta Smelt  
16 because Delta Smelt are semi-transparent (making them hard to see in turbid  
17 water) and do not school, unlike more favored prey such as Threadfin Shad,  
18 juvenile Striped Bass, and Mississippi Silverside. Delta Smelt were a minor item  
19 in Striped Bass diets when they were highly abundant in the early 1960s  
20 (Stevens 1966), as well as in recent years at record low abundance (Nobriga and  
21 Feyrer 2008).

22 Predator control measures are included in Alternative 3, including an increased  
23 bag limit (10/day) with a minimum size limit of 12 inches on Striped Bass and  
24 black bass. In addition, a sport reward program for Sacramento Pikeminnow  
25 (\$2/fish > 8 inches) would be implemented to encourage fishing for and removal  
26 of this native predatory fish.

27 A number of studies have been conducted on predation effects in the Delta, and a  
28 recent (2013) workshop was held to assess the status of information and  
29 potentially establish conclusions regarding the importance of fish predation on  
30 salmonid populations in the Delta (Grossman et al. 2013). The workshop  
31 concluded that:

32 “Available data and analyses have generated valuable information  
33 regarding aspects of the predation process in the Delta but do not provide  
34 unambiguous and comprehensive estimates of fish predation rates on  
35 juvenile salmon or steelhead nor on population-level effects for these  
36 species in the Delta.”

37 And:

38 “Juvenile salmon are clearly consumed by fish predators and several  
39 studies indicate that the population of predators is large enough to  
40 effectively consume all juvenile salmon production. However, given  
41 extensive flow modification, altered habitat conditions, native and non-  
42 native fish and avian predators, temperature and dissolved oxygen  
43 limitations, and overall reduction in historical salmon population size, it is

1 not clear what proportion of juvenile mortality can be directly attributed to  
2 fish predation. Fish predation may serve as the proximate mechanism of  
3 mortality in a large proportion of the population but the ultimate causes of  
4 mortality and declines in productivity are less clear.”

5 The proposed bag and size limits are intended and expected to encourage more  
6 fishing effort for and greater harvest of Striped Bass and black bass species,  
7 resulting in a reduction in the Striped Bass and black bass populations throughout  
8 the Delta. It is reasonable to assume that removing or relaxing restrictions on the  
9 harvest of these predatory species would lead to a substantial reduction in their  
10 number. However, whether or not this reduction would lead to a substantial  
11 benefit or population-level effect on salmonid populations is unknown  
12 (Moyle and Bennett 2010). For the proposed (under Alternative 3) predator  
13 reduction program to be effective, it must be true that predation by Striped Bass  
14 and black bass regulates populations of salmon, steelhead, and smelt, with  
15 predation by other species (other fish, birds, marine mammals, etc.) playing a  
16 minor role. The program may not be effective, or the effectiveness would be  
17 reduced if other predators exhibit compensatory increases in predation if Striped  
18 Bass and black bass are removed.

19 As noted above, the modification of the hydrology, loss of tidal freshwater  
20 wetlands, increases in non-native submerged aquatic vegetation, and other effects  
21 of human population growth within the Delta play a role in the survival of  
22 salmonids in the Delta and contribute to the uncertainty that any predator  
23 reduction program will have the desired results. It is unknown whether reducing  
24 Striped bass and black bass populations can measurably compensate for the large  
25 changes to the estuary and watershed, which also contribute to reduced  
26 populations of salmon, steelhead and smelt.

27 In addition to the proposed bag and size limits, Alternative 3 includes a proposal  
28 to implement a sport reward program for Sacramento Pikeminnow to encourage  
29 fishing for and removal of predatory Sacramento Pikeminnow. It is unknown  
30 whether a Sacramento Pikeminnow bounty would be feasible under California  
31 regulations. Currently, the Sacramento Pikeminnow is regulated under CCR  
32 Title 14, section 5.95 (no limit or season), sections 2.25 and 2.30 (bow and arrow  
33 and spear fishing) and section 1.87 (no wastage of fish). Therefore, any fishing  
34 practice, derby or bounty program in which the Sacramento Pikeminnow is  
35 wasted would be in violation of the regulations. In addition, Sacramento  
36 Pikeminnow is listed as a "game fish" in commission regulations (CCR Title 14,  
37 section 230) and a permit is required before any prizes can be offered to  
38 take them.

39 Regardless of whether a Sacramento Pikeminnow reward system is feasible to  
40 implement, the effectiveness of such a program is not assured. This same  
41 approach to predator reduction is ongoing in the Columbia River through the  
42 Northern Pikeminnow (*Ptychocheilus oregonensis*) Sport-Reward Program  
43 sponsored by Bonneville Power Administration that began in 1991. The program  
44 seeks to maintain 10 to 20 percent exploitation rate on Northern Pikeminnow  
45 throughout the Columbia River by paying anglers \$4 to \$8 to harvest fish >

1 228 mm (>9 inches) in total length. In 2012, a total of 158,159 fish were  
2 harvested in the sport-reward fishery. Vouchers for 156,837 untagged fish were  
3 submitted for payment totaling rewards of \$1,016,672. System-wide pikeminnow  
4 exploitation efforts suggest that the desired 10 to 20 percent exploitation rate has  
5 been achieved for a number of years (Porter 2012). The program has removed  
6 over 2.2 million fish from 1998-2009 and is believed to have reduced predation  
7 on juvenile salmonids; however, predation estimates have varied widely and  
8 positive effects on salmonid populations have been difficult to detect (Carey et al.  
9 2012).

10 Control of undesired and invasive fishes is a common fishery management  
11 strategy (Kolar et al. 2010). However, changes in predator abundance produced  
12 via removal, augmentation, or invasion can produce unintended consequences  
13 (Polis and Strong 1996). It is possible that other species on which Striped Bass  
14 prey, such as Mississippi Silverside, would increase in abundance, causing harm  
15 by competing with and preying on desired species, particularly Delta Smelt.  
16 Mississippi Silversides are important in the diets of 1 to 3 year old Striped Bass;  
17 predation by Striped Bass could be regulating the silverside population. Reducing  
18 Striped Bass predation pressure on Mississippi Silversides may increase their  
19 numbers, which could have negative effects on Delta Smelt through predation on  
20 eggs and larvae (Bennett and Moyle 2006).

21 The predator reduction program under Alternative 3 is intended to improve the  
22 survival of listed species (e.g., salmonids and Delta Smelt) by reducing predation  
23 on these species. As described above, the program may be difficult to implement,  
24 may not be effective, and may cause unintended harm to other native Delta fish  
25 species. Consequently, the outcome of the predator management program is  
26 highly uncertain. Compared to the No Action Alternative, which does not include  
27 a predator reduction program, Alternative 3 may or may not provide a benefit to  
28 salmonids and may result in an adverse effect on Delta smelt.

### 29 *Changes in Ocean Salmon Harvest*

30 Alternative 3 includes an action to change ocean salmon harvest for the purpose  
31 of increasing escapement of adult winter-run Chinook Salmon as well as other  
32 runs. The following outlines the benefits and challenges associated with such a  
33 program.

34 Central Valley origin Chinook Salmon of all races are harvested in commercial  
35 and recreational fisheries off the coast of California. Central Valley origin fall-  
36 run Chinook Salmon are the primary target of this harvest. Harvested Chinook  
37 Salmon between Point Conception and Bodega Bay were found to be composed  
38 of 89-95 percent Central Valley fall-run Chinook Salmon (Winans et al. 2001).  
39 More recent studies have shown most Central Valley fall-run Chinook Salmon are  
40 produced by hatcheries, and are not of natural origin. Barnett-Johnson et al.  
41 (2007) analyzed otolith microstructure from harvested Chinook Salmon and  
42 estimated 90 percent were of hatchery origin. Palmer-Zwhalen and Kormos  
43 (2012; Table 9) reported data indicating spawning-escapement for Central Valley  
44 fall-run Chinook Salmon was composed of 75 percent hatchery origin fish.

1 Despite the relatively high abundance of hatchery-produced fall-run Chinook  
2 Salmon, ocean fisheries are often constrained to protect ESA-listed Chinook  
3 Salmon stocks (including Sacramento winter-run and spring-run Chinook Salmon,  
4 and Coastal Chinook Salmon), which constitute less than 10 percent of available  
5 Chinook Salmon (Winans et al. 2001). This “mixed-stock” fishery is managed by  
6 using stock-specific differences in ocean distribution, age at maturity, size-at-date,  
7 and/or timing of river entry to help minimize harvest of sensitive stocks.  
8 However, such management strategies are only partially effective.

9 For example, spring-run Chinook Salmon return to freshwater in the spring and  
10 thus avoid most ocean harvest during the year in which they mature. However,  
11 spring-run Chinook Salmon that mature at age 4 (or older) are subjected to a full  
12 season of harvest at “impact levels” comparable to those directed at Central  
13 Valley fall-run Chinook Salmon. Harvest managers define “impact rate” as the  
14 proportion of a particular stock that will suffer mortality associated with the ocean  
15 fishery. Fall-run Chinook Salmon often experience impact rates between 40 and  
16 70 percent.

17 Thus, the impact of ocean harvest varies substantially by stock, but all stocks are  
18 impacted by harvest directed at the most abundant Chinook Salmon population  
19 (typically hatchery origin fall-run Chinook Salmon). Several analyses are  
20 available that provide a basis for assessing how harvest management identified in  
21 Alternative 3 would affect Central Valley Chinook Salmon populations. Though  
22 there are political and societal considerations for changes in ocean harvest  
23 management, there are no technical or scientific constraints. We have the tools,  
24 the knowledge and the ability to manage Chinook ocean harvest in whatever way  
25 is needed. As such, Alternative 3 is, from a technical and scientific level,  
26 entirely feasible.

27 Alternative 3 calls for ocean harvest to be managed with the standard of causing  
28 no appreciable reduction in viability criteria for natural origin Chinook Salmon.  
29 This alternative is addressed separately for Central Valley spring-run, winter-run,  
30 and fall-run Chinook Salmon.

### 31 *Spring-Run Chinook Salmon.*

32 Fifteen years have elapsed since NMFS last updated its spring-run Chinook  
33 Salmon ocean harvest Biological Opinion (NMFS 2000). The 2000 BO did not  
34 report an estimated “impact rate” for the ocean harvest impact on spring-run  
35 Chinook Salmon. The BO reached a non-jeopardy opinion for the impacts of  
36 ocean harvest primarily by referring to the growth in Central Valley spring-run  
37 Chinook Salmon population which was occurring at that time. Though NMFS  
38 (2010) did not provide a quantitative analysis of spring-run Chinook Salmon  
39 harvest, Grover et al. (2004) estimated that two thirds of spring-run Chinook  
40 Salmon matured at age 4, indicating that a large fraction of the spring-run  
41 Chinook Salmon population is annually subject to high impact rates (40 to  
42 70 percent), which would greatly influence population productivity and  
43 abundance. Harvest of age-3 spring-run Chinook Salmon is likely to be  
44 comparable to that experienced by winter-run Chinook Salmon (which also  
45 mature and return to fresh water, missing most of the ocean fishing season).

1 Though a comparable analysis for spring-run Chinook Salmon is not available,  
2 Winship et al. (2013) applied a simulation model that showed a 25 percent impact  
3 rate (much less than that likely experienced by age 4 spring-run Chinook Salmon)  
4 on winter-run Chinook Salmon substantially decreased population abundance and  
5 population resiliency relative to alternatives with less harvest.

6 Harvest pressure of this intensity can also alter diversity in age at-maturity, a  
7 critical factor for population viability (NMFS 2010). The ocean fishery is thought  
8 to select against fish that mature later because fish that would do so are vulnerable  
9 to harvest for more years (Ricker 1981; Hankin and Healey 1986; Sierra and  
10 Lackey 2015), and age at maturity has moderate heritability (Hankin et al. 1993).  
11 As such, reduced ocean harvest would contribute substantially to age at-maturity  
12 diversity (certainly demographically, if not genetically) and thereby enhance  
13 population viability. A downward shift in size and age at maturity also affect  
14 fitness by reducing fecundity and reproductive rates (Calduch-Verdiell et al.  
15 2014). Larger females generally have larger and more numerous eggs  
16 (Wertheimer et al. 2004), both of which provide reproductive advantages. Larger  
17 eggs produce larger juveniles, which tend to have higher survival rates  
18 (Quinn 2005) and are more resistance to temperature extremes. Since size and  
19 age-at-maturity are heritable, selection for earlier adult maturity leads to a  
20 feedback loop in which younger and smaller adults produce offspring that mature  
21 earlier at smaller sizes. Change in body size may also influence spawning habitat  
22 use where larger fish occupy areas with coarser substrate that smaller fish may not  
23 be able to use. Thus, advantages of diversity in age at-maturity could be  
24 especially important in degraded and thermally stressful habitats typical of  
25 Central Valley tributaries.

26 *Winter-Run Chinook Salmon*

27 NMFS updated their winter-run Chinook Salmon ocean harvest BO in 2010  
28 (NMFS 2010) and concluded:

29 *The effect of harvest and indirect mortality associated with the salmon*  
30 *ocean fishery reduces the reproductive capability of this population, and*  
31 *subsequently the entire ESU, by 10-25 percent per brood, when ocean*  
32 *fisheries occur at a level similar to what has been observed for most of the*  
33 *last decade south of Point Arena, California.*

34 *There is concern about the relatively high impact rate for age-4 fish and*  
35 *the consequences of this relative to the genetic diversity of winter-run. If*  
36 *age at maturity is strongly related to a genetic component, the removal of*  
37 *older fish at a high rate before they can return to spawn, however few of*  
38 *these individuals in the population there might be, could theoretically*  
39 *reduce the potential for that trait to pass on to successive generation. The*  
40 *change in an average life history trait over time, such as age at maturity,*  
41 *has been suggested as evidence for fisheries induced evolution in some*  
42 *situations (Law 2000; Kuparinen and Merilä 2007; Hard et al. 2008).*

1 NMFS has since implemented changes in ocean harvest regulations intended to  
 2 reduce impacts, but the effectiveness of those programs is unclear. Winship et al.  
 3 (2013) applied a simulation model and showed that all current winter-run  
 4 Chinook Salmon harvest alternatives substantially decreased population  
 5 abundance and population extinction risk relative to closing recreational and  
 6 commercial fisheries south of Point Arena. While closing these fisheries may not  
 7 be a realistic management alternative, Winship et al. (2013) did not consider  
 8 intermediate harvest management strategies such as a mark-selective fishery  
 9 (Pyper et al. 2012) or quota based fishing seasons. Currently, about 90 percent of  
 10 winter-run Chinook Salmon mature at age-3. As identified in the winter-run  
 11 Chinook Salmon harvest BO (NMFS 2010), diversity in age at maturity is an  
 12 important viability criterion likely to be adversely impacted by current harvest  
 13 management; winter-run Chinook Salmon currently maturing at age-4 are  
 14 subjected to impact rates comparable to those targeting fall-run Chinook Salmon  
 15 (40 to 70 percent). Given information presented in the spring-run Chinook  
 16 Salmon section, it seems likely that in the absence of this harvest, winter-run  
 17 Chinook Salmon would have a larger fraction of their population maturing at  
 18 age-4 or possibly older. Age-4 and older winter-run Chinook Salmon would  
 19 enhance demographic population viability, but also benefit the population by  
 20 more effectively spawning in coarse substrates, and producing more, larger, and  
 21 more thermally tolerant eggs.

22 *Fall-Run Chinook Salmon.*

23 As indicated previously, fall-run Chinook Salmon produced by Central Valley  
 24 hatcheries are the most abundant stock harvested off the coast of California. The  
 25 current management of Central Valley fall-run Chinook Salmon makes no  
 26 distinction between natural and hatchery fish, and, as such, harvest of natural  
 27 origin fall-run Chinook Salmon appears to occur at a much higher rate than  
 28 population productivity can sustain. The recently convened California HSRG  
 29 concluded:

30 *“Fishery harvests that are sustained at high levels by targeting abundant*  
 31 *hatchery-origin fish may over-exploit naturally reproducing salmonids*  
 32 *and may also induce selection on maturation schedule and other traits...*  
 33 *fishery exploitation rates must be in alignment with the productivity of*  
 34 *naturally reproducing salmon stocks for the recommendations in this*  
 35 *report to be successful at conserving natural salmonid populations”*  
 36 *(p. 19)*

37 *“The California HSRG also believes that an aggregate escapement target*  
 38 *for [the Central Valley natural stocks] that includes returns to hatcheries*  
 39 *lacks biological support. The target could theoretically be met if all fish*  
 40 *returned to hatcheries and none returned to natural spawning areas, or if*  
 41 *all fish in natural spawning areas were of hatchery origin” (p. 21).*

42 Quantitative analyses of current ocean harvest impacts to natural origin fall-run  
 43 Chinook Salmon are not currently available. However, impact rates combined  
 44 with relatively low abundances of natural origin fall-run Chinook Salmon indicate  
 45 adverse impacts to population viability are likely severe. Changes in harvest



1 strategies which could more effectively target hatchery origin fall Chinook while  
2 better protecting natural origin fish would yield substantial benefits. Pyper et al.  
3 (2012) analyzed one alternative, a mark-selective fishery, and found that natural  
4 origin spawning escapement would increase from 24 to 48 percent.

5 Managing ocean salmon harvest as described in Alternative 3 would contribute to  
6 the abundance, productivity and diversity viability criteria for natural origin  
7 spring-run, winter-run, and fall-run Chinook Salmon.

8 *Summary of Effects on Winter-Run Chinook Salmon*

9 The multiple model and analysis outputs described above characterize the  
10 anticipated conditions for winter-run Chinook Salmon and their response to  
11 change under Alternative 3 as compared to the No Action Alternative. For the  
12 purpose of analyzing effects on winter-run Chinook Salmon and developing  
13 conclusions, greater reliance was placed on the outputs from the two life cycle  
14 models, IOS and OBAN because they each integrate the available information to  
15 produce single estimates of winter-run Chinook Salmon escapement. The output  
16 from IOS indicated that winter-run Chinook Salmon escapement would be similar  
17 under both scenarios, whereas the OBAN results indicated that escapement under  
18 Alternative 3 would be lower than under the No Action Alternative.

19 These model results suggest that effects on winter-run Chinook Salmon would be  
20 similar under both scenarios, with a small likelihood that winter-run Chinook  
21 Salmon escapement would be lower under Alternative 3 than under the No Action  
22 Alternative. This potential distinction between the two scenarios, however, may  
23 be increased due to the benefits of implementation of fish passage under the No  
24 Action Alternative. This potential beneficial effect and its magnitude would  
25 depend on the success of the fish passage program. In addition, RPA actions  
26 intended to increase the efficiency of the Tracy and Skinner Fish Collection  
27 Facilities could improve the overall salvage survival of winter-run Chinook  
28 Salmon.

29 The ocean harvest restriction component of Alternative 3 could increase winter-  
30 run Chinook Salmon numbers by reducing ocean harvest and the predator control  
31 measures under Alternative 3 could reduce predation on juvenile winter-run  
32 Chinook Salmon and thereby increase survival.

33 Overall, given the small differences, distinguishing a clear difference between  
34 alternatives is difficult. The non-operational components associated with  
35 Alternative 3 could benefit winter-run Chinook Salmon relative to the No Action  
36 Alternative over the short term if successful; however, these measures would not  
37 address the long-term temperature challenges in the river downstream of Shasta  
38 Dam that would be addressed under the No Action Alternative if fish passage is  
39 successful. Even though the success of fish passage is uncertain, it is concluded  
40 that the potential for adverse effects on winter-run Chinook Salmon under  
41 Alternative 3 would be greater than those under the No Action Alternative,  
42 principally because Alternative 3 does not include a strategy to address water  
43 temperatures critical to winter-run Chinook Salmon sustainability over the long  
44 term with climate change by 2030.

1           *Spring-run Chinook Salmon*

2 Changes in operations that influence temperature and flow conditions in the  
3 Sacramento River downstream of Keswick Dam could affect spring-run Chinook  
4 Salmon. The following describes those changes and their potential effects.

5           *Changes in Water Temperature*

6 Changes in water temperature that could affect spring-run Chinook Salmon could  
7 occur in the Sacramento River, Clear Creek, and Feather River. The following  
8 describes temperature conditions in those water bodies.

9           *Sacramento River*

10 Average monthly water temperature in the Sacramento River at Keswick Dam  
11 under Alternative 3 relative to the No Action Alternative generally would be  
12 similar to (less than 0.5°F differences) water temperatures under the No Action  
13 Alternative during most months of the year (Appendix 6B, Table B-5-2). In  
14 September, average water temperatures in wetter years would be increased by up  
15 to 0.8°F and decreased by up to 1.2°F in critical years. A similar temperature  
16 pattern generally would be exhibited downstream at Ball's Ferry, Jelly's Ferry,  
17 Bend Bridge, and Red Bluff, with average monthly temperatures progressively  
18 increasing in the downstream direction (e.g., average difference of about 3°F  
19 between Keswick Dam and Red Bluff). The water temperature differences  
20 between Alternative 3 and the No Action Alternative in September of wetter years  
21 would increase to as high as 3.0°F warmer under Alternative 3 at Red Bluff, while  
22 the differences in water temperatures in September associated with Alternative 3  
23 during drier years would remain similar to the differences at upstream locations.

24 Overall, the temperature differences between Alternative 3 and the No Action  
25 Alternative would be relatively minor (less than 0.5°F) and likely would have  
26 little effect on spring-run Chinook Salmon in the Sacramento River. The  
27 increased water temperatures in September of wetter years under Alternative 3  
28 could increase the likelihood of adverse effects on spring-run Chinook Salmon  
29 spawning and egg incubation during this water year type. The slightly lower  
30 water temperatures in September of drier years under Alternative 3 would reduce  
31 the likelihood of adverse effects on spring-run Chinook Salmon spawning and egg  
32 incubation in the Sacramento River as compared to the No Action Alternative.  
33 There would be little difference in potential effects on spring-run Chinook  
34 Salmon holding in other summer months due to the similar water temperatures  
35 during this time period under Alternative 3 and the No Action Alternative.

36           *Clear Creek*

37 Average monthly water temperatures in Clear Creek at Igo under Alternative 3  
38 would be similar to (less than 0.5°F differences) water temperatures under the No  
39 Action Alternative with the exception of May when average monthly  
40 temperatures under Alternative 3 would be somewhat higher (up to about 0.8°F)  
41 than the No Action Alternative (Appendix 6B, Table B-3-2). The lower water  
42 temperatures in May associated with the No Action Alternative reflect the effects  
43 of the additional water that would be discharged from Whiskeytown Dam to meet  
44 the spring attraction flow requirements to promote attraction of spring-run

1 Chinook Salmon into the creek. Overall, water temperature conditions for  
2 spring-run Chinook Salmon in Clear Creek would be similar under Alternative 3  
3 and the No Action Alternative.

4 *Feather River*

5 Average monthly water temperatures in the Feather River low flow channel under  
6 Alternative 3 generally would be similar (within 0.5°F) to water temperatures  
7 under the No Action Alternative, except in November and December (differences  
8 as much as 1.6°F lower in December in below normal water years) (Appendix 6B,  
9 Table B-20-2). In September average monthly water temperatures under  
10 Alternative 3 could be somewhat higher (up to about 1.5°F) in wetter years than  
11 under the No Action Alternative. Although temperatures in the river would  
12 become progressively higher in the downstream direction, the differences between  
13 Alternative 3 and the No Action Alternative would exhibit a similar pattern at the  
14 downstream locations (Robinson Riffle and Gridley Bridge), with temperatures  
15 under Alternative 3 and the No Action Alternative generally becoming more  
16 similar at the confluence with the Sacramento River, except in September when  
17 the water temperature under Alternative 3 could be up to 4.4 °F higher than under  
18 the No Action Alternative and in June when temperatures under Alternative 3  
19 could be up to 0.8°F cooler in drier years (Appendix 6B, Table B-23-2).

20 Overall, the temperature differences in the Feather River between Alternative 3  
21 and the No Action Alternative would be relatively minor (less than 0.5°F) and  
22 likely would have little effect on spring-run Chinook Salmon in the Feather River.  
23 The somewhat lower water temperatures in November and December under  
24 Alternative 3 would likely have little effect on spring-run Chinook Salmon as  
25 water temperatures in the Feather River are typically low during this time period.  
26 The somewhat higher water temperatures in September of wetter years may  
27 increase the likelihood of adverse effects on spring-run Chinook Salmon egg  
28 incubation and fry rearing in the Feather River. There would be little difference  
29 in potential for adverse effects on spring-run Chinook Salmon holding over the  
30 summer due to the similar water temperatures during this time period under  
31 Alternative 3 and the No Action Alternative.

32 *Changes in Exceedances of Water Temperature Thresholds*

33 Changes in water temperature could result in the exceedance of established water  
34 temperature thresholds for spring-run Chinook Salmon in the Sacramento River,  
35 Clear Creek, and Feather River. The following describes the extent of those  
36 exceedance for each of those water bodies.

37 *Sacramento River*

38 Average monthly water temperatures under both Alternative 3 and the No Action  
39 Alternative would show exceedances of the water temperature threshold of 56°F  
40 established in the Sacramento River at Red Bluff for spring-run Chinook Salmon  
41 (spawning and egg incubation) in October, November, and again in April. The  
42 exceedances would occur at the greatest frequency in October (78 percent of the  
43 time under Alternative 3). The water temperature threshold would be exceeded  
44 less frequently in November (8 percent of the time) and not exceeded at all during

1 December through March under Alternative 3. As water temperatures warm in  
2 the spring, the threshold would be exceeded in April by 14 percent under  
3 Alternative 3. In the months when the greatest frequency of exceedances occur  
4 (October, November, and April), model results generally indicate that the  
5 threshold would be exceeded less frequently (by up to 4 percent in October) under  
6 Alternative 3 than under the No Action Alternative. Temperature conditions in  
7 the Sacramento River under Alternative 3 could be less likely to affect spring-run  
8 Chinook Salmon egg incubation than under the No Action Alternative because of  
9 the decreased frequency of exceedance of the 56°F threshold in October,  
10 November, and April.

11 *Clear Creek*

12 Average monthly water temperatures under both Alternative 3 and the No Action  
13 Alternative would not exceed the water temperature threshold of 60°F established  
14 in Clear Creek at Igo for spring-run Chinook Salmon pre-spawning and rearing in  
15 June through August. However, water temperatures under Alternative 3 would  
16 exceed the water temperature threshold of 56°F established for spawning in  
17 September and October about 12 percent to 11 percent of the time, respectively.  
18 Water temperatures under Alternative 3 could exceed the threshold about  
19 4 percent less frequently than under the No Action Alternative in September and  
20 about 2 percent less frequently in October. Temperature conditions in Clear  
21 Creek under Alternative 3 could be less likely to affect spring-run Chinook  
22 Salmon spawning than under the No Action Alternative because of the decreased  
23 frequency of exceedance of the 56°F threshold in September and October.  
24 However, this difference may be partially offset if the thermal stress reduction  
25 measures associated with 2009 NMFS BO RPA Action I.1.5 under the No Action  
26 Alternative are successful in improving water temperatures in Clear Creek.

27 *Feather River*

28 Average monthly water temperatures under both Alternative 3 and the No Action  
29 Alternative would exceed the water temperature threshold of 56°F established in  
30 the Feather River at Robinson Riffle for spring-run Chinook Salmon egg  
31 incubation and rearing) during some months, particularly in October and  
32 November, and March and April, when temperature thresholds could be exceeded  
33 frequently (Appendix 9N). The frequency of exceedance would be highest  
34 (about 97 percent) in October, a month in which average monthly water could get  
35 as high as about 68°F under Alternative 3. However, water temperatures under  
36 Alternative 3 would exceed the temperature threshold about 1 percent less  
37 frequently than the No Action Alternative from October to December, and  
38 1 percent more frequently in March.

39 The established water temperature threshold of 63°F for rearing during May  
40 through August would be exceeded often under both Alternative 3 and the No  
41 Action Alternative in May and June, but not at all in July and August. Water  
42 temperatures under Alternative 3 would exceed the rearing temperature threshold  
43 about 5 percent less frequently than under the No Action Alternative in May, with  
44 the same likelihood of exceedance in June. Temperature conditions in the Feather  
45 River under Alternative 3 could be less likely to affect spring-run Chinook

1 Salmon spawning and rearing than under the No Action Alternative because of  
2 the decreased frequency of exceedance of the water temperature thresholds.

3 *Changes in Egg Mortality*

4 The temperature differences described above are reflected in the analysis of egg  
5 mortality using the Reclamation model (Appendix 9C). For spring-run Chinook  
6 Salmon in the Sacramento River, the long-term average egg mortality rate is  
7 predicted to be relatively high (exceeding 20 percent), with high mortality rates  
8 (around 80 percent) occurring in critical dry years under Action Alternative 3. In  
9 critical dry years the average egg mortality rate would be 6.6 percent less under  
10 Alternative 3 than under the No Action Alternative (Appendix 9C, Table B-3).  
11 Overall, spring-run Chinook Salmon egg mortality in the Sacramento River under  
12 Alternative 3 and the No Action Alternative would be similar, except in critical  
13 dry water years.

14 *Changes in Weighted Usable Area*

15 Weighted usable area curves are available for spring-run Chinook Salmon in  
16 Clear Creek. As described above, flows in Clear Creek downstream of  
17 Whiskeytown Dam are not anticipated to differ under Alternative 3 relative to the  
18 No Action Alternative except in May due to the release of spring attraction flows  
19 in accordance with the 2009 NMFS BO under the No Action Alternative.  
20 Therefore, there would be no change in the amount of potentially suitable  
21 spawning and rearing habitat for spring-run Chinook Salmon (as indexed by  
22 WUA) available under Alternative 3 as compared to the No Action Alternative.

23 *Changes in SALMOD Output*

24 SALMOD results indicate that potential juvenile production would be similar  
25 under Alternative 3 and the No Action Alternative (Appendix 9D, Table B-3-6).

26 *Changes in Delta Passage Model Output*

27 The Delta Passage Model predicted similar estimates of annual Delta survival  
28 across the 81-year time period for spring-run Chinook Salmon between  
29 Alternative 3 and the No Action Alternative (Appendix 9J). Median Delta survival  
30 was 0.286 for Alternative 3 and 0.296 for the No Action Alternative.

31 *Changes in Delta Hydrodynamics*

32 Spring-run Chinook Salmon are most abundant in the Delta from March through  
33 May. Near the junction of Georgiana Slough, the median proportion of time that  
34 velocity would be positive was similar in March, April, and May under both  
35 alternatives (Appendix 9K). Near the confluence of the San Joaquin River and  
36 the Mokelumne River, the median proportion of positive velocities would be  
37 similar in March and slightly to moderately, lower under Alternative 3 relative to  
38 the No Action Alternative in April and May, respectively. A similar pattern was  
39 observed in the San Joaquin River downstream of the Head of Old River  
40 (Appendix 9K). In Old River upstream of the facilities, the median proportion of  
41 positive velocities would be slightly higher in April and May under Alternative 3  
42 relative to the No Action Alternative and similar in March. In Old River  
43 downstream of the facilities, the median proportion of positive velocities would

1 be similar in March and substantially lower in April and May under Alternative 3  
2 relative to the No Action Alternative.

### 3 *Changes in Junction Entrainment*

4 Entrainment at Georgiana Slough would be similar under both alternatives during  
5 March, April and May, when spring-run Chinook Salmon are most abundant in  
6 the Delta (Appendix 9L). At the Head of Old River, median entrainment  
7 probabilities would be slightly greater under Alternative 3 during April and May,  
8 whereas probabilities would be similar in March. At the Turner Cut junction,  
9 median entrainment probabilities under Alternative 3 and the No Action  
10 Alternative would be similar in March. During April and May, entrainment  
11 probabilities would be more divergent with slightly higher values for  
12 Alternative 3 relative to the No Action Alternative. Overall, entrainment was  
13 slightly lower at the Columbia Cut junction relative to Turner Cut, but patterns of  
14 entrainment between these two alternatives would be similar with moderately  
15 higher values for median entrainment in April and May under Alternative 3.  
16 Patterns at the Middle River and Old River junctions would be similar to those  
17 observed at Columbia and Turner Cut junctions.

### 18 *Changes in Salvage*

19 Salvage of Sacramento River-origin Chinook Salmon is predicted to be similar  
20 under Alternative 3 and the No Action Alternative in every month except during  
21 April, May, and June (Appendix 9M). Spring-run Chinook Salmon smolts  
22 migrating through the Delta would be most susceptible in the months of March,  
23 April, and May. Predicted values in April and May indicated a substantially  
24 larger fraction of fish salvaged under Alternative 3 relative to the No Action  
25 Alternative. Predicted median salvage was similar in March under Alternative 3  
26 and the No Action Alternative.

### 27 *Summary of Effects on Spring-Run Chinook Salmon*

28 The multiple model and analysis outputs described above characterize the  
29 anticipated conditions for spring-run Chinook Salmon and their response to  
30 change under Alternative 3 and the No Action Alternative. For the purpose of  
31 analyzing effects on spring-run Chinook Salmon in the Sacramento River, greater  
32 reliance was placed on the outputs from the SALMOD model because it integrates  
33 the available information on temperature and flows to produce estimates of  
34 mortality for each life stage and an overall, integrated estimate of potential  
35 spring-run Chinook Salmon juvenile production. The output from SALMOD  
36 indicated that spring-run Chinook Salmon production in the Sacramento River  
37 would be similar under Alternative 3 and the No Action Alternative.

38 The analyses attempting to assess the effects on routing, entrainment, and salvage  
39 of juvenile salmonids in the Delta suggest that salvage (as an indicator of  
40 potential losses of juvenile salmon at the export facilities) of Sacramento River-  
41 origin Chinook Salmon is predicted to be greater under Alternative 3 relative to  
42 the No Action Alternative.

43 In Clear Creek and the Feather River, the analysis of the effects of Alternative 3  
44 and the No Action Alternative for spring-run Chinook Salmon relied on output

1 from the WUA analysis and water temperature output for Clear Creek at Igo, and  
2 in the Feather River low flow channel and downstream of the Thermalito  
3 complex. The WUA analysis suggests that there would be little difference in the  
4 availability of spawning and rearing habitat in Clear Creek. The temperature  
5 model outputs suggest that thermal conditions and effects on each of the  
6 spring-run Chinook Salmon life stages generally would be similar under both  
7 scenarios in Clear Creek and the Feather River, although water temperatures  
8 could be somewhat less suitable for spring-run Chinook Salmon holding and  
9 spawning/egg incubation in the Feather River under Alternative 3. This  
10 conclusion is supported by the water temperature threshold exceedance analysis  
11 that indicated that water temperature thresholds for spawning and egg incubation  
12 would be exceeded slightly more frequently under Alternative 3 than under the  
13 No Action Alternative in Clear Creek and the Feather River. Because of the  
14 inherent uncertainty associated with the resolution of the temperature model  
15 (average monthly outputs), the slightly greater likelihood of exceeding water  
16 temperature thresholds under Alternative 3 could increase the potential for  
17 adverse effects on spring-run Chinook Salmon in the Feather River. Given the  
18 similarity of the results, Alternative 3 and the No Action Alternative are likely to  
19 have similar effects on the spring-run Chinook Salmon population in Clear Creek.

20 These model results suggest that overall, effects on spring-run Chinook Salmon  
21 could be slightly more adverse under Alternative 3 than under the No Action  
22 Alternative. The potential differences between the two scenarios, however, may  
23 be even larger due to the benefits of implementation of fish passage under the No  
24 Action Alternative intended to address the limited availability of suitable habitat  
25 for spring-run Chinook Salmon in the Sacramento River reaches downstream of  
26 Shasta Dam. This potential beneficial effect and its magnitude would depend on  
27 the success of the fish passage program. In addition, RPA actions intended to  
28 increase the efficiency of the Tracy and Skinner Fish Collection Facilities could  
29 improve the overall salvage survival of spring-run Chinook Salmon under the No  
30 Action Alternative.

31 The ocean harvest restriction component of Alternative 3 could increase spring-  
32 run Chinook Salmon numbers by reducing ocean harvest and the trap and haul  
33 program and predator control measures under Alternative 3 could reduce  
34 predation on juvenile spring-run Chinook Salmon and thereby increase survival.

35 Although the operational components associated with Alternative 3 could have  
36 greater adverse effects on spring-run Chinook Salmon than the No Action  
37 Alternative, the non-operational components associated with Alternative 3 could  
38 benefit spring-run Chinook Salmon relative to the No Action Alternative over the  
39 short term if successful. However, these measures would not address the long-  
40 term temperature challenges in the river downstream of Shasta Dam that would be  
41 addressed under the No Action Alternative if fish passage is successful. Even  
42 though the success of fish passage is uncertain, it is concluded that the potential  
43 for adverse effects on spring-run Chinook Salmon under Alternative 3 clearly  
44 would be greater than those under the No Action Alternative, principally because  
45 Alternative 3 does not include a strategy to address water temperatures critical to

1 spring-run Chinook Salmon sustainability over the long term with climate change  
2 by 2030.

3 *Fall-Run Chinook Salmon*

4 Changes in operations that influence temperature and flow conditions in the  
5 Sacramento River downstream of Keswick Dam, Clear Creek downstream of  
6 Whiskeytown Dam, Feather River downstream of Oroville Dam and American  
7 River downstream of Nimbus could affect fall-run Chinook Salmon. The  
8 following describes those changes and their potential effects.

9 *Changes in Water Temperature*

10 Changes in water temperature could affect fall-run Chinook Salmon in the  
11 Sacramento, Feather, and American rivers, and Clear Creek. The following  
12 describes temperature conditions in those water bodies.

13 *Sacramento River*

14 Average monthly water temperature in the Sacramento River at Keswick Dam  
15 under Alternative 3 relative to the No Action Alternative generally would be  
16 similar (less than 0.5°F differences) water temperatures under the No Action  
17 Alternative during most months of the year (Appendix 6B, Table B-5-2). In  
18 September, average water temperatures in wetter years could be increased by up  
19 to 0.8°F and decreased by up to 1.2°F in critical years. A similar temperature  
20 pattern generally would be exhibited downstream at Ball's Ferry, Jelly's Ferry,  
21 Bend Bridge, Red Bluff, Hamilton City, and Knights Landing, with average  
22 monthly temperatures progressively increasing in the downstream direction  
23 (e.g., average difference in September of about 9°F between Keswick Dam and  
24 Knights Landing). The water temperature differences between Alternative 3 and  
25 the No Action Alternative in September of wetter years would increase to as high  
26 as 4.4°F warmer under Alternative 3 at Knight's Landing, while the differences in  
27 water temperatures in September associated with Alternative 3 during drier years  
28 would remain similar to upstream locations.

29 Overall, the water temperature differences between Alternative 3 and the No  
30 Action Alternative would be relatively minor (less than 0.5°F) and likely would  
31 have little effect on fall-run Chinook Salmon in the Sacramento River. The  
32 increased water temperatures in September of wetter years under Alternative 3  
33 could increase the likelihood of adverse effects on early spawning fall-run  
34 Chinook Salmon during this water year type. The slightly lower water  
35 temperatures in September of drier years under Alternative 3 would reduce the  
36 likelihood of adverse effects on early spawning fall-run Chinook Salmon in the  
37 Sacramento River as compared to the No Action Alternative.

38 *Clear Creek*

39 Average monthly water temperatures in Clear Creek at Igo under Alternative 3  
40 would be similar to (less than 0.5°F differences) water temperatures under the No  
41 Action Alternative with the exception of May when average monthly  
42 temperatures under Alternative 3 would be somewhat higher (up to about 0.8°F)  
43 than the No Action Alternative (Appendix 6B, Table B-3-2). Alternative 32). As



1 described above for spring-run Chinook Salmon, the lower water temperatures in  
2 May associated with the No Action Alternative reflect the effects of the additional  
3 water that would be discharged from Whiskeytown Dam to meet the 2009 NMFS  
4 BO RPA spring attraction flow requirements.

5 Under Alternative 3, temperature conditions at Igo would be similar to water  
6 temperatures under the No Action Alternative. However, these temperature  
7 outputs are at a location upstream of most fall-run Chinook Salmon spawning and  
8 rearing in Clear Creek. Temperatures where fall-run Chinook Salmon inhabit the  
9 creek would be somewhat higher as indicated by average monthly temperatures at  
10 the confluence with the Sacramento River, although these temperatures would be  
11 similar under Alternative 3 and the No Action Alternative. Overall, effects on  
12 fall-run Chinook Salmon in Clear Creek due to temperature differences between  
13 Alternative 3 and the No Action Alternative would be relatively minor.

14 *Feather River*

15 Average monthly water temperatures in the Feather River at the low flow channel  
16 under the Alternative 3 relative generally would be similar (within 0.5°F) to water  
17 temperatures under the No Action Alternative generally would be, except in  
18 November and December (differences as much as 1.6°F lower in December in  
19 below normal water years) (Appendix 6B, Table B-20-2). In September average  
20 monthly water temperatures under Alternative 3 could be somewhat higher (up to  
21 about 1.5°F) in wetter years than under the No Action Alternative. Although  
22 temperatures in the river would become progressively higher in the downstream  
23 direction, the differences between Alternative 3 and the No Action  
24 Alternative would exhibit a similar pattern at the downstream locations (Robinson  
25 Riffle and Gridley Bridge), with temperatures under Alternative 3 and the No  
26 Action Alternative generally becoming more similar at the confluence with the  
27 Sacramento River, except in September when water temperatures under  
28 Alternative 3 could be up to 4.4 °F higher than under the No Action  
29 Alternative and in June when temperatures under Alternative 3 could be up to  
30 0.8°F cooler in drier years.

31 Overall, the temperature differences in the Feather River between Alternative 3  
32 and the No Action Alternative would be relatively minor (less than 0.5°F) and  
33 likely would have little effect on fall-run Chinook Salmon in the Feather River.  
34 The somewhat lower water temperatures in November and December under  
35 Alternative 3 would likely have little effect on fall-run Chinook Salmon as water  
36 temperatures in the Feather River are typically low during this time period. The  
37 somewhat higher water temperatures in September of wetter years may increase  
38 the likelihood of adverse effects on early spawning fall-run Chinook Salmon in  
39 these water year types.

40 *American River*

41 Long term average monthly water temperatures in the American River at Nimbus  
42 Dam under Alternative 3 generally would be similar (differences less than 0.5°F)  
43 to those under the No Action Alternative (Appendix 6B, Table B-12-2). This  
44 pattern generally would persist downstream to Watt Avenue and the mouth

1 although the temperature differences between scenarios would increase in June  
 2 and September (Appendix 6B, Tables b-13-2 and B-13-2 and B-14-2). In June  
 3 water temperatures could be up to 0.7°F lower under Alternative 3 than under the  
 4 No Action Alternative in some water year types. In September, average monthly  
 5 water temperatures at the mouth generally would be higher under Alternative 3  
 6 than under the No Action Alternative, especially in wetter water year types when  
 7 the water temperatures under Alternative 3 could be up to 1.6°F warmer.

8 Overall, the temperature differences in the American River between Alternative 3  
 9 and the No Action Alternative would be relatively minor (less than 0.5°F) and  
 10 likely would have little effect on fall-run Chinook Salmon in the American River.  
 11 The lower water temperatures in June under Alternative 3 may reduce the  
 12 likelihood of adverse effects on fall-run Chinook Salmon rearing in the American  
 13 River if they were present. Higher water temperatures during September under  
 14 Alternative 3 would have little effect on fall-run Chinook Salmon spawning in the  
 15 American River because most spawning occurs later in November.

#### 16 *Changes in Exceedances of Water Temperature Thresholds*

17 Changes in water temperature could result in the exceedance of water  
 18 temperatures that are protective of fall-run Chinook Salmon in the Sacramento  
 19 River, Clear Creek, Feather River, and American River. The following describes  
 20 the extent of those exceedances for each of those water bodies.

#### 21 *Sacramento River*

22 Average monthly water temperatures under both Alternative and the No Action  
 23 Alternative would show exceedances of the water temperature threshold of 56°F  
 24 established in the Sacramento River at Red Bluff for fall-run Chinook Salmon  
 25 (spawning and egg incubation) in October, November, and again in April. The  
 26 exceedances would occur at the greatest frequency in October (78 percent of the  
 27 time under Alternative 3). The water temperature threshold would be exceeded  
 28 less frequently in November (8 percent of the time) and not exceeded at all during  
 29 December through March under Alternative 3. As water temperatures warm in  
 30 the spring, the threshold would be exceeded in April by 14 percent under  
 31 Alternative 3. In the months when the greatest frequency of exceedances occur  
 32 (October, November, and April), model results generally indicate that the  
 33 threshold would be exceeded less frequently (by up to 4 percent in October) under  
 34 Alternative 3 than under the No Action Alternative. Temperature conditions in  
 35 the Sacramento River under Alternative 3 could be less likely to affect fall-run  
 36 Chinook Salmon spawning and egg incubation than under the No Action  
 37 Alternative because of the decreased frequency of exceedance of the 56°F  
 38 threshold in October, November, and April.

#### 39 *Clear Creek*

40 Fall-run Chinook Salmon spawning in lower Clear Creek typically occurs during  
 41 October through December (USFWS 2015). Average monthly water  
 42 temperatures at Igo during this period generally remain below 56°F, except in  
 43 October. Under Alternative 3, 56°F would be exceeded in October about  
 44 10 percent of the time as compared to 12 percent under the No Action Alternative.

1 At the confluence with the Sacramento River, average monthly water  
2 temperatures would be warmer, with 56°F exceeded about 15 percent of the time  
3 under Alternative 3 and slightly more frequently under the No Action  
4 Alternative (Appendix 6B, Figure B-4-1). During November and December,  
5 average monthly water temperatures generally would remain below 56°F at both  
6 locations. Temperature conditions in Clear Creek under Alternative 3 could be  
7 less likely to affect fall-run Chinook Salmon spawning and egg incubation than  
8 under the No Action Alternative because of the reduced frequency of exceedance  
9 of the 56°F threshold in October.

10 For fall-run Chinook Salmon rearing (January through August), the exceedances  
11 described previously for spring-run Chinook Salmon would apply, with the  
12 average monthly temperatures remaining below the 60°F threshold in all months  
13 Downstream at the mouth of Clear Creek, average monthly water temperatures  
14 would exceed the 60°F threshold often during the summer, but the frequency of  
15 exceedance would be similar under Alternative 3 and the No Action  
16 Alternative (Appendix 6B Figures). Temperature conditions for fall-run Chinook  
17 Salmon rearing in Clear Creek would be similar under Alternative 3 and the No  
18 Action Alternative.

19 *Feather River*

20 Average monthly water temperatures under both Alternative 3 and the No Action  
21 Alternative would exceed the water temperature threshold of 56°F established in  
22 the Feather River at Gridley Bridge for fall-run Chinook Salmon spawning and  
23 rearing during some months, particularly in October, November, March, and  
24 April, when temperature thresholds would be exceeded frequently  
25 (Appendix 9N). The frequency of exceedance would be greatest in October,  
26 when average monthly temperatures under both Alternative 3 and the No Action  
27 Alternative would be above the threshold in nearly every year. The magnitude of  
28 the exceedances would be high as well, with average monthly temperatures in  
29 October reaching about 68°F. Similarly, the threshold would be exceeded under  
30 both alternatives about 85 percent of the time in April. However, water  
31 temperatures under Alternative 3 could exceed temperature thresholds about  
32 1-4 percent less frequently than under the No Action Alternative. Temperature  
33 conditions in the Feather River under Alternative 3 could be less likely to affect  
34 fall-run Chinook Salmon spawning and egg incubation than under the No Action  
35 Alternative because of the reduced frequency of exceedance of the 56°F threshold  
36 from October through April.

37 *Changes in Egg Mortality*

38 The analysis of fall-run Chinook Salmon included the application of the  
39 Reclamation Salmon Survival Model. The following describes the differences in  
40 egg mortality for the Sacramento, Feather, and American rivers based on the  
41 model output.

1                    *Sacramento River*

2 For fall-run Chinook Salmon in the Sacramento River, the long-term average egg  
3 mortality rate is predicted to be around 17 percent, with higher mortality rates (in  
4 excess of 35 percent) occurring in critical dry years under Alternative 3. Overall,  
5 egg mortality would similar under Alternative 3 and the No Action Alternative in  
6 all water year types (Appendix 9C, Table B-1).

7                    *Feather River*

8 For fall-run Chinook Salmon in the Feather River, the long-term average egg  
9 mortality rate is predicted to be relatively low (around 6 percent), with higher  
10 mortality rates (around 14.6 percent) occurring in critical dry years under  
11 Alternative 3. Overall, egg mortality would be similar under Alternative 3 and  
12 the No Action Alternative in all water year types (Appendix 9C, Table B-7).

13                    *American River*

14 For fall-run Chinook Salmon in the American River, the long-term average egg  
15 mortality rate is predicted to range from approximately 22 to 25 percent in all  
16 water year types under Alternative 3. Overall, egg mortality would be similar  
17 under Alternative 3 and the No Action Alternative in all water year types  
18 (Appendix 9C, Table B-6).

19                    *Changes in Weighted Usable Area*

20 Weighted usable area, which is influenced by flow, is a measure of habitat  
21 suitability. The following describes changes in WUA for fall-run Chinook  
22 Salmon in the Sacramento, Feather, and American rivers and Clear Creek.

23                    *Sacramento River*

24 As an indicator of the amount of suitable spawning habitat for fall-run Chinook  
25 Salmon between Keswick Dam and Battle Creek, modeling results indicate that,  
26 in general, there would be greater amounts of spawning habitat available from  
27 September and November under Alternative 3 as compared to the No Action  
28 Alternative; fall-run spawning WUA would be similar in October and December  
29 (Appendix 9E, Table C-11-2). The increase in long-term average spawning WUA  
30 in September under Alternative 3 (prior to the peak spawning period) would be  
31 relatively large (around 20 percent), with a smaller increase in November (around  
32 15 percent) which comprises the peak spawning period for fall-run Chinook  
33 Salmon. Results for the reach from Battle Creek to Deer Creek show the same  
34 pattern in changes in WUA for spawning fall-run Chinook Salmon between  
35 Alternative 3 and the No Action Alternative (Appendix 9E, Table C-10-2).  
36 Overall, spawning habitat availability could be increased under Alternative 3  
37 relative to the No Action Alternative.

38 Modeling results indicate that, in general, there would be similar amounts of  
39 suitable fry rearing habitat available from December to March under Alternative 3  
40 (Appendix 9E, Table C-12-2). Similar to the results for fry rearing WUA,  
41 modeling results indicate that, there would be similar amounts of suitable juvenile  
42 rearing habitat available during the juvenile rearing period from February to June  
43 (Appendix 9E, Table C-13-2).

1 *Clear Creek*

2 Flows in Clear Creek below Whiskeytown Dam are not anticipated to differ under  
3 Alternative 3 relative to the No Action Alternative except in May due to the  
4 release of spring attraction flows in accordance with the 2009 NMFS BO under  
5 the No Action Alternative. Therefore, there would be no change in the amount of  
6 potentially suitable spawning and rearing habitat for fall-run Chinook Salmon (as  
7 indexed by WUA) available under Alternative 3 as compared to the No Action  
8 Alternative.

9 *Feather River*

10 Flows in the low flow channel of the Feather River are not anticipated to differ  
11 under Alternative 3 relative to the No Action Alternative. Therefore, there would  
12 be no change in the amount of potentially suitable spawning habitat for fall-run  
13 Chinook Salmon (as indexed by WUA) available under Alternative 3 as compared  
14 to the No Action Alternative. The majority of spawning activity by fall-run  
15 Chinook Salmon in the Feather River occurs in this reach with a lesser amount of  
16 spawning occurring downstream of the Thermalito Complex.

17 Modeling results indicate that, in general, there would be greater amounts of  
18 spawning habitat available in September under Alternative 3 as compared to the  
19 No Action Alternative. The increase in long-term average spawning WUA during  
20 September (prior to the peak spawning period) would be relatively large (around  
21 30 percent), with similar amounts of spawning WUA for fall-run Chinook Salmon  
22 predicted during other months. Overall, spawning habitat availability would be  
23 somewhat similar under Alternative 3 relative to the No Action Alternative.

24 *American River*

25 Modeling results indicate that, in general, there would be similar amounts of  
26 spawning habitat available for fall-run Chinook Salmon in the American River  
27 from October to December under Alternative 3 as compared to the No Action  
28 Alternative (Appendix 9E, Table C-25-2).

29 *Changes in SALMOD Output*

30 SALMOD results indicate that potential juvenile production would be similar  
31 under Alternative 3 and the No Action Alternative, but up to 5 percent greater  
32 under Alternative 3 in critical dry years.

33 *Changes in Delta Passage Model Output*

34 The Delta Passage Model predicted similar estimates of annual Delta survival  
35 across the 81-year time period for fall-run Chinook Salmon between Alternative 3  
36 and the No Action Alternative (Appendix 9J). Median Delta survival was  
37 0.246 for Alternative 3 and 0.245 for the No Action Alternative.

38 *Changes in Delta Hydrodynamics*

39 Fall-run Chinook Salmon smolts are most abundant in the Delta during the  
40 months of April, May and June. At the junction of Georgiana Slough and the  
41 Sacramento River, the median proportion of positive velocities would be similar  
42 in April, May and June under Alternative 3 and the No Action  
43 Alternative (Appendix 9K). Near the confluence of the San Joaquin River and the

1 Mokelumne River, the median proportion of positive velocities would be slightly  
2 lower under Alternative 3 relative to the No Action Alternative in April and May  
3 and similar in June. On Old River downstream of the facilities, the median  
4 proportion of positive velocities would be substantially lower in April and May  
5 under Alternative 3 relative to the No Action Alternative, but would be only  
6 moderately lower in June. In Old River upstream of the facilities, the median  
7 proportion of positive velocities would be similar for Alternative 3 relative to the  
8 No Action Alternative in June. In April and May, values for Alternative 3 would  
9 be slightly higher under Alternative 3 relative to the No Action Alternative. On  
10 the San Joaquin River downstream of the Head of Old River, the median  
11 proportion of positive velocities would be similar under Alternative 3 relative to  
12 the No Action Alternative in April, May, and June.

### 13 *Changes in Junction Entrainment*

14 The median entrainment at Georgiana Slough under Alternative 3 would be  
15 slightly greater in June relative to the No Action Alternative (Appendix 9L). In  
16 April and May, median entrainment would be almost identical under both  
17 alternatives. At the Head of Old River junction, entrainment under Alternative 3  
18 would be slightly higher in April, May, and June relative to the No Action  
19 Alternative. Median entrainment into Turner Cut would be slightly greater under  
20 Alternative 3 during April, and May and similar in June. At the Columbia Cut  
21 junction, entrainment would be moderately higher under Alternative 3 during  
22 April and May, whereas entrainment would be slightly higher in June.  
23 Entrainment probabilities at the Middle River junction from April through June  
24 would be moderately greater under Alternative 3 relative to the No Action  
25 Alternative. A similar pattern would be observed at the Old River junction.

### 26 *Changes in Salvage*

27 Salvage of Sacramento River-origin Chinook Salmon is predicted to be similar  
28 under Alternative 3 and No Action Alternative in every month except April, May,  
29 and June (Appendix 9M). Fall-run Chinook Salmon smolts migrating through the  
30 Delta would be most susceptible in the months of April, May, and June.  
31 Predicted values in April and May indicated a substantially increased fraction of  
32 fish salvaged under Alternative 3 relative to the No Action Alternative and a  
33 moderately increased fraction salvaged in June under Alternative 3.

### 34 *Summary of Effects on Fall-Run Chinook Salmon*

35 The multiple model and analysis outputs described above characterize the  
36 anticipated conditions for fall-run Chinook Salmon and their response to change  
37 under Alternative 3 and the No Action Alternative. For the purpose of analyzing  
38 effects on fall-run Chinook Salmon in the Sacramento River, greater reliance was  
39 placed on the outputs from the SALMOD model because it integrates the  
40 available information on temperature and flows to produce estimates of mortality  
41 for each life stage and an overall, integrated estimate of potential fall-run Chinook  
42 Salmon juvenile production. The output from SALMOD indicated that fall-run  
43 Chinook Salmon production would be similar in most water year types under  
44 Alternative 3 and the No Action Alternative, but up to 5 percent greater under  
45 Alternative 3 than under the No Action Alternative in critical dry years.

1 The analyses attempting to assess the effects on routing, entrainment, and salvage  
2 of juvenile salmonids in the Delta suggest that salvage (as an indicator of  
3 potential losses of juvenile salmon at the export facilities) of Sacramento  
4 River-origin Chinook Salmon is predicted to be greater under Alternative 3  
5 relative to the No Action Alternative.

6 In Clear Creek and the Feather and American rivers, the analysis of the effects of  
7 Alternative 3 and the No Action Alternative for fall-run Chinook Salmon relied  
8 on the WUA analysis for habitat and water temperature model output for the  
9 rivers at various locations downstream of the CVP and SWP facilities. The WUA  
10 analysis indicated that the availability of spawning and rearing habitat in Clear  
11 Creek and spawning habitat in the Feather and American rivers would be similar  
12 under Alternative 3 and the No Action Alternative. The temperature model  
13 outputs for each of the fall-run Chinook Salmon life stages suggest that thermal  
14 conditions and effects on fall-run Chinook Salmon in all of these streams  
15 generally would be similar under both scenarios. The water temperature threshold  
16 exceedance analysis that indicated that the water temperature thresholds for  
17 fall-run Chinook Salmon spawning and egg incubation would be exceeded  
18 slightly less frequently in the Feather River and Clear Creek under Alternative 3  
19 and could reduce the potential for adverse effects on the fall-run Chinook Salmon  
20 populations in Clear Creek and the Feather River. Results of the analysis using  
21 Reclamation's salmon mortality model indicate that there would be slightly  
22 reduced fall-run Chinook Salmon egg mortality in the Feather River under  
23 Alternative 3 compared to the No Action Alternative.

24 These model results suggest that overall, effects on fall-run Chinook Salmon  
25 could be slightly less adverse under Alternative 3 than the No Action Alternative.  
26 This potential distinction between the two scenarios, however, may be partially  
27 offset by the benefits of implementation of fish passage under the No Action  
28 Alternative intended to address the limited availability of suitable habitat for  
29 winter-run and spring-run Chinook Salmon in the Sacramento River reaches  
30 downstream of Keswick Dam. This potential benefit, however, would only apply  
31 if passage is provided for fall-run Chinook Salmon that allows access to  
32 additional habitat. In addition, RPA actions under the No Action  
33 Alternative intended to increase the efficiency of the Tracy and Skinner Fish  
34 Collection Facilities could improve the overall salvage survival of fall-run  
35 Chinook Salmon. The ocean harvest restriction component of Alternative 3 could  
36 increase fall-run Chinook Salmon numbers by reducing ocean harvest and the trap  
37 and haul program and predator control measures under Alternative 3 could reduce  
38 predation on juvenile fall-run Chinook Salmon and thereby increase survival.

39 Overall, the results of the numerical models suggest the potential for less adverse  
40 effects on fall-run Chinook Salmon under Alternative 3 as compared to the No  
41 Action Alternative. However, discerning a meaningful difference between these  
42 two scenarios based on the quantitative results is not possible because of the  
43 similarity in results (generally differences less than 5 percent) and the inherent  
44 uncertainty of the models. In addition, adverse effects of the No Action  
45 Alternative could be offset by the potentially beneficial effects resulting from the

1 RPA actions evaluated qualitatively for the No Action Alternative. Adverse  
2 effects of Alternative 3 could be offset by the potentially beneficial effects  
3 resulting from predator control and ocean harvest restrictions. Thus, it is  
4 concluded that the effects on fall-run Chinook Salmon would be similar under  
5 Alternative 3 and the No Action Alternative.

#### 6 *Late Fall-Run Chinook Salmon*

7 Changes in operations that influence temperature and flow conditions in the  
8 Sacramento River downstream of Keswick Dam could affect late fall-run Chinook  
9 Salmon. The following describes those changes and their potential effects.

#### 10 *Changes in Water Temperature*

11 Average monthly water temperature in the Sacramento River at Keswick Dam  
12 under Alternative 3 relative to the No Action Alternative generally would be  
13 similar to (less than 0.5°F differences) water temperatures under the No Action  
14 Alternative during most months of the year (Appendix 6B, Table B-5-2). In  
15 September, average water temperatures in wetter years could be increased by up  
16 to 0.8°F and decreased by up to 1.2°F in critical years. A similar temperature  
17 pattern generally would be exhibited downstream at Ball's Ferry, Jelly's Ferry,  
18 Bend Bridge, Red Bluff, Hamilton City, and Knights Landing, with average  
19 monthly temperatures progressively increasing in the downstream direction  
20 (e.g., average difference in September of about 9°F between Keswick Dam and  
21 Knights Landing). The temperature differences between Alternative 3 and the No  
22 Action Alternative in September of wetter years would increase to as high as  
23 4.4°F warmer under Alternative 3 at Knight's Landing, while the differences in  
24 water temperatures in September associated with Alternative 3 during drier years  
25 would remain similar to upstream locations.

26 Overall, the temperature differences between Alternative 3 and the No Action  
27 Alternative would be relatively minor (less than 0.5°F) and likely would have  
28 little effect on late fall-run Chinook Salmon in the Sacramento River. The  
29 likelihood of adverse effects on late fall-run Chinook Salmon spawning and egg  
30 incubation would be similar under Alternative 3 and the No Action  
31 Alternative due to similar water temperatures during the January to May time  
32 period. Because late fall-run Chinook Salmon have an extended rearing period,  
33 the similar water temperatures during the summer under Alternative 3 and the No  
34 Action Alternative would have similar effects on rearing fry and juvenile late fall-  
35 run Chinook Salmon in the Sacramento River. The slightly higher water  
36 temperatures under Alternative 3 in September of wetter years may increase the  
37 likelihood of adverse effects on fry and juvenile late fall-run Chinook Salmon  
38 rearing in the Sacramento River during this limited time period.

#### 39 *Changes in Exceedances of Water Temperature Thresholds*

40 Average monthly water temperatures under both Alternative and the No Action  
41 Alternative would show exceedances of the water temperature threshold of 56°F  
42 established in the Sacramento River at Red Bluff for Chinook Salmon (spawning  
43 and egg incubation) in October, November, and again in April. The exceedances  
44 would occur at the greatest frequency in October (78 percent of the time under



1 Alternative 3). The water temperature threshold would be exceeded less  
2 frequently in November (8 percent of the time) and not exceeded at all during  
3 December through March under Alternative 3. As water temperatures warm in  
4 the spring, the threshold would be exceeded in April by 14 percent under  
5 Alternative 3. In the months when the greatest frequency of exceedances occur  
6 (October, November, and April), model results generally indicate that the  
7 threshold would be exceeded less frequently (by up to 4 percent in October) under  
8 Alternative 3 than under the No Action Alternative. Temperature conditions in  
9 the Sacramento River under Alternative 3 could be less likely to affect late fall-  
10 run Chinook Salmon spawning and egg incubation than under the No Action  
11 Alternative because of the decreased frequency of exceedance of the 56°F  
12 threshold in October, November, and April.

13 *Changes in Egg Mortality*

14 For late fall-run Chinook Salmon in the Sacramento River, the long-term average  
15 egg mortality rate is predicted to range from approximately 1.8 to nearly 5 percent  
16 in all water year types under Alternative 3. Overall, egg mortality would be  
17 similar under Alternative 3 and the No Action Alternative (Appendix 9C,  
18 Table B-2) in all water year types.

19 *Changes in Weighted Usable Area*

20 Modeling results indicate that there would be similar amounts of spawning habitat  
21 available for late fall-run Chinook Salmon in the Sacramento River from January  
22 through April under Alternative 3 as compared to the No Action  
23 Alternative (Appendix 9E, Table C-14-4).

24 Modeling results indicate that, in general, there would be similar amounts of  
25 suitable late fall-run Chinook Salmon fry rearing habitat available during April  
26 and May under Alternative 3 and the No Action Alternative (Appendix 9E,  
27 Table C-15-4).

28 A substantial fraction of late fall run Chinook Salmon juveniles overwinter in  
29 the Sacramento River before emigrating, which allows them to avoid predation  
30 through both their larger size and greater swimming ability. One implication of  
31 this life history strategy is that rearing habitat is most likely the limiting factor for  
32 late-fall-run Chinook Salmon, especially if availability of cool water determines  
33 the downstream extent of spawning habitat for late-fall-run salmon. Modeling  
34 results indicate that, there would generally be similar amounts of suitable juvenile  
35 rearing habitat available from December through August under Alternative 3 and  
36 the No Action Alternative. There could an increase in the amount of late fall-run  
37 Chinook Salmon juvenile rearing WUA in September and November of up to  
38 nearly 10 percent (Appendix 9E, Table C-16-4). Overall, late fall-run juvenile  
39 rearing habitat availability would be similar under Alternative 3 and the No  
40 Action Alternative.

41 *Changes in SALMOD Output*

42 SALMOD results indicate that potential juvenile production would be the same  
43 under Alternative 3 and the No Action Alternative (Appendix 9D, Table B-2-6).

1            *Changes in Delta Passage Model Output*

2 For late fall-run Chinook Salmon, Delta survival was predicted to be slightly  
3 lower for Alternative 3 versus the No Action Alternative for all 81 years  
4 simulated by the Delta Passage Model (Appendix 9J). Median Delta survival  
5 across all years was 0.199 for Alternative 3 and 0.244 for the No Action  
6 Alternative.

7            *Changes in Delta Hydrodynamics*

8 The late fall-run Chinook Salmon migration period overlaps with the winter-run.  
9 See the section on hydrodynamic analysis for winter-run Chinook Salmon for  
10 potential effects on late fall-run Chinook Salmon.

11           *Changes in Junction Entrainment*

12 Entrainment probabilities for late fall-run Chinook Salmon are assumed to mimic  
13 that of winter-run Chinook Salmon due to the overlap in timing. See the section  
14 on winter-run Chinook Salmon entrainment for potential effects on late fall-run  
15 Chinook Salmon.

16           *Changes in Salvage*

17 Salvage of late fall-run Chinook Salmon is assumed to mimic that of winter-run  
18 Chinook Salmon due to the overlap in timing. See the section on winter-run  
19 Chinook Salmon entrainment for potential effects on late fall-run Chinook  
20 Salmon.

21           *Summary of Effects on Late Fall-Run Chinook Salmon*

22 The multiple model and analysis outputs described above characterize the  
23 anticipated conditions for late fall-run Chinook Salmon and their response to  
24 change under Alternative 3 and the No Action Alternative. For the purpose of  
25 analyzing effects on late fall-run Chinook Salmon and developing conclusions,  
26 greater reliance was placed on the outputs from the SALMOD model because it  
27 integrates the available information on temperature and flows to produce  
28 estimates of mortality for each life stage and an overall, integrated estimate of  
29 potential fall-run Chinook Salmon juvenile production. The output from  
30 SALMOD indicated that late fall-run Chinook Salmon production would be  
31 similar under Alternative 3 and the No Action Alternative.

32 The analyses attempting to assess the effects on routing, entrainment, and salvage  
33 of juvenile salmonids in the Delta suggest that salvage (as an indicator of  
34 potential losses of juvenile salmon at the export facilities) of Sacramento  
35 River-origin Chinook Salmon is predicted to be similar under Alternative 3  
36 relative to the No Action Alternative. Actions under the No Action  
37 Alternative intended to increase the efficiency of the Tracy and Skinner Fish  
38 Collection Facilities could improve the overall salvage survival of late fall-run  
39 Chinook Salmon.

40 Overall, the results of the numerical models suggest that potential effects on late  
41 fall-run Chinook Salmon would be similar for Alternative 3 and the No Action  
42 Alternative. Discerning a meaningful difference between these two scenarios  
43 based on the quantitative results is not possible because of the similarity in results

1 (generally differences less than 5 percent) and the inherent uncertainty of the  
2 models. Because fish passage under the No Action Alternative is not expected to  
3 directly benefit late fall-run Chinook Salmon, the non-operational actions  
4 intended to benefit salmonids under both alternatives are expected to balance.  
5 Thus, it is concluded that the effects on late fall-run Chinook Salmon would be  
6 similar under Alternative 3 and the No Action Alternative.

7 *Steelhead*

8 Changes in operations that influence temperature and flow conditions that could  
9 affect steelhead. The following describes those changes and their potential  
10 effects.

11 *Changes in Water Temperature*

12 Changes in water temperature could affect steelhead in the Sacramento, Feather,  
13 and American rivers, and Clear Creek. The following describes temperature  
14 conditions in those water bodies.

15 *Sacramento River*

16 Average monthly water temperature in the Sacramento River at Keswick Dam  
17 under Alternative 3 relative to the No Action Alternative generally would be  
18 similar (less than 0.5°F differences) water temperatures under the No Action  
19 Alternative during most months of the year (Appendix 6B, Table B-5-2). In  
20 September, average water temperatures in wetter years could be increased by up  
21 to 0.8°F and decreased by up to 1.2°F in critical years. A similar temperature  
22 pattern generally would be exhibited downstream at Ball's Ferry, Jelly's Ferry,  
23 Bend Bridge, and Red Bluff, with average monthly temperatures progressively  
24 increasing in the downstream direction (e.g., average difference of about 3°F  
25 between Keswick Dam and Red Bluff). The water temperature differences  
26 between Alternative 3 and the No Action Alternative in September of wetter years  
27 would increase to as high as 3.0°F warmer under Alternative 3 at Red Bluff, while  
28 the differences in water temperatures in September associated with Alternative 3  
29 during drier years would remain similar to upstream locations.

30 Overall, the water temperature differences between Alternative 3 and the No  
31 Action Alternative would be relatively (less than 0.5°F) minor and likely would  
32 have little effect on steelhead in the Sacramento River. The increased water  
33 temperatures in September of wetter years under Alternative 3 could increase the  
34 likelihood of adverse effects on migrating adult steelhead during this water year  
35 type. The slightly lower water temperatures in September of drier years under  
36 Alternative 3 could reduce the likelihood of adverse effects on migrating adult  
37 steelhead during drier years as compared to the No Action Alternative.

38 *Clear Creek*

39 Average monthly water temperatures in Clear Creek at Igo under Alternative 3  
40 would be similar to (less than 0.5°F differences) water temperatures under the No  
41 Action Alternative with the exception of May when average monthly  
42 temperatures under Alternative 3 would be somewhat higher (up to about 0.8°F)  
43 than the No Action Alternative. As described above for spring-run Chinook

1 Salmon, the lower water temperatures in May associated with the No Action  
2 Alternative reflect the effects of the additional water that would be discharged  
3 from Whiskeytown Dam to meet the 2009 NMFS BO RPA spring attraction flow  
4 requirements. Overall, thermal conditions for steelhead in Clear Creek would be  
5 similar under Alternative 3 and the No Action Alternative.

#### 6 *Feather River*

7 Average monthly water temperatures in the Feather River at the low flow channel  
8 under the Alternative 3 relative generally would be similar (within 0.5°F) to water  
9 temperatures under the No Action Alternative except in November and December  
10 (differences as much as 1.6°F in December in below normal water years)  
11 (Appendix 6B, Table B-20-2). In September average monthly water temperatures  
12 under Alternative 3 could be somewhat higher (up to about 1.5°F) in wetter years  
13 than under the No Action Alternative. Although temperatures in the river would  
14 become progressively higher in the downstream direction, the differences between  
15 Alternative 3 and the No Action Alternative would exhibit a similar pattern at the  
16 downstream locations (Robinson Riffle and Gridley Bridge), with temperatures  
17 under Alternative 3 and the No Action Alternative generally becoming more  
18 similar among months at the confluence with the Sacramento River, except in  
19 September when water temperatures under Alternative 3 could be up to 4.4 °F  
20 higher than under the No Action Alternative and in June when temperatures under  
21 Alternative 3 could be up to 0.8°F cooler in drier years.

22 Overall, the temperature differences in the Feather River between Alternative 3  
23 and the No Action Alternative would be relatively minor (less than 0.5°F) and  
24 likely would have little effect on steelhead in the Feather River. The somewhat  
25 higher water temperatures in September of wetter years may increase the  
26 likelihood of adverse effects on migrating adult steelhead during this water year  
27 type. The somewhat lower water temperatures in in November and December  
28 under Alternative 3 also could reduce the likelihood of adverse effects on  
29 steelhead adults migrating upstream and juveniles migrating downstream in the  
30 Feather River as compared to the No Action Alternative.

#### 31 *American River*

32 Long term average monthly water temperatures in the American River at Nimbus  
33 Dam under Alternative 3 generally would be similar (differences less than 0.5°F)  
34 to those under the No Action Alternative (Appendix 6B, Table B-12-2). This  
35 pattern generally would persist downstream to Watt Avenue and the mouth,  
36 although the temperature differences between scenarios would increase in June  
37 and September (Appendix 6B, Tables B-13-2 and B-13-2 and B-14-2). In June  
38 water temperatures could be up to 0.7°F lower under Alternative 3 than under the  
39 No Action Alternative in some water year types. In September, average monthly  
40 water temperatures at the mouth generally would be higher under Alternative 3  
41 than under the No Action Alternative, especially in wetter water year types when  
42 the water temperatures under Alternative 3 could be up to 1.6°F warmer.

1 Overall, the temperature differences between Alternative 3 and the No Action  
2 Alternative would be minor (less than 0.5°F) and likely would have little effect on  
3 steelhead in the American River. The somewhat higher water temperatures in  
4 September of wetter years may increase the likelihood of adverse effects on  
5 migrating adult steelhead during this water year type. The cooler water  
6 temperatures in June under Alternative 3 may reduce the likelihood of adverse  
7 effects on steelhead rearing in the American River compared to the No Action  
8 Alternative.

9 *Changes in Exceedances of Water Temperature Thresholds*

10 Changes in water temperature could result in the exceedance of established water  
11 temperature thresholds for steelhead in the Sacramento River, Clear Creek, and  
12 Feather River. The following describes the extent of those exceedance for each of  
13 those streams.

14 *Sacramento River*

15 As described in the life history accounts, steelhead spawning in the mainstem  
16 Sacramento River generally occurs in the upper reaches from Keswick Dam  
17 downstream to near Balls Ferry, with most spawning concentrated near Redding.  
18 Most steelhead, however, spawn in tributaries to the Sacramento River.  
19 Spawning generally takes place in the January through March period when water  
20 temperatures in the river generally do not exceed 52°F under either Alternative 3  
21 or the No Action Alternative. While there are no established temperature  
22 thresholds for steelhead rearing in the mainstem Sacramento River, average  
23 monthly temperatures when fry and juvenile steelhead are in the river would  
24 generally remain below 56°F at Balls Ferry except in August and September  
25 when this temperature would be exceeded 30 to 40 percent of the time under both  
26 Alternative 3 and the No Action Alternative. However, water temperatures in the  
27 Sacramento River at Balls Ferry would exceed 56°F about 10 percent more often  
28 in September under Alternative 3. Overall, thermal conditions for steelhead in the  
29 Sacramento River would be more likely to result in adverse effects on steelhead  
30 under Alternative 3 than under the No Action Alternative because of the increased  
31 frequency of exceedance of 56°F in September.

32 *Clear Creek*

33 While there are no established temperature thresholds for steelhead spawning in  
34 Clear Creek, average monthly water temperatures in the river generally would not  
35 exceed 49°F during the spawning period (December to April) under Alternative 3  
36 and the No Action Alternative. Similarly, while there are no established  
37 temperature thresholds for steelhead rearing in Clear Creek, average monthly  
38 temperatures in most months of the year would not exceed 56°F at Igo under both  
39 alternatives. Overall, thermal conditions for steelhead in Clear Creek would be  
40 similar under Alternative 3 and the No Action Alternative.

41 *Feather River*

42 Average monthly water temperatures in the Feather River at Robinson Riffle  
43 would on occasion exceed the water temperature threshold of 56°F established for  
44 steelhead spawning and incubation during some months, particularly in October

1 and November, and March and April, when temperature thresholds could be  
 2 exceeded frequently (Appendix 9N). There would be a 1 percent exceedance of  
 3 the 56°F threshold in December under the No Action Alternative and no  
 4 exceedances of the 56°F threshold from December through February under  
 5 Alternative 3. However, the differences in the frequency of exceedance between  
 6 Alternative 3 and No Action Alternative during March and April would be  
 7 relatively small with water temperatures under Alternative 3 exceeding the  
 8 threshold about 1 percent more frequently in March (19 percent) and the same  
 9 exceedance frequency (75 percent) as the No Action Alternative in April.

10 The established water temperature threshold of 63°F for rearing during May  
 11 through August would be exceeded often under both Alternative 3 and the No  
 12 Action Alternative in May and June, but not at all in July and August. Water  
 13 temperatures under Alternative 3 would exceed the rearing temperature threshold  
 14 about 5 percent less frequently than under the No Action Alternative in May, but  
 15 no more frequently in June. Temperature conditions in the Feather River under  
 16 Alternative 3 could be less likely to affect steelhead spawning and rearing than  
 17 under the No Action Alternative because of the reduced frequency of exceedance  
 18 of the spawning and rearing thresholds.

#### 19 *American River*

20 In the American River, the water temperature threshold for steelhead rearing  
 21 (May through October) is 65°F at the Watt Avenue Bridge. Average monthly  
 22 water temperatures would exceed this threshold often under both Alternative 3  
 23 and the No Action Alternative, especially in the July through September period  
 24 when the threshold is exceeded nearly all of the time. In addition, the magnitude  
 25 of the exceedance would be high, with average monthly water temperatures  
 26 sometimes higher than 76°F. The differences between Alternative 3 and No  
 27 Action Alternative, however, would be relatively small (differences within  
 28 2 percent), except in September, when water temperatures under Alternative 3  
 29 would exceed 65°F about 7 percent more frequently than under the No Action  
 30 Alternative. Temperature conditions in the American River under Alternative 3  
 31 could be more likely to affect steelhead rearing than under the No Action  
 32 Alternative because of the increased frequency of exceedance of the 65°F rearing  
 33 threshold.

#### 34 *Changes in Weighted Usable Area*

35 The following describes changes in WUA for steelhead in the Sacramento,  
 36 Feather, and American rivers and Clear Creek.

#### 37 *Sacramento River*

38 Modeling results indicate that, in general, there would be similar amounts of  
 39 suitable steelhead spawning habitat available from December through March  
 40 under Alternative 3 as compared to the No Action Alternative (Appendix 9E,  
 41 Table C-20-2).

1 *Clear Creek*

2 Flows in Clear Creek below Whiskeytown Dam are not anticipated to differ under  
3 Alternative 3 relative to the No Action Alternative except in May due to the  
4 release of spring attraction flows in accordance with the 2009 NMFS BO under  
5 the No Action Alternative. Therefore, there would be no change in the amount of  
6 potentially suitable spawning and rearing habitat for steelhead (as indexed by  
7 WUA) available under Alternative 3 as compared to the No Action Alternative.

8 *Feather River*

9 Flows in the low flow channel of the Feather River are not anticipated to differ  
10 under Alternative 3 relative to the No Action Alternative. Therefore, there would  
11 be no change in the amount of potentially suitable spawning habitat for steelhead  
12 (as indexed by WUA) available under Alternative 3 as compared to the No Action  
13 Alternative. The majority of spawning activity by steelhead in the Feather River  
14 occurs in this reach with a lesser amount of spawning occurring downstream of  
15 the Thermalito Complex.

16 Modeling results indicate that, in general, there would be similar amounts of  
17 spawning habitat for steelhead in the Feather River below Thermalito available  
18 from December through April under Alternative 3 and the No Action Alternative.

19 *American River*

20 Modeling results indicate that, in general, there would be similar amounts of  
21 spawning habitat for steelhead in the American River downstream of Nimbus  
22 Dam available from December through April under Alternative 3 and the No  
23 Action Alternative.

24 *Summary of Effects on Steelhead*

25 The multiple model and analysis outputs described above characterize the  
26 anticipated conditions for steelhead and their response to change under  
27 Alternative 3 and the No Action Alternative. The analysis of the effects of  
28 Alternative 3 and the No Action Alternative for steelhead relied on the WUA  
29 analysis for habitat and water temperature model output for the rivers at various  
30 locations downstream of the CVP and SWP facilities. The WUA analysis  
31 indicated that the availability of steelhead spawning and rearing habitat in Clear  
32 Creek and steelhead spawning habitat in the Sacramento, Feather and American  
33 rivers would be similar under Alternative 3 and the No Action Alternative. The  
34 temperature model outputs for each of the steelhead life stages suggest that  
35 thermal conditions and effects on steelhead could be slightly less adverse for  
36 some life stages in various rivers under Alternative 3. This conclusion is  
37 supported by the water temperature threshold exceedance analysis that indicated  
38 that the water temperature thresholds for steelhead spawning and egg incubation  
39 would be exceeded less frequently in the Feather River under Alternative 3. The  
40 water temperature threshold for steelhead rearing would also be exceeded less  
41 frequently in the Feather River. However, the water temperature threshold for  
42 steelhead rearing in the American River would be exceeded more frequently  
43 under Alternative 3 than under the No Action Alternative. The reduced frequency  
44 of exceedance of temperature thresholds under Alternative 3 could reduce the  
45 potential for adverse effects on the steelhead population in the Feather River

1 while the increased frequency of exceedance could increase the likelihood of  
2 adverse effects on steelhead rearing in the American River.

3 These model results suggest that overall, effects on steelhead could be slightly  
4 less adverse under Alternative 3 than the No Action Alternative, particularly in  
5 the Feather River. Implementation of the fish passage program under the No  
6 Action Alternative intended to address the limited availability of suitable habitat  
7 for steelhead in the Sacramento and American river could provide a benefit to  
8 Central Valley steelhead in the Sacramento and American rivers. This is  
9 particularly important in light of anticipated increases in water temperature  
10 associated with climate change in 2030. In addition to fish passage, preparation  
11 and implementation of an HGMP for steelhead at the Nimbus Fish Hatchery and  
12 actions under the No Action Alternative intended to increase the efficiency of the  
13 Tracy and Skinner Fish Collection Facilities could benefit steelhead under the No  
14 Action Alternative in comparison to Alternative 3. Thus, on balance and over the  
15 long term, the adverse effects on steelhead under Alternative 3 would be greater  
16 than those under the No Action Alternative.

#### 17 *Green Sturgeon*

18 The effects on Green Sturgeon were analyzed by comparing changes in water  
19 temperature and the frequency of temperature threshold exceedance between  
20 Alternative 3 and the No Action Alternative. In addition, potential effects on  
21 Green Sturgeon during the Delta portion of their life cycle were evaluated based  
22 on changes in Delta outflow. The effects are described and summarized below.

#### 23 *Changes in Water Temperature*

24 Changes in water temperature could affect Green Sturgeon in the Sacramento and  
25 Feather rivers. The following describes temperature conditions in those water  
26 bodies.

#### 27 *Sacramento River*

28 Average monthly water temperature in the Sacramento River at Keswick Dam  
29 under Alternative 3 relative to the No Action Alternative generally would be  
30 similar (less than 0.5°F differences) water temperatures under the No Action  
31 Alternative during most months of the year (Appendix 6B, Table B-5-2). In  
32 September, average water temperatures in wetter years could be increased by up  
33 to 0.8°F and decreased by up to 1.2°F in critical years. A similar temperature  
34 pattern generally would be exhibited downstream at Ball's Ferry, Jelly's Ferry,  
35 Bend Bridge, and Red Bluff, with average monthly temperatures progressively  
36 increasing in the downstream direction (e.g., average difference of about 3°F  
37 between Keswick Dam and Red Bluff). The temperature differences between  
38 Alternative 3 and the No Action Alternative in September of wetter years would  
39 increase to as high as 3.0°F warmer under Alternative 3 at Red Bluff, while the  
40 differences in water temperatures in September associated with Alternative 3  
41 during drier years would remain similar to upstream locations.

42 Overall, the temperature differences between Alternative 3 and the No Action  
43 Alternative would be relatively minor (less than 0.5°F). The similar water  
44 temperatures during most months suggest that temperature-related effects on



1 Green Sturgeon would likely be similar under Alternative 3 and the No Action  
2 Alternative.

3 *Feather River*

4 Average monthly water temperatures in the Feather River at the low flow channel  
5 under the Alternative 3 relative generally would be similar (within 0.5°F) to water  
6 temperatures under the No Action Alternative except in November and December  
7 (differences as much as 1.6°F in December in below normal water years)  
8 (Appendix 6B, Table B-20-2). In September average monthly water temperatures  
9 under Alternative 3 could be somewhat higher (up to about 1.5°F) in wetter years  
10 than under the No Action Alternative. Although temperatures in the river would  
11 become progressively higher in the downstream direction, the differences between  
12 Alternative 3 and the No Action Alternative would exhibit a similar pattern at the  
13 downstream locations (Robinson Riffle and Gridley Bridge), with temperatures  
14 under Alternative 3 and the No Action Alternative generally becoming more  
15 similar at the confluence with the Sacramento River, except in September when  
16 the water temperature under Alternative 3 could be up to 4.4 °F higher than under  
17 the No Action Alternative and in June when temperatures under Alternative 3  
18 could be up to 0.8°F cooler in drier years.

19 Overall, the temperature differences between Alternative 3 and the No Action  
20 Alternative would be relatively minor (less than 0.5°F). The similar water  
21 temperatures during most months suggest that temperature-related effects on  
22 Green Sturgeon would likely be similar under Alternative 3 and the No Action  
23 Alternative. The somewhat higher water temperatures in September under  
24 Alternative 3 could affect spawning by Green Sturgeon in the Feather River.

25 *Changes in Exceedances of Water Temperature Thresholds*

26 Changes in water temperature could result in the exceedance of established water  
27 temperature thresholds for Green Sturgeon in the Sacramento and Feather rivers.  
28 The following describes the extent of those exceedance for each of those rivers.

29 *Sacramento River*

30 Average monthly water temperatures in the Sacramento River at Bend Bridge  
31 under both Alternative 3 and the No Action Alternative would exceed the water  
32 temperature threshold of 63°F established for Green Sturgeon larval rearing in  
33 August and September, with exceedances under Alternative 3 occurring about  
34 6 percent of the time in August relative the No Action Alternative (7 percent), and  
35 about 9 percent of the time in September relative to 12 percent under the No  
36 Action Alternative. Average monthly water temperatures at Bend Bridge could  
37 be as high as about 73°F during this period. Temperature conditions in the  
38 Sacramento River under Alternative 3 could be less likely to affect Green  
39 Sturgeon rearing than under the No Action Alternative because of the reduced  
40 frequency of exceedance of the 63°F threshold in August and September.

1                    *Feather River*

2 Average monthly water temperatures in the Feather River at Gridley Bridge under  
3 both Alternative 3 and the No Action Alternative would exceed the water  
4 temperature threshold of 64°F established for Green Sturgeon spawning,  
5 incubation, and rearing in May, June, and September; no exceedances under either  
6 condition would occur in July and August. The frequency of exceedances would  
7 be high, with both Alternative 3 and the No Action Alternative exceeding the  
8 threshold in June nearly 100 percent of the time. The magnitude of the  
9 exceedance also would be substantial, with average monthly temperatures higher  
10 than 72°F in June, and higher than 75°F in July and August. Water temperatures  
11 under Alternative 3 would exceed the threshold for May about 7 percent less  
12 frequently than the No Action Alternative and about 33 percent more frequently  
13 in September. Temperature conditions in the Feather River under Alternative 3  
14 could be less likely to result in adverse effects on Green Sturgeon rearing than  
15 under the No Action Alternative because of the reduced frequency of exceedance  
16 of the 64°F threshold in May. The increase in exceedance frequency in  
17 September under Alternative 3 may have little effect on rearing Green Sturgeon as  
18 many juvenile sturgeon may have migrated downstream to the lower Sacramento  
19 River and Delta by this time.

20                    *Changes in Delta Outflow*

21 As described in Appendix 9P, mean (March to July) Delta outflow was used an  
22 indicator of potential year class strength and the likelihood of producing a strong  
23 year class of sturgeon. The median value over the 82-year CalSim II modeling  
24 period of mean (March to July) Delta outflow was predicted to be 9 percent lower  
25 under the Alternative 3 than under the No Action Alternative. In addition, the  
26 likelihood of mean (March to July) Delta outflow exceeding the threshold of  
27 50,000 cfs was the same under both alternatives.

28                    *Summary of Effects on Green Sturgeon*

29 The analysis of the effects of Alternative 3 and the No Action Alternative for  
30 Green Sturgeon relied on water temperature model output for the Sacramento and  
31 Feather rivers at various locations downstream of Shasta Dam and the Thermalito  
32 complex. The temperature model outputs for each of these rivers suggest that  
33 thermal conditions and effects on Green Sturgeon in the Sacramento and Feather  
34 rivers generally would be slightly less adverse under Alternative 3. This  
35 conclusion is supported by the water temperature threshold exceedance analysis  
36 that indicated that the water temperature thresholds for Green Sturgeon spawning,  
37 incubation, and rearing would be exceeded less frequently under Alternative 3 in  
38 the Sacramento River. The water temperature threshold for Green Sturgeon  
39 spawning, incubation, and rearing would also be exceeded less frequently during  
40 some months in the Feather River but would be exceeded substantially more  
41 frequently in September under Alternative 3 and could increase the potential for  
42 adverse effects on Green Sturgeon in the Sacramento and Feather rivers relative to  
43 the No Action Alternative. The analysis based on Delta outflows suggests that  
44 Alternative 3 provides lower mean (March to July) outflows which could result in  
45 weaker year classes of juvenile Green Sturgeon relative to the No Action

1 Alternative. In addition, actions under the No Action Alternative intended to  
2 increase the efficiency of the Tracy and Skinner Fish Collection Facilities could  
3 improve the overall salvage survival of green sturgeon. However, early life stage  
4 survival in the natal rivers is crucial in development of a strong year class.  
5 Therefore, based primarily on the analysis of water temperatures, Alternative 3  
6 could be less likely to result in adverse effects on Green Sturgeon than the No  
7 Action Alternative.

8 *White Sturgeon*

9 Changes in water temperature conditions in the Sacramento and Feather rivers  
10 would be the same as those described above for Green Sturgeon. Overall, the  
11 temperature differences between Alternative 3 and the No Action  
12 Alternative would be relatively minor (less than 0.5°F) and likely would have  
13 little effect on White Sturgeon in the Sacramento and Feather rivers.

14 The water temperature threshold established for White Sturgeon spawning and  
15 egg incubation in the Sacramento River at Hamilton City is 61°F during March  
16 through June. Both Alternative 3 and the No Action Alternative would exceed  
17 this threshold in May and June. The average monthly water temperatures in May  
18 under Alternative 3 would exceed this threshold about 49 percent of the time  
19 (about 6 percent less frequently than the No Action Alternative). In June, the  
20 temperature under Alternative 3 would exceed the threshold about 74 percent of  
21 the time (about 13 percent less frequently than the No Action Alternative).  
22 Average monthly water temperatures during May and June under Alternative 3  
23 would as high as about 65°F, which is below the 68°F threshold considered lethal  
24 for White Sturgeon eggs. Temperature conditions in the Sacramento River under  
25 Alternative 3 could be less likely to result in adverse effects on White Sturgeon  
26 rearing than under the No Action Alternative because of the reduced frequency of  
27 exceedance of the 61°F threshold in May and June.

28 The analysis of the effects of Alternative 3 and the No Action Alternative for  
29 White Sturgeon relied on water temperature model output for the Sacramento  
30 River at various locations downstream of Shasta Dam. The temperature model  
31 outputs suggest that thermal conditions and effects on White Sturgeon in the  
32 Sacramento River generally would be less adverse under Alternative 3. This  
33 conclusion is supported by the water temperature threshold exceedance analysis  
34 that indicated that the water temperature thresholds for White Sturgeon spawning,  
35 incubation, and rearing would be exceeded less frequently under Alternative 3 in  
36 the Sacramento River. The reduced frequency of exceedance of water  
37 temperature thresholds under Alternative 3 could reduce the potential for adverse  
38 effects on White Sturgeon in the Sacramento River relative to the No Action  
39 Alternative.

40 Changes in Delta outflows would be the same as those described above for Green  
41 Sturgeon. Mean (March to July) Delta outflow was predicted to be 9 percent  
42 lower under Alternative 3 than under the No Action Alternative. In addition, the  
43 likelihood of mean (March to July) Delta outflow exceeding the threshold of  
44 50,000 cfs was the same under both alternatives.

1 Overall, the temperature model outputs suggest that thermal conditions and  
2 effects on White Sturgeon in the Sacramento River generally would be slightly  
3 less adverse under Alternative 3. The analysis based on Delta outflows suggests  
4 that Alternative 3 provides lower mean (March to July) outflows which could  
5 result in weaker year classes of juvenile Green Sturgeon relative to the No Action  
6 Alternative. However, early life stage survival in the natal rivers is crucial in  
7 development of a strong year class. Therefore, based primarily on the analysis of  
8 water temperatures, Alternative 3 could be less likely to result in adverse effects  
9 on White Sturgeon than the No Action Alternative.

#### 10 *Delta Smelt*

11 As described in Appendix 9G, a proportional entrainment regression model  
12 (based on Kimmerer 2008, 2011) was used to simulate adult Delta Smelt  
13 entrainment, as influenced by OMR flow in December through March. Results  
14 indicate that the percentage of entrainment of migrating and spawning adult Delta  
15 Smelt under Alternative 3 would be 7.3 to 8.5 percent, depending on the water  
16 year type, with a long term average percent entrainment of 7.9 percent. Percent  
17 entrainment of adult Delta Smelt under Alternative 3 would be similar to results  
18 under the No Action Alternative.

19 As described in Appendix 9G, a proportional entrainment regression model  
20 (based on Kimmerer 2008) was used to simulate larval and early juvenile Delta  
21 Smelt entrainment, as influenced by OMR flow and location of X2 in March  
22 through June. Results indicate that the percentage of entrainment of larval and  
23 early juvenile Delta Smelt under Alternative 3 would be 5.6 to 20.5 percent,  
24 depending on the water year type, with a long term average percent entrainment  
25 of 12.7 percent, and highest entrainment under Critical water year conditions.  
26 Percent entrainment of larval and early juvenile Delta Smelt under Alternative 3  
27 would be similar to results under the No Action Alternative, except in above- and  
28 below-normal years when entrainment would be higher under Alternative 3 by  
29 5 to 6 percent.

30 The average September through December X2 position in km was used to  
31 evaluate the fall abiotic habitat availability for Delta Smelt under the Alternatives.  
32 X2 values simulated in the CalSim II model for each alternative were averaged  
33 over September through December, and compared. Results indicate that under  
34 the No Action Alternative, the X2 position would range from 75.9 km to 92.4 km,  
35 depending on the water year type, with a long term average X2 position of 84 km.  
36 The most eastward location of X2 is predicted under Critical water year  
37 conditions. The X2 positions predicted under Alternative 3 would be similar to  
38 results under the No Action Alternative in drier water year types. In wetter years,  
39 the X2 location would be further east under Alternative 3 than under the No  
40 Action Alternative, by 6.0 to 9.7 km. This difference is largely due to  
41 implementation of 2008 USFWS BO RPA Component 3 (Action 4), under the No  
42 Action Alternative, which requires Reclamation and DWR to provide sufficient  
43 Delta outflow to maintain a monthly average X2 no more eastward than 74 km in  
44 Above Normal and Wet years. Under Alternative 3, the long term average X2

1 position would be 88.1 km, a location that does not provide for the advantageous  
2 overlap of the low salinity zone with Suisun Bay/Marsh.

3 Overall, Alternative 3 likely would have adverse effects on Delta Smelt, as  
4 compared to the No Action Alternative, primarily due to increased percentage  
5 entrainment during larval and juvenile life stages, and less favorable location of  
6 Fall X2 in wetter years, and on average. Given the current condition of the Delta  
7 Smelt population, even small differences between alternatives may be important.

8 *Longfin Smelt*

9 The effects of the Alternative 3 as compared to the No Action Alternative were  
10 analyzed based on the direction and magnitude of OMR flows during the period  
11 (December through June) when adult, larvae, and young juvenile Longfin Smelt  
12 are present in the Delta in the vicinity of the export facilities (Appendix 5A). The  
13 analysis was augmented with calculated Longfin Smelt abundance index values  
14 (Appendix 9G) per Kimmerer et al. (2009), which is based on the assumptions  
15 that lower X2 values reflect higher flows and that transporting Longfin Smelt  
16 farther downstream leads to greater Longfin Smelt survival. The index value  
17 indicates the relative abundance of Longfin Smelt and not the calculated  
18 population.

19 As described in Appendix 5A, OMR flows would generally be negative in all  
20 months, except April and May where OMR flows would be positive, under the No  
21 Action Alternative and the long-term average negative flow ranges from -2,700 to  
22 -6,200 cfs from December through June. Because there would be no restrictions  
23 on export pumping from December 1 to June 15 due to OMR flow criteria under  
24 Alternative 3, OMR flows would generally be more negative during this time  
25 period under Alternative 3 as compared to the No Action Alternative. The  
26 greatest differences between alternatives would be in April and May, where long-  
27 term average OMR flows would be negative under Alternative 3 instead of  
28 positive as under the No Action Alternative. The increase in the magnitude of  
29 negative flows, particularly the negative flows in April and May, under  
30 Alternative 3 as compared to the No Action Alternative could increase the  
31 potential for entrainment of Longfin Smelt at the export facilities.

32 Under Alternative 3, Longfin Smelt abundance index values range from  
33 1,147 under critical water year conditions to a high of 16,635 under wet water  
34 year conditions, with a long-term average value of 7951 (Appendix 9G). Under  
35 the No Action Alternative, Longfin Smelt abundance index values range from  
36 947 under critical water year conditions to a high of 15,822 under wet water year  
37 conditions, with a long-term average value of 7,257.

38 Results indicate that the Longfin Smelt abundance index values would be lower in  
39 every water year type under Alternative 3 than under the No Action Alternative,  
40 with a long-term average index for Alternative 3 that is 7.6 percent lower than the  
41 long-term average index under the No Action Alternative. The greatest decrease  
42 in the Longfin Smelt abundance index occurs in above normal years where the  
43 index value is 12.3 percent less under Alternative 3 than under the No Action  
44 Alternative. For below normal, dry, and critical water years, the Longfin Smelt

1 abundance index values would be 4.6 to 9.9 percent lower under Alternative 3  
2 than under the No Action Alternative.

3 Overall, based on the increase in frequency and magnitude of negative OMR  
4 flows and the lower Longfin Smelt abundance index values, potential adverse  
5 effects on the Longfin Smelt population under Alternative 3 likely would be  
6 greater than under the No Action Alternative. Given the current condition of the  
7 Longfin Smelt population, even small differences between alternatives may be  
8 important.

#### 9 *Sacramento Splittail*

10 Under Alternative 3, flows entering the Yolo Bypass generally would be  
11 somewhat higher than under the No Action Alternative from December through  
12 March, especially during wetter years (Appendix 5A, Table C-26-2), providing  
13 similar value to Sacramento Splittail because of the similar area of potential  
14 habitat (inundation). Given the relatively minor changes in flows into the Yolo  
15 Bypass, and the inherent uncertainty associated with the resolution of the  
16 CalSim II model (average monthly outputs), it is concluded that there would be no  
17 definitive difference in effects on Sacramento Splittail between Alternative 3 and  
18 the No Action Alternative.

#### 19 *Reservoir Fishes*

20 The analysis of effects associated with changes in operation on reservoir fishes  
21 relied on evaluation of changes in available habitat (reservoir storage) and  
22 anticipated changes in black bass nesting success.

23 Changes in CVP and SWP water supplies and operations under Alternative 3 as  
24 compared to the No Action Alternative generally would result in higher reservoir  
25 storage in CVP and SWP reservoirs in the Central Valley Region. Storage levels  
26 in Shasta Lake, Lake Oroville, and Folsom Lake would be higher under  
27 Alternative 3 as compared to the No Action Alternative (Appendix 9F).

28 The greatest increases in Shasta Lake storage could be as high as 15 percent.  
29 Storage in Lake Oroville could be increased by up to 30 percent in some months  
30 under Alternative 3 as compared to the No Action Alternative. Storage in Folsom  
31 Lake could be increased up to around 20 percent in some months of some water  
32 year types and could be reduced by up to 10 percent in July, August, and  
33 September. Additional information related to monthly reservoir elevations is  
34 provided in Appendix 5A, CalSim II and DSM2 Modeling. Although aquatic  
35 habitat within the CVP and SWP water supply reservoirs is not limiting, storage  
36 volume, as an indicator of how much habitat is available to fish species inhabiting  
37 these reservoirs, suggests that the amount of habitat for reservoir fishes could be  
38 higher under Alternative 3 as compared to the No Action Alternative.

39 Results of the bass nesting success analysis are presented in Appendix 9F,  
40 Reservoir Fish Analysis Documentation. Black bass nest survival in CVP and  
41 SWP reservoirs is anticipated to be near 100 percent in March and April due to  
42 increasing reservoir elevations. For May, the likelihood of nest survival for  
43 Largemouth and Smallmouth Bass in Shasta Lake being in the 40 to 100 percent

1 range is similar under Alternative 3 and the No Action Alternative. For June, the  
2 likelihood of nest survival being greater than 40 percent for Largemouth and  
3 Smallmouth Bass is the same under Alternative 3 and the No Action Alternative;  
4 however, nest survival of greater than 40 percent is likely only in about 20 percent  
5 of the years evaluated. For Spotted Bass, the likelihood of nest survival being  
6 greater than 40 percent is high (nearly 100 percent) in May under both  
7 Alternative 3 and the No Action Alternative. For June, Spotted Bass nest survival  
8 would be less than for May due to greater daily reductions in water surface  
9 elevation as Shasta Lake is drawn down. The likelihood of survival being greater  
10 than 40 percent is about 10 percent less under Alternative 3 as compared to the  
11 No Action Alternative.

12 For May and June, the likelihood of nest survival for Largemouth Bass in Lake  
13 Oroville being in the 40 to 100 percent range is somewhat (4 to 10 percent) lower  
14 under Alternative 3 as compared to the No Action Alternative. However, June  
15 nest survival of greater than 40 percent is likely only in about 30 percent of the  
16 years evaluated under Alternative 3. The likelihood of nest survival for  
17 Smallmouth Bass in Lake Oroville exhibits nearly the same pattern. For Spotted  
18 Bass, the likelihood of nest survival being greater than 40 percent is high (over  
19 90 percent) in May under both Alternative 3 and the No Action Alternative with  
20 the likelihood of greater than 40 percent survival being similar under  
21 Alternative 3 as compared to the No Action Alternative. For June, Spotted Bass  
22 survival would be less than for May due to greater daily reductions in water  
23 surface elevation as Lake Oroville is drawn down. The likelihood of survival  
24 being greater than 40 percent is substantially lower (nearly 20 percent) under  
25 Alternative 3 as compared to the No Action Alternative.

26 Black bass nest survival in Folsom Lake is anticipated to be near 100 percent in  
27 March, April, and May due to increasing reservoir elevations. For June, the  
28 likelihood of nest survival for Largemouth Bass and Smallmouth Bass in Folsom  
29 Lake being in the 40 to 100 percent range would be about 5 percent lower under  
30 Alternative 3 than the No Action Alternative. For Spotted Bass, nest survival for  
31 June would be less than for May due to greater daily reductions in water surface  
32 elevation. However, the likelihood of survival being greater than 40 percent is  
33 around 7 percent lower under Alternative 3 as compared to the No Action  
34 Alternative. Most black bass spawning likely occurs prior to June, such that  
35 drawdowns during June would likely affect only a small proportion of the  
36 spawning population. Thus, it is concluded that effects on black bass nesting  
37 success would be similar under Alternative 3 and the No Action Alternative.

#### 38 *Summary of Effects on Reservoir Fishes*

39 The analysis of the effects of Alternative 3 and the No Action Alternative for  
40 reservoir fish relied on CalSim II output for reservoir storage levels and water  
41 surface elevation changes as described in Appendix 9F. As described above,  
42 reservoir storage is anticipated to be increased under Alternative 3 relative to the  
43 No Action Alternative and this increase could affect the amount of warm and cold  
44 water habitat available within the reservoirs. However, it is unlikely that aquatic  
45 habitat within the CVP and SWP water supply reservoirs is limiting.

1 The analysis of black bass nest survival based on changes in water surface  
2 elevation during the spawning period indicated that the likelihood of high  
3 (>40 percent) nest survival in most of the reservoirs would be similar in March,  
4 April, and May under Alternative 3 and the No Action Alternative, but somewhat  
5 lower in June. Most black bass spawning likely occurs prior to June, such that  
6 drawdowns during June would likely affect only a small proportion of the  
7 spawning population. Overall, the results of the habitat and nest survival analysis  
8 suggest that conditions in the reservoirs likely to support self-sustaining  
9 populations of black bass would be similar under Alternative 3 and the No Action  
10 Alternative.

#### 11 *Other Species*

12 Several other fish species could be affected by changes in operations that  
13 influence temperature and flow. The following describes the extent of these  
14 changes and the potential effects on these species.

#### 15 *Pacific Lamprey*

16 Little information is available on factors that influence populations of Pacific  
17 Lamprey in the Sacramento River, but they are likely affected by many of the  
18 same factors as salmon and steelhead because of the parallels in their life cycles.

19 Pacific Lamprey would be subjected to the same temperature conditions described  
20 above for salmonids. Average monthly water temperatures under Alternative 3  
21 and the No Action Alternative would generally be similar. Pacific Lamprey can  
22 tolerate higher temperatures than salmonids, up to around 72°F during their entire  
23 life history. Given the somewhat increased flows and similar temperatures under  
24 Alternative 3 and the No Action Alternative from January through the summer,  
25 there would be little difference in potential effects on Pacific Lamprey in the  
26 Sacramento, Feather, and American rivers under Alternative 3 and the No Action  
27 Alternative. This conclusion likely applies to other species of lamprey that  
28 inhabit these rivers (e.g., River Lamprey).

#### 29 *Striped Bass, American Shad, and Hardhead*

30 Average monthly water temperatures under Alternative 3 and the No Action  
31 Alternative would generally be similar. Striped Bass, American Shad, and  
32 Hardhead can generally tolerate higher temperatures than salmonids. Based on  
33 the similar water temperatures during their spawning and incubation period under  
34 Alternative 3, it is likely that thermal conditions for and effects on Striped Bass,  
35 American Shad, and Hardhead in the Sacramento, Feather, and American rivers  
36 would be similar under Alternative 1 and the No Action Alternative.

37 Alternative 3 would result in a more eastward X2 position as compared to the No  
38 Action Alternative during April and May, with similar values in June  
39 (Appendix 5A, Section C Table C-16-2). Based on Kimmerer (2002) and  
40 Kimmerer et al. (2009), this change in X2 would likely reduce the survival index  
41 and the habitat index as measured by salinity for Striped Bass and abundance and  
42 habitat index for American Shad. In addition, the increased bag limits and ability  
43 of anglers to retain Striped Bass that are 12 inches in length versus 18 inches



1 under Alternative 3 could reduce the ability to meet the doubling goals for Striped  
2 Bass populations under the requirements of Section 3406(b)(1) of CVPIA.

3 Overall, Alternative 3 likely would have similar effects on Hardhead, but slightly  
4 greater potential for adverse effects on Striped Bass and American Shad as  
5 compared to the No Action Alternative, primarily due to the potential for reduced  
6 survival during larval and juvenile life stages, and less favorable location of  
7 Spring X2 on average.

8 *Stanislaus River/Lower San Joaquin River*

9 *Fall-Run Chinook Salmon*

10 Changes in operations influence temperature and flow conditions that could affect  
11 fall-run Chinook Salmon in the Stanislaus River downstream of Goodwin Dam  
12 and in the San Joaquin River below Vernalis. The following describes those  
13 changes and their potential effects.

14 *Changes in Water Temperature (Stanislaus River)*

15 Average monthly water temperatures in the Stanislaus River at Goodwin Dam  
16 under Alternative 3 and the No Action Alternative generally would be similar  
17 (differences less than 0.5°F), except from May through October of drier years  
18 when average monthly water temperatures could be up to 2.9°F cooler  
19 (September) under Alternative 3 as compared to the No Action  
20 Alternative (Appendix 6B, Table B-17-2).

21 Downstream at Orange Blossom Bridge, average monthly water temperatures  
22 would be similar (less than 0.5°F differences) under Alternative 3 and the No  
23 Action Alternative, except in October when water temperatures under  
24 Alternative 3 could be higher than water temperatures under the No Action  
25 Alternative by up to 1.5°F in some water year types. Water temperatures in June  
26 under Alternative 3 would be substantially higher (2.3°F on average) and up to  
27 3.7°F warmer in wetter years. In September of drier years, water temperatures  
28 under Alternative 3 could be cooler (by up to 2.1°F in critical years) than under  
29 the No Action Alternative (Appendix 6B, Table B-18-2).

30 This temperature pattern would continue downstream to the confluence with the  
31 San Joaquin River, although temperatures and magnitude of temperature  
32 differences under Alternative 3 compared to the No Action Alternative would  
33 progressively increase in a downstream direction except for in September when  
34 temperature differences would diminish at this location (Appendix 6B,  
35 Table B-19-2).

36 Overall, the temperature differences between Alternative 3 and the No Action  
37 Alternative would be relatively minor (less than 0.5°F) and likely would have  
38 little effect on fall-run Chinook Salmon in the Stanislaus River. Based on the life  
39 history timing for fall-run Chinook Salmon, the lower water temperatures in  
40 September and October below Goodwin Dam under Alternative 3 likely would  
41 have little effect on fall-run Chinook Salmon spawning as the majority of  
42 spawning occurs later, in November. The higher water temperatures in June at  
43 Orange Blossom Bridge and the mouth under Alternative 3 may increase the

1 likelihood of adverse effects on fall-run Chinook Salmon rearing in the Stanislaus  
2 River, if they are present, as compared to the No action Alternative.

3 *Changes in Exceedance of Water Temperature Thresholds*  
4 *(Stanislaus River)*

5 While specific water temperature thresholds for fall-run Chinook Salmon in the  
6 Stanislaus River are not established, temperatures generally suitable for fall-run  
7 Chinook Salmon spawning (56°F) would be exceeded in October (over 30 percent  
8 of the time) and November over 20 percent of the time in the Stanislaus River at  
9 Goodwin Dam under Alternative 3 (Appendix 6B, Table B-17-2). Similar  
10 exceedances would occur under the No Action Alternative, although average  
11 monthly water temperatures under Alternative 3 would remain lower than under  
12 the No Action Alternative during the periods when the threshold is exceeded.  
13 Water temperatures under Alternative 3 also would exceed the threshold about  
14 5 percent less frequently in November than under the No Action Alternative.  
15 Water temperatures for rearing generally would be below 56°F, except in May  
16 and June when average monthly water temperatures would reach about 60°F  
17 under the No Action Alternative (Appendix 6B, Figures B-17-8 and B-17-9).

18 Downstream at Orange Blossom Bridge, water temperatures suitable for fall-run  
19 Chinook Salmon spawning would be exceeded frequently under both  
20 Alternative 3 and the No Action Alternative during October and November.  
21 Under Alternative 3, average monthly water temperatures would exceed 56°F  
22 about 87 percent of the time in October. This would be about 31 percent more  
23 frequently than under the No Action Alternative. In November, average monthly  
24 water temperatures would exceed 56°F about 24 percent of the time under  
25 Alternative 3, which would be about 9 percent less frequent than under the No  
26 Action Alternative (Appendix 6B, Figure B-18-1 and B-18-2).

27 During January through May, rearing fall-run Chinook Salmon under  
28 Alternative 3 would occasionally encounter average monthly water temperatures  
29 that exceed 56°F at Orange Blossom Bridge under both Alternative 3 and the No  
30 Action Alternative (Appendix 6B, Table B-18-2).

31 *Changes in Egg Mortality (Stanislaus River)*

32 For fall-run Chinook Salmon in the Stanislaus River, the long-term average egg  
33 mortality rate is predicted to be around 6 percent, with higher mortality rates (in  
34 excess of 13 percent) occurring in critical dry years under Alternative 3. Overall,  
35 egg mortality would be similar under Alternative 3 and the No Action  
36 Alternative in all water year types (Appendix 9C, Table B-1).

37 *Changes in Delta Hydrodynamics*

38 San Joaquin River-origin Chinook Salmon smolts are most abundant in the Delta  
39 from April through June. Near the confluence of the San Joaquin River and the  
40 Mokelumne River, the median proportion of positive velocities would be slightly  
41 lower under Alternative 3 relative to the No Action Alternative in April and May,  
42 and similar in June (Appendix 9K). On Old River downstream of the facilities,  
43 the median proportion of positive velocities would be substantially lower in April

1 and May under Alternative 3 relative to the No Action Alternative, but would be  
2 only moderately lower in June. In Old River upstream of the facilities, the  
3 median proportion of positive velocities would be similar for Alternative 3  
4 relative to the No Action Alternative in June. In April and May, values for  
5 Alternative 3 would be slightly higher under Alternative 3 relative to the No  
6 Action Alternative. On the San Joaquin River downstream of the Head of Old  
7 River, the median proportion of positive velocities would be similar under  
8 Alternative 3 relative to the No action Alternative in April, May and June.

9 *Changes in Junction Entrainment*

10 At the Head of Old River junction, entrainment under Alternative 3 would be  
11 slightly higher in April, May, and June (Appendix 9L). Median entrainment into  
12 Turner Cut would be slightly greater under Alternative 3 during April and May,  
13 and similar in June. At the Columbia Cut junction, entrainment would be  
14 moderately higher under Alternative 3 during April and May, whereas  
15 entrainment would be slightly higher in June. Entrainment probabilities at the  
16 Middle River junction from April through June would be moderately greater  
17 under Alternative 3 relative to the No action Alternative. A similar pattern would  
18 be observed at the Old River junction.

19 *Changes in Juvenile Salmonid Passage through the Delta (Trap and Haul)*

20 Poor survival of juvenile salmonids in the Sacramento-San Joaquin Delta has  
21 been hypothesized as a major contributor to declines in the number of returning  
22 adults and may be a significant impediment to the recovery of threatened or  
23 endangered populations (NOAA 2009). Under Alternative 3, fish would be  
24 trapped in the San Joaquin River between the mouth of the Stanislaus River and  
25 the Head of Old River to capture juveniles migrating from natal rearing habitat in  
26 the San Joaquin River, Merced River, Tuolumne River and Stanislaus River.  
27 Captured fish would be transported by barge through the Delta and released at  
28 locations within San Francisco Bay. Although trucks are currently used to  
29 transport hatchery reared salmonids and salvaged fishes (including salmonids),  
30 barging results in greater survival benefits (Ward et al. 1997) and may reduce  
31 straying of returning adults.

32 In response to low survival in the Columbia River hydro system, a transportation  
33 program was initiated where migrating salmonids (Chinook salmon and  
34 steelhead) are captured at dams and transported by barge to the lowest dam in the  
35 system before being released (Williams et al. 2004). The effectiveness of the  
36 Columbia River transportation program has been questioned because although  
37 survival of transported Chinook ( $\approx 98$  percent; McMichael et al. 2011) is greater  
38 than in-river migrants ( $\approx 50$  percent; Faulkner et al. 2010), SAR rates have not  
39 been proportional to the increase in hydro system survival. The most recent  
40 evidence suggests that that differences in ocean entry timing that occur due to the  
41 rapid rate of barge transport and the long distances transported are likely  
42 responsible for the lower post-hydro system survival of transported fish (Muir  
43 et al 2006; Rechisky et al 2012). To assess the potential benefits and risks of a  
44 transportation program for salmonids in the San Joaquin River, an analysis of  
45 CWT recovery rates for Chinook Salmon reared at the Feather River Hatchery

1 and the Mokelumne River Hatchery was performed (Appendix 9O). Based on  
 2 this analysis, Alternative 3 is expected to improve the survival of juvenile fall-run  
 3 Chinook Salmon and steelhead smolts originating from the San Joaquin River  
 4 basin in comparison to the No Action Alternative. Previous work on the  
 5 Columbia River suggests that benefits may be greater than demonstrated in  
 6 Appendix 9O if juveniles were transported by barge instead of truck (Ward et al.  
 7 1997). The program would also improve the survival of spring-run Chinook  
 8 Salmon if these fish become established as part of the San Joaquin River  
 9 Restoration Program, or as part of the New Melones fish passage project. As  
 10 indicated in Chapter 3, Description of Alternatives, this action will include  
 11 measures to quantify the benefit.

12 While a trap and haul program may increase survival, it also may result in  
 13 unintended consequences or population impacts. For example, a study of  
 14 returning adult Chinook Salmon and steelhead on the Columbia River following  
 15 transport as juveniles found that the proportion of adults successfully homing was  
 16 significantly lower and that the unaccounted loss and permanent straying into  
 17 non-natal rivers was higher for barged fish of both species (Keefer et al. 2008).  
 18 Increased straying could have consequences for populations in their natal streams,  
 19 but also could adversely influence populations in other streams if those fish breed  
 20 with other wild populations. The conditions and transport distances in the Delta  
 21 differ from those studied on the Columbia River system, thus the overall influence  
 22 on straying is uncertain.

23 However, as indicated in Appendix 9O, straying rates of transported fish are  
 24 anticipated to be greater than fish allowed to migrate within the river system. An  
 25 important consideration for this analysis of straying is that all releases into the bay  
 26 were transported by truck to bypass the Delta. Barge transport where water is  
 27 recirculated may reduce straying by allowing fish to “sample” water along the  
 28 migration route. Additionally, the location of collection on the San Joaquin River  
 29 would be downstream of natal rearing locations allowing fish to experience  
 30 portions of the migration route during rearing. In addition, trapping and hauling  
 31 is inconsistent with CDFW’s goal of achieving volitional fish passage.

32 *Summary of Effects on Fall-Run Chinook Salmon*

33 The analysis of temperatures indicates lower temperatures and a lesser likelihood  
 34 of exceedance of suitable temperatures for spawning and rearing of fall-run  
 35 Chinook Salmon under Alternative 3 as compared to the No Action Alternative in  
 36 the Stanislaus River downstream of Goodwin Dam and in the San Joaquin River  
 37 at Vernalis. The effect of lower temperatures is not reflected in the overall  
 38 mortality of fall-run Chinook Salmon eggs predicted by Reclamation’s salmon  
 39 mortality model for fall-run in the Stanislaus River.

40 Implementation of a fish passage project under the No Action Alternative,  
 41 although intended to address the limited availability of suitable habitat for spring-  
 42 run Chinook Salmon and steelhead in the Stanislaus River reaches downstream of  
 43 Goodwin Dam, likely would provide some benefit to fall-run Chinook Salmon if  
 44 passage for fall-run Chinook Salmon was provided and additional habitat could be  
 45 accessed. Any potential benefit to fall-run Chinook Salmon under the No Action

1 Alternative relative to Alternative 3 is uncertain. The potential benefits of actions  
2 under the No Action Alternative intended to increase the efficiency of the Tracy  
3 and Skinner Fish Collection Facilities could improve the overall salvage survival  
4 of fall-run Chinook Salmon relative to Alternative 3.

5 Overall, Alternative 3 likely would have similar effects on the fall-run Chinook  
6 Salmon population in the San Joaquin River watershed as compared to the No  
7 Action Alternative. Alternative 3 could also provide beneficial effects to juvenile  
8 fall-run Chinook Salmon as a result of trap and haul passage through the Delta  
9 and ocean harvest restrictions. It remains uncertain, however, if predator  
10 management actions under Alternative 3 and fish passage under the No Action  
11 Alternative would benefit fall-run Chinook Salmon.

#### 12 *Steelhead*

13 Changes in operations that influence temperature and flow conditions in the  
14 Stanislaus River downstream of Goodwin Dam and the San Joaquin River  
15 downstream of the Stanislaus River confluence, as measured at Vernalis could  
16 affect steelhead. The following describes those changes and their potential  
17 effects.

#### 18 *Changes in Water Temperature (Stanislaus River)*

19 Average monthly water temperatures in the Stanislaus River at Goodwin Dam  
20 under Alternative 3 and the No Action Alternative generally would be similar  
21 (differences less than 0.5°F), except from May through October of drier years  
22 when average monthly water temperatures could be up to 2.9°F cooler  
23 (September) under Alternative 3 than under the No Action Alternative.

24 Downstream at Orange Blossom Bridge, average monthly water temperatures  
25 would be similar (less than 0.5°F differences) under Alternative 3 and the No  
26 Action Alternative, except in October when water temperatures under  
27 Alternative 3 could be higher than water temperatures under the No Action  
28 Alternative by up to 1.5°F in some water year types. Water temperatures in June  
29 under Alternative 3 would be substantially higher (2.3°F on average) and up to  
30 3.7°F warmer in wetter years. In September of drier years, water temperatures  
31 under Alternative 3 could be cooler (by up to 2.1°F in critical years) than under  
32 the No Action Alternative.

33 This temperature pattern would continue downstream to the confluence with the  
34 San Joaquin River, although temperatures and magnitude of temperature  
35 differences under Alternative 3 compared to the No Action Alternative would  
36 progressively increase in a downstream direction except for in September when  
37 temperature differences would diminish at this location (Appendix 6B,  
38 Table B-19-2).

39 Overall, the temperature differences between Alternative 3 and the No Action  
40 Alternative would be relatively minor (less than 0.5°F) and likely would have  
41 little effect on steelhead in the Stanislaus River. The higher water temperatures in  
42 June at Orange Blossom Bridge and the mouth under Alternative 3 may increase  
43 the likelihood of adverse effects on steelhead rearing in the Stanislaus River as

1 compared to the No action Alternative. The lower water temperatures in  
 2 September of drier years under Alternative 3 may decrease the likelihood of  
 3 adverse effects to steelhead rearing in the Stanislaus River during this month.

4 *Changes in Exceedance of Water Temperature Thresholds*  
 5 *(Stanislaus River)*

6 Average monthly water temperatures in the Stanislaus River at Orange Blossom  
 7 Bridge would frequently exceed the temperature threshold (56°F) established for  
 8 adult steelhead migration under both Alternative 3 and the No Action  
 9 Alternative during October and November. Under Alternative 3, average monthly  
 10 water temperatures would exceed 56°F about 87 percent of the time in October  
 11 and about 57 percent of the time under the No Action Alternative. In November,  
 12 average monthly water temperatures would exceed 56°F about 24 percent of the  
 13 time under Alternative 3, which would be about 9 percent less frequent than under  
 14 the No Action Alternative.

15 From January through May, the temperature threshold at Orange Blossom Bridge  
 16 is 55°F, which is intended to support steelhead spawning. This threshold could be  
 17 exceeded about 1 percent of the time under Alternative 3 in February. In March  
 18 through May, exceedances would occur under both alternatives in each month,  
 19 with the threshold most frequently exceeded (nearly half the time) in May.  
 20 Compared to the No Action Alternative, water temperatures under Alternative 3  
 21 would exceed the threshold 3 percent more frequently in March, 1 percent more  
 22 frequently in April, and 4 percent more frequently in May. From June through  
 23 November, the temperature threshold of 65°F established to support steelhead  
 24 rearing would be exceeded by both Alternative 3 and No Action Alternative in all  
 25 months but November, with the highest frequency of exceedance in July  
 26 (19 percent under Alternative 3). The differences between Alternative 3 and No  
 27 Action Alternative, however, would be variable depending on the month, with  
 28 Alternative 3 exceeding the threshold up to about 6 percent less frequently than  
 29 under the No Action Alternative in June and from August through October.  
 30 Under Alternative 3, water temperatures would exceed the rearing temperature  
 31 threshold up to 4 percent more frequently in April, May, and July.

32 Average monthly water temperatures also would exceed the threshold (52°F)  
 33 established for smoltification at Knights Ferry. At Goodwin Dam, about 4 miles  
 34 upstream of Knights Ferry, average monthly water temperatures under  
 35 Alternative 3 would exceed 52°F in March, April, and May about 12 percent,  
 36 30 percent, and 63 percent of the time, respectively and 2 percent of the time in  
 37 January and February. By comparison to the No Action Alternative, Alternative 3  
 38 would result in exceedances occurring about 2 to 4 percent more frequently  
 39 during the January through March period. Farther downstream at Orange  
 40 Blossom Bridge, the temperature threshold for smoltification is higher (57°F) and  
 41 would be exceeded less frequently. The magnitude of the exceedance also would  
 42 be less. Average monthly water temperatures under Alternative 3 and the No  
 43 Action Alternative would not exceed the threshold during January through March.  
 44 In April and May, exceedances of 3 percent and 17 percent would occur under

1 Alternative 3, which would be nearly the same as under the No Action  
2 Alternative.

3 Overall, the differences in exceedance frequency between Alternative 3 and the  
4 No Action Alternative would be relatively small, with the exception of substantial  
5 differences in the frequency of exceedances in October when the average monthly  
6 water temperatures under Alternative 3 would exceed the threshold for adult  
7 steelhead migration about 28 percent less frequently and in April during the  
8 spawning period when the frequency would be about 17 percent less. Given the  
9 frequency of exceedance under both Alternative 3 and the No Action  
10 Alternative and the generally stressful temperature conditions in the river, the  
11 substantial differences (improvements) in October and April under Alternative 3  
12 suggest that there would be less potential to result in adverse effects on steelhead  
13 under Alternative 3 than under the No Action Alternative. Even during months  
14 when the differences would be relatively small, the lower frequency of  
15 exceedances under Alternative 3 suggest that there would be less potential to  
16 result in adverse effects on steelhead under Alternative 3 than under the No  
17 Action Alternative.

18 *Changes in Delta Hydrodynamics*

19 San Joaquin River-origin steelhead generally move through the Delta during  
20 spring; however, there is less information on their timing relative to Chinook  
21 Salmon. Thus, hydrodynamics in the entire January through June period have the  
22 potential to affect juvenile steelhead. For a description of potential hydrodynamic  
23 effects on steelhead, see the descriptions for winter-run Chinook Salmon in the  
24 Sacramento Basin and fall-run Chinook Salmon in the San Joaquin River basin  
25 above.

26 *Summary of Effects on Steelhead*

27 Given the frequency of exceedance under both Alternative 3 and the No Action  
28 Alternative, water temperature conditions for steelhead in the Stanislaus River  
29 would be generally stressful in the fall, late spring, and summer months. The  
30 differences in temperature exceedance (both positive and negative) between  
31 Alternative 3 and the No Action Alternative would be relatively small, with no  
32 clear benefit associated with either alternative. However, because Alternative 3  
33 generally would exceed thresholds less frequently during the warmest months, it  
34 may have slightly less impact than the No Action Alternative. Alternative 3 also  
35 could provide additional beneficial effects to juvenile steelhead as a result of trap  
36 and haul passage through the Delta. It remains uncertain, however, if predator  
37 management actions under Alternative 3 would benefit steelhead.

38 Implementation of the fish passage program under the No Action  
39 Alternative intended to address the limited availability of suitable habitat for  
40 steelhead in the Stanislaus River reaches downstream of Goodwin Dam could  
41 provide a benefit to Central Valley steelhead in the Stanislaus River. This is  
42 particularly important in light of anticipated increases in water temperature  
43 associated with climate change in 2030. In addition, RPA actions intended to  
44 increase the efficiency of the Tracy and Skinner Fish Collection Facilities could

1 improve the overall salvage survival of steelhead under the No Action  
2 Alternative. Thus, it is concluded that the potential for adverse effects on  
3 steelhead under Alternative 3 would be greater, principally because Alternative 3  
4 does not include a strategy to address water temperatures critical to steelhead  
5 sustainability over the long term with climate change by 2030.

#### 6 *White Sturgeon*

7 Evidence of White Sturgeon spawning has been recorded in the San Joaquin River  
8 upstream of the confluence with the Stanislaus River. While flows in the San  
9 Joaquin River upstream of the Stanislaus River are expected to be similar under all  
10 alternatives, flow contributions from the Stanislaus River could influence water  
11 temperatures in the San Joaquin River where White Sturgeon eggs or larvae may  
12 occur during the spring and early summer. The magnitude of influence on water  
13 temperature would depend on the proportional flow contribution of the Stanislaus  
14 River and the temperatures in both the Stanislaus and San Joaquin rivers. The  
15 potential for an effect on White Sturgeon eggs and larvae would be influenced by  
16 the proportion of the population occurring in the San Joaquin River. In  
17 consideration of this uncertainty, it is not possible to distinguish potential effects  
18 on White Sturgeon between alternatives.

#### 19 *Reservoir Fishes*

20 The analysis of effects associated with changes in operation on reservoir fishes  
21 relied on evaluation of changes in available habitat (reservoir storage) and  
22 anticipated changes in black bass nesting success.

23 Under Alternative 3, storage in New Melones could be increased up to around  
24 20 percent in some months of some water year types (Appendix 5A). Additional  
25 information related to monthly reservoir elevations is provided in Appendix 5A,  
26 CalSim II and DSM2 Modeling. It is anticipated that aquatic habitat within New  
27 Melones is not limiting; however, storage volume is an indicator of how much  
28 habitat is available to fish species inhabiting these reservoirs. Therefore, the  
29 amount of habitat for reservoir fishes could be increased under Alternative 3 as  
30 compared to the No Action Alternative.

31 Results of the bass nesting success analysis are presented in Appendix 9F. For  
32 March, the likelihood of Largemouth Bass and Smallmouth Bass nest survival in  
33 New Melones being above 40 percent is 100 percent under Alternative 3 and the  
34 No Action Alternative. For April, the likelihood that nest survival of Largemouth  
35 Bass and Smallmouth Bass is between 40 and 100 percent is reasonably high  
36 (around 80 percent) but is substantially (about 10 percent) higher under  
37 Alternative 3 than under the No Action Alternative. For May, the pattern is  
38 similar with the likelihood of high nest survival being about 6 percent greater  
39 under Alternative 3. For June, the likelihood of survival being greater than  
40 40 percent for Largemouth Bass and Smallmouth Bass in New Melones is similar  
41 under Alternative 3 and the No Action Alternative. For Spotted Bass, nest  
42 survival from March through June is anticipated to be near 100 percent in every  
43 year under both Alternative 3 and the No Action Alternative. Most black bass  
44 spawning likely occurs prior to June, such that drawdowns during June would



1 likely affect only a small proportion of the spawning population. Thus, it is  
2 concluded that effects on black bass nesting success would be similar under  
3 Alternative 3 and the No Action Alternative.

4 *Other Species*

5 Changes in operations that influence temperature and flow conditions in the  
6 Stanislaus River downstream of Keswick Dam and the San Joaquin River at  
7 Vernalis could affect other species such as lampreys, Hardhead, and Striped Bass.

8 As described above, average monthly water temperatures in the Stanislaus River  
9 at Goodwin Dam under Alternative 3 and the No Action Alternative generally  
10 would be similar. Downstream at Orange Blossom Bridge, average monthly  
11 water temperatures under Alternative 3 generally would be similar to water  
12 temperatures under the No Action Alternative except in September when they  
13 could be cooler and October when they could be warmer than under the No  
14 Action Alternative. This temperature pattern would continue downstream to the  
15 confluence with the San Joaquin River, although temperatures would  
16 progressively increase. Water temperatures from May to July may also be  
17 warmer under Alternative 3 compared to the No Action  
18 Alternative (Appendix 6B, Table B-19-2).

19 In general, lamprey species can tolerate higher temperatures than salmonids, up to  
20 around 72°F during their entire life history. Because lamprey ammocoetes remain  
21 in the river for several years, any substantial flow reductions or water temperature  
22 increases could result in adverse effects on larval lamprey. Given the slightly  
23 lower flows and increased water temperatures during portions of their spawning  
24 and incubation period, it is likely that the potential to affect lamprey species in the  
25 Stanislaus and San Joaquin rivers would be somewhat greater under Alternative 3  
26 and the No Action Alternative.

27 In general, Striped Bass and Hardhead also can tolerate higher temperatures than  
28 salmonids. Thus, thermal conditions for these species are expected to be similar  
29 under Alternative 3 and the No Action Alternative. However, implementation of  
30 a predator control program under Alternative 3 could result in adverse effects on  
31 Striped Bass.

32 *San Francisco Bay Area Region*

33 *Killer Whale*

34 As described above for the comparison of Alternative 1 to the No Action  
35 Alternative, it is unlikely that the Chinook Salmon prey base of killer whales,  
36 supported heavily by hatchery production of fall-run Chinook Salmon, would be  
37 appreciably affected by any of the alternatives.

38 **9.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison**

39 As described in Chapter 3, Description of Alternatives, the CVP and SWP  
40 operations and ongoing operational management policies of the CVP and SWP  
41 under Alternative 3 would be similar to the operational assumptions under the  
42 Second Basis of Comparison except for changes to water demand assumptions,

1 OMR flow criteria, and operations of New Melones Reservoir to meet SWRCB  
2 D-1641 flow requirements on the San Joaquin River at Vernalis. As a  
3 consequence, conditions for fish and aquatic resources would be relatively  
4 unchanged in most of the system under Alternative 3. The following briefly  
5 summarizes these minor changes, but focuses on portions of the CVP and SWP  
6 where changes would occur under Alternative 3 relative to the Second Basis of  
7 Comparison.

#### 8 *Trinity River Region*

##### 9 *Coho Salmon*

10 The analysis of effects associated with changes in operation on Coho Salmon was  
11 conducted using temperature model outputs for Lewiston Dam to anticipate the  
12 likely effects on conditions in the Trinity River downstream of Lewiston Dam for  
13 Coho Salmon.

14 Long-term average monthly water temperature in the Trinity River at Lewiston  
15 Dam under Alternative 3 would be similar (less than 0.5°F) to long-term average  
16 water temperatures under the Second Basis of Comparison in all months. The  
17 greatest differences would occur in critical years when average monthly  
18 temperatures would be 0.6°F lower in September and October and 0.8°F higher in  
19 November under Alternative 3 (Appendix 6B, Table B-1-5). The differences in  
20 the frequency with which Alternative 3 and the Second Basis of Comparison  
21 would exceed established temperature thresholds also would be small, with water  
22 temperatures under Alternative 3 exceeding thresholds about 0-2 percent less  
23 frequently than under the Second Basis of Comparison.

24 Given the similarity of the results and the inherent uncertainty associated with the  
25 resolution of the water temperature model (average monthly outputs), it is  
26 concluded that Alternative 3 and the Second Basis of Comparison are likely to  
27 have similar effects on the Coho Salmon population in the Trinity River.

##### 28 *Spring-run Chinook Salmon*

29 As described above for Coho Salmon, water temperatures would generally be  
30 similar (less than 0.5°F difference) under Alternative 3 and the Second Basis of  
31 Comparison. Similarly, the differences in the frequency with which water  
32 temperatures under Alternative 3 and the Second Basis of Comparison would  
33 exceed established temperature thresholds also would be small, with Alternative 3  
34 exceeding water temperature thresholds about 1 to 2 percent less frequently than  
35 the Second Basis of Comparison.

36 Given the similarity of the results and the inherent uncertainty associated with the  
37 resolution of the temperature model (average monthly outputs), it is concluded  
38 that Alternative 3 and Second Basis of Comparison are likely to have similar  
39 effects on the spring-run Chinook Salmon population in the Trinity River.

##### 40 *Fall-Run Chinook Salmon*

41 As described above for Coho Salmon, water temperatures under Alternative 3 and  
42 the Second Basis of Comparison generally would be similar (Appendix 6B,  
43 Table B-1-5. This is reflected in the egg mortality results, which indicate similar

1 levels of mortality, under Alternative 3 and the Second Basis of Comparison  
2 (Appendix 9C, Table 5-5).

3 Given the similarity of the results and the inherent uncertainty associated with the  
4 resolution of the temperature model (average monthly outputs), it is concluded  
5 that Alternative 3 and Second Basis of Comparison are likely to have similar  
6 effects on the fall-run Chinook Salmon population in the Trinity River.

7 *Steelhead*

8 Differences in water temperature conditions for steelhead in the Trinity River  
9 between Alternative 3 and the Second Basis of Comparison would be minor as  
10 described above for salmon. These results suggest that conditions for steelhead in  
11 the Trinity River generally would be similar under Alternative 3 and the Second  
12 Basis of Comparison.

13 *Green Sturgeon*

14 Green Sturgeon would be subjected to the same water temperature conditions  
15 described above for salmonids. The similarity in temperatures between  
16 Alternative 3 and the Second Basis of Comparison suggest that conditions for  
17 Green Sturgeon in the Trinity River generally would be similar under  
18 Alternative 3 and the Second Basis of Comparison.

19 *Reservoir Fishes*

20 Reservoir fishes in Trinity Lake would be exposed to relatively minor differences  
21 in storage under Alternative 3 as compared to the Second Basis of Comparison  
22 and these relatively small differences would have little effect on the amount of  
23 habitat available for these species. Black bass nesting survival would be similar  
24 under Alternative 3 and the Second Basis of Comparison. Overall, effects on  
25 reservoir fishes in Trinity Lake would be similar under both Alternative 3 and the  
26 Second Basis of Comparison.

27 *Pacific Lamprey and Eulachon*

28 As described above for Coho Salmon, there would be only minor differences in  
29 water temperatures between Alternative 3 and the Second Basis of Comparison.  
30 This suggests that water temperature conditions for Pacific Lamprey and  
31 Eulachon in the Trinity River and Klamath River downstream of the confluence  
32 generally would be similar under Alternative 3 and the Second Basis of  
33 Comparison.

34 *Sacramento River System*

35 *Winter-run Chinook Salmon*

36 Changes in operations that influence temperature and flow conditions in the  
37 Sacramento River downstream of Keswick Dam could affect winter-run Chinook  
38 Salmon. The following describes those changes and their potential effects.

39 *Changes in Water Temperature*

40 Long-term average monthly water temperature in the Sacramento River at  
41 Keswick Dam under Alternative 3 and the Second Basis would be similar  
42 (Appendix 6B, Table B-5-5). There would be slight differences in the frequency

1 of exceeding temperature thresholds under Alternative 3 and the Second Basis of  
 2 Comparison with the frequency of exceedance being up to 4 percent less under  
 3 Alternative 3 at Balls Ferry and up to 4 percent more at Bend Bridge. Egg  
 4 mortality would be similar under Alternative 3 and the Second Basis of  
 5 Comparison (Appendix 9C, Table B-4).

6 *Changes in Weighted Usable Area*

7 The WUA results for winter-run Chinook Salmon spawning habitat between  
 8 Keswick Dam and Battle Creek indicated that the amount of spawning habitat  
 9 would be similar under Alternative 3 and the Second Basis of Comparison  
 10 (Appendix 9E, Table C-17-5). Results were similar for fry rearing,  
 11 (Appendix 9E, Table C-18-5). Results for juvenile rearing also were similar  
 12 under both Alternative 3 and the Second Basis of Comparison (Appendix 9E,  
 13 Table C-19-5).

14 *Changes in SALMOD Output*

15 SALMOD results indicate that potential production of winter-run Chinook  
 16 Salmon under Alternative 3 would be essentially the same as under the Second  
 17 Basis of Comparison. (Appendix 9D, Table B-4-21).

18 *Changes in Delta Passage Model Output*

19 The Delta Passage Model predicted similar estimates of annual Delta survival  
 20 across the 81-year time period for winter-run Chinook Salmon between  
 21 Alternative 3 and the Second Basis of Comparison (Appendix 9J). Median Delta  
 22 survival was 0.354 for Alternative 3 and 0.352 for the Second Basis of  
 23 Comparison.

24 *Changes in Delta Hydrodynamics*

25 Winter-run Chinook Salmon smolts are most abundant in the Delta during  
 26 January, February, and March. On the Sacramento River near the confluence of  
 27 Georgiana Slough, the median proportion of positive velocities under  
 28 Alternative 3 was indistinguishable from the Second Basis of Comparison  
 29 (Appendix 9K). On the San Joaquin River near the Mokelumne River confluence,  
 30 the median proportion of positive velocities would be slightly higher under  
 31 Alternative 3 than under the Second Basis of Comparison. In Old River  
 32 downstream of the facilities, the median proportion of positive velocities would  
 33 be similar under Alternative 3 and the Second Basis of Comparison in March, but  
 34 would be moderately to slightly higher January and February, respectively under  
 35 Alternative 3. In Old River upstream of the facilities, the median proportion of  
 36 positive velocities would be slightly to moderately lower under Alternative 3 and  
 37 the Second Basis of Comparison in these months. On the San Joaquin River  
 38 downstream of Head of Old River, the percent of positive velocities would be  
 39 similar under both alternative in January, February and March.

40 *Changes in Junction Entrainment*

41 Entrainment at the Georgiana Slough Junction under Alternative 3 would be  
 42 almost indistinguishable from the Second Basis of Comparison (Appendix 9L).  
 43 At the Head of Old River junction, median entrainment probability would be

1 slightly lower under Alternative 3 in January and February and similar in March.  
2 At Turner Cut, median entrainment probabilities would be slightly lower under  
3 Alternative 3 relative to the Second Basis of Comparison in January and  
4 February; however, median entrainment probability would be similar in March.  
5 The median entrainment probability under Alternative 3 at Columbia Cut, Middle  
6 River, and Old River would be slightly lower from January to March relative to  
7 the Second Basis of Comparison.

8 *Changes in Salvage*

9 Salvage of Sacramento River-origin Chinook salmon is predicted to be  
10 substantially lower under Alternative 3 relative to the Second Basis of  
11 Comparison in January (Appendix 9M). In February salvage would be only  
12 moderately lower and slightly lower in March.

13 *Changes in Oncorhynchus Bayesian Analysis Output*

14 Escapement of winter-run Chinook Salmon and Delta survival was modeled by  
15 the Oncorhynchus Bayesian Analysis (OBAN) model for winter-run Chinook  
16 salmon. Differences in escapement between Alternative 3 and the Second Basis  
17 scenarios were moderately small (Appendix 9I). Escapement was generally  
18 greater under Alternative 3 relative to Second Basis of Comparison, and it was  
19 consistently greater over the 1986 to 1988 simulation period (dark gray and light  
20 gray areas above the dashed line). In most other years the difference in  
21 escapement estimates included 0 (i.e., dashed line located in the dark gray, central  
22 0.50 probability region) (see Appendix 9I). The median delta survival was  
23 slightly higher under Alternative 3 relative to the Second Basis scenario  
24 (6 percent), although the probability of no difference between alternatives was  
25 generally high throughout the simulation time period.

26 *Changes in Interactive Object-Oriented Simulation Output*

27 The IOS model predicted similar adult escapement trajectories for winter-run  
28 Chinook Salmon between Alternative 3 and the Second Basis of Comparison  
29 across the 81 years (Appendix 9H). Median adult escapement under Alternative 3  
30 was 4,025 and under the Second Basis of Comparison median escapement  
31 was 4,042.

32 Similar to adult escapement, the IOS model predicted similar egg survival for  
33 winter-run Chinook Salmon between Alternative 3 and the Second Basis of  
34 Comparison across the 81 water years. Median egg survival was 0.987 for both  
35 scenarios.

36 *Summary of Effects on Winter-Run Chinook Salmon*

37 The multiple model and analysis outputs described above characterize the  
38 anticipated conditions for winter-run Chinook Salmon and their response to  
39 change under Alternative 3 as compared to the Second Basis of Comparison. For  
40 the purpose of analyzing effects on winter-run Chinook Salmon and developing  
41 conclusions, greater reliance was placed on the outputs from the two life cycle  
42 models, IOS and OBAN because they each integrate the available information to  
43 produce single estimates of winter-run Chinook Salmon escapement. The output

1 from IOS indicated that winter-run Chinook Salmon escapement would be similar  
2 under both scenarios, whereas the OBAN results indicated that escapement under  
3 Alternative 3 could be higher than under the Second Basis of Comparison.

4 These model results suggest that effects on winter-run Chinook Salmon would be  
5 similar under both scenarios, with a small likelihood that winter-run Chinook  
6 Salmon escapement would be higher under Alternative 3 than under the Second  
7 Basis of Comparison. The ocean harvest restrictions under Alternative 3 could  
8 provide additional benefit, although the effects of the predator management  
9 program are uncertain. Overall, given the small differences, distinguishing a clear  
10 difference between alternatives is difficult. The non-operational components  
11 associated with Alternative 3 could benefit winter-run Chinook Salmon relative to  
12 the Second Basis of Comparison over the short term if successful. Thus, it is  
13 concluded that the potential for adverse effects on winter-run Chinook Salmon  
14 would be slightly less under Alternative 3 than under the Second Basis of  
15 Comparison.

#### 16 *Spring-run Chinook Salmon*

17 Operations under Alternative 3 generally would be similar to those for the Second  
18 Basis of Comparison. The following describes those changes and their potential  
19 effects.

#### 20 *Changes in Water Temperature*

21 Long-term average monthly water temperature in the Sacramento River under  
22 Alternative 3 and the Second Basis of Comparison would be similar  
23 (Appendix 6B). Differences in the frequency of exceeding temperature thresholds  
24 under Alternative 3 and the Second Basis of Comparison also would be minor  
25 (differences of about 1 percent), as would egg mortality, which would be similar  
26 under Alternative 3 and the Second Basis of Comparison (Appendix 9C,  
27 Table B-3).

28 In Clear Creek, average monthly water temperature at Igo under Alternative 3  
29 relative to the Second Basis of Comparison would be similar (Appendix 6B,  
30 Table B-3-5). The frequency of exceeding temperature thresholds for spring-run  
31 Chinook Salmon rearing also would be minor (differences of 1 percent).

32 In the Feather River, average monthly water temperature at the low flow channel  
33 under Alternative 3 relative to the Second Basis of Comparison also would be  
34 similar (differences less than 0.5°F), with a slight reduction in temperature (0.7°F)  
35 in August of below normal years (Appendix 6B, Table B-20-5). Water  
36 temperatures at the downstream location also would be similar, with temperatures  
37 under Alternative 3 at Robinson Riffle and Gridley up to 2°F percent cooler in  
38 July and August of some water year types (Appendix 6B, Table B-21-5).  
39 Changes in the frequency of temperature thresholds would be minor (differences  
40 of 1 percent or less), except in May when the temperature threshold for rearing  
41 would be exceeded about 4 percent more frequently than under the Second Basis  
42 of Comparison.

1            *Changes in Weighted Usable Area*

2 Weighted usable area curves are available for spring-run Chinook Salmon in  
3 Clear Creek. Flows in Clear Creek downstream of Whiskeytown Dam are not  
4 anticipated to differ under Alternative 3 relative to the Second Basis of  
5 Comparison. Therefore, there would be no change in the amount of potentially  
6 suitable spawning and rearing habitat for spring-run Chinook Salmon (as indexed  
7 by WUA) available under the Alternative 3 as compared to the Second Basis of  
8 Comparison.

9            *Changes in SALMOD Output*

10 SALMOD results indicate that potential production of spring-run Chinook  
11 Salmon would be essentially the same under Alternative 3 relative to the Second  
12 Basis of Comparison, but could be up to 8 percent less than under the Second  
13 Basis of Comparison in critical dry years (Appendix 9D, Table B-3-21).

14           *Changes in Delta Passage Model Output*

15 The Delta Passage Model predicted similar estimates of annual Delta survival  
16 across the 81-year time period for spring-run Chinook Salmon between  
17 Alternative 3 and the Second Basis of Comparison (Appendix 9J). Median Delta  
18 survival would be 0.286 for both scenarios.

19           *Changes in Delta Hydrodynamics*

20 Spring-run Chinook Salmon are most abundant in the Delta from March through  
21 May. Near the junction of Georgiana Slough, the median proportion of time that  
22 velocity would be positive was similar for both Alternative 3 and the Second  
23 Basis of Comparison in March, April and May (Appendix 9K). Near the  
24 confluence of the San Joaquin River and the Mokelumne River, the median  
25 proportion with positive velocity was similar during these months under  
26 Alternative 3 and the Second Basis of Comparison. In the San Joaquin River  
27 downstream of the Head of Old River, the median proportion of positive  
28 velocities was similar between scenarios in March, whereas values were slightly  
29 to moderately lower under Alternative 3 relative to the Second Basis of  
30 Comparison in April and May, respectively. In Old River upstream of the  
31 facilities, the median proportion with positive velocities was similar between  
32 scenarios in March and moderately higher in April and May under Alternative 3  
33 relative to the Second Basis of Comparison. In Old River downstream of the  
34 facilities, the median proportion with positive velocities was similar between  
35 scenarios in March and slightly higher in April and May under Alternative 3  
36 relative to the Second Basis of Comparison.

37           *Changes in Junction Entrainment*

38 Entrainment at the Georgiana Slough Junction under Alternative 3 would be  
39 almost indistinguishable from the Second Basis of Comparison during March  
40 April and May (Appendix 9L). At the Head of Old River junction, entrainment  
41 would be similar under Alternative 3 and the Second Basis of Comparison in  
42 March, whereas entrainment would be much greater under Alternative 3 relative  
43 to the Second Basis of Comparison in April and May. At Turner Cut, entrainment  
44 would be similar under Alternative 3 relative to the Second Basis of Comparison

1 in March and slightly to moderately lower in April and May, respectively under  
2 Alternative 3. Entrainment at Columbia Cut, Middle River, and Old River would  
3 yield similar patterns as those observed at Turner Cut.

#### 4 *Changes in Salvage*

5 Spring-run Chinook Salmon smolts migrating through the Delta would be most  
6 susceptible in the months of March, April, and May. Salvage of Sacramento  
7 River-origin Chinook salmon is predicted to be similar under Alternative 3 and  
8 the Second Basis of Comparison in March, April, and May (Appendix 9M).

#### 9 *Summary of Effects on Spring-Run Chinook Salmon*

10 The multiple model and analysis outputs described above characterize the  
11 anticipated conditions for spring-run Chinook Salmon and their response to  
12 change under Alternative 3 and the Second Basis of Comparison. For the purpose  
13 of analyzing effects on spring-run Chinook Salmon in the Sacramento River,  
14 greater reliance was placed on the outputs from the SALMOD model because it  
15 integrates the available information on temperature and flows to produce  
16 estimates of mortality for each life stage and an overall, integrated estimate of  
17 potential spring-run Chinook Salmon juvenile production. The output from  
18 SALMOD indicated that spring-run Chinook Salmon production in the  
19 Sacramento River would be similar under Alternative 3 and the Second Basis of  
20 Comparison, although production under Alternative 3 could be up to 8 percent  
21 less than under the Second Basis of Comparison in critical dry years.

22 The analyses attempting to assess the effects on routing, entrainment, and salvage  
23 of juvenile salmonids in the Delta suggest that salvage (as an indicator of  
24 potential losses of juvenile salmon at the export facilities) of Sacramento  
25 River-origin Chinook Salmon generally would be similar under Alternative 3 and  
26 the Second Basis of Comparison.

27 In Clear Creek and the Feather River, the analysis of the effects of Alternative 3  
28 and the Second Basis of Comparison for spring-run Chinook Salmon relied on  
29 output from the WUA analysis and water temperature output for Clear Creek at  
30 Igo, and in the Feather River low flow channel and downstream of the Thermalito  
31 complex. The WUA analysis suggests that there would be little difference in the  
32 availability of spawning and rearing habitat in Clear Creek. The temperature  
33 model outputs suggest that thermal conditions and effects on each of the  
34 spring-run Chinook Salmon life stages generally cannot be fully characterized in  
35 Clear Creek and the Feather River. This conclusion is supported by the water  
36 temperature threshold exceedance analysis that indicated that water temperature  
37 thresholds for spawning and egg incubation in Clear Creek and the Feather River  
38 would be exceeded less frequently in some months and more frequently in others  
39 under Alternative 3 than under the Second Basis of Comparison. The water  
40 temperature threshold for rearing spring-run Chinook Salmon in the Feather River  
41 would also be exceeded less frequently in some months and more frequently in  
42 others under Alternative 3. Because of the inherent uncertainty associated with  
43 the resolution of the temperature model (average monthly outputs), and the  
44 differences in the magnitude and direction of the temperature exceedances under



1 Alternative 3, the extent of temperature-related effects on spring-run Chinook  
2 Salmon in Clear Creek and the Feather River is uncertain.

3 These model results suggest that overall, effects on spring-run Chinook Salmon  
4 could be slightly more adverse under Alternative 3 than the Second Basis of  
5 Comparison, with a small likelihood that spring-run Chinook Salmon production  
6 would be lower under the Second Basis of Comparison. Although the operational  
7 components associated with Alternative 3 could have greater adverse effects on  
8 spring-run Chinook Salmon than the Second Basis of Comparison, the non-  
9 operational components associated with Alternative 3 could benefit spring-run  
10 Chinook Salmon relative to the Second Basis of Comparison over the short term  
11 if successful. The ocean harvest restriction component of Alternative 3 could  
12 increase spring-run Chinook Salmon numbers by reducing ocean harvest and the  
13 trap and haul program and predator control measures under Alternative 3 could  
14 reduce predation on juvenile spring-run Chinook Salmon and thereby increase  
15 survival. The effects of the trap and haul and predator management programs  
16 under Alternative 3 are uncertain. Thus, it is concluded that the potential for  
17 adverse effects on spring-run Chinook Salmon would be slightly less under  
18 Alternative 3 than under the Second Basis of Comparison.

19 *Fall-Run Chinook Salmon*

20 Changes in operations that influence temperature and flow conditions in the  
21 Sacramento River downstream of Keswick Dam, Clear Creek downstream of  
22 Whiskeytown Dam, Feather River downstream of Oroville Dam and American  
23 River below Nimbus could affect fall-run Chinook Salmon. The following  
24 describes those changes and their potential effects.

25 *Changes in Water Temperature*

26 Water temperature conditions in the Sacramento River, Clear Creek, and Feather  
27 River under Alternative 3 and the Second Basis of Comparison would be same as  
28 those described above for spring-run Chinook Salmon. Temperature conditions in  
29 the Sacramento River, Clear Creek, Feather River, and American River would  
30 generally be similar (differences less than 0.5°F) under Alternative 3 and the  
31 Second Basis of Comparison (Appendix 6B).

32 The frequency of exceeding established temperature thresholds in the Sacramento  
33 and Feather rivers for fall-run Chinook Salmon would be the same or nearly so  
34 (differences of up to 2 percent) for both Alternative 3 and the Second Basis of  
35 Comparison. Similarly, in the American River (Appendix 9C, Table B-6),  
36 differences in the frequency of temperature threshold exceedance would be minor  
37 (up to about 1 percent).

38 The results from Reclamation's salmon mortality model reflect the similarities in  
39 temperature described above. For fall-run Chinook Salmon in the Sacramento  
40 River, egg mortality would be similar under Alternative 3 and the Second Basis of  
41 Comparison (Appendix 9C, Table B-1). Differences in the Feather and American  
42 rivers would also be similar under Alternative 3 and the Second Basis of  
43 Comparison.

1            *Changes in Weighted Usable Area*

2 Modeling results indicate that, in general, there would be similar amounts (less  
3 than 5 percent differences) of fall-run Chinook Salmon spawning habitat available  
4 in the Sacramento, Feather, and American rivers under Alternative 3 as compared  
5 to the Second Basis of Comparison; fall-run fry and juvenile rearing WUA would  
6 also be similar under Alternative 3 and the Second Basis of Comparison in the  
7 Sacramento River. Overall, spawning and rearing habitat availability for fall-run  
8 Chinook Salmon would be similar under Alternative 3 and the Second Basis of  
9 Comparison.

10           *Changes in SALMOD Output*

11 SALMOD results indicate that production for fall-run Chinook Salmon would be  
12 similar under Alternative 3 and the Second Basis of Comparison (Appendix 9D,  
13 Table B-1-21).

14           *Changes in Delta Passage Model Output*

15 The Delta Passage Model predicted similar estimates of annual Delta survival  
16 across the 8-year time period for fall-run Chinook Salmon between Alternative 3  
17 and the Second Basis of Comparison (Appendix 9J). Median Delta survival was  
18 0.246 for Alternative 3 and 0.245 for the Second Basis of Comparison.

19           *Changes in Delta Hydrodynamics*

20 Fall-run Chinook Salmon smolts are most abundant in the Delta during the  
21 months of April, May and June. At the junction of Georgiana Slough and the  
22 Sacramento River, the median proportion of positive velocities would be similar  
23 in April, May, and June under Alternative 3 and the Second Basis of Comparison  
24 (Appendix 9K). Near the confluence of the San Joaquin River and the  
25 Mokelumne River, the median proportion of positive velocities would be similar  
26 to or slightly lower under Alternative 3 relative to the Second Basis of  
27 Comparison in the months when fall-run Chinook Salmon are most abundant. On  
28 Old River downstream of the facilities, the median proportion of positive  
29 velocities would be slightly higher in April and May, and similar in June under  
30 Alternative 3 relative to the Second Basis of Comparison. In Old River upstream  
31 of the facilities, the median proportion of positive velocities would be moderately  
32 higher under Alternative 3 in April and May and slightly lower in June. On the  
33 San Joaquin River downstream of the Head of Old River, the median proportion  
34 of positive velocities would be slightly to moderately lower under Alternative 3  
35 relative to the Second Basis of Comparison in April and May, respectively, and  
36 slightly lower in June.

37           *Changes in Junction Entrainment*

38 Entrainment at the Georgiana Slough Junction under Alternative 3 would be  
39 almost indistinguishable from the Second Basis of Comparison in April, May, and  
40 June (Appendix 9L). At the Head of Old River junction in April and May,  
41 entrainment would be much greater under Alternative 3 relative to the Second  
42 Basis of Comparison. In June, entrainment would be similar under each scenario.  
43 Patterns of entrainment would be similar at Turner Cut, Columbia Cut, Middle  
44 River, and Old River. At these junctions, median entrainment under Alternative 3

1 would be slightly to moderately lower in April and May, and almost  
2 indistinguishable in June.

3 *Changes in Salvage*

4 Salvage of Sacramento River-origin Chinook Salmon is predicted to be lower  
5 under Alternative 3 relative to the Second Basis of Comparison in every month  
6 except April, May, and June (Appendix 9M). Fall-run Chinook Salmon smolts  
7 migrating through the Delta would be most susceptible in the months of April,  
8 May, and June. Predicted values in April and May indicated a similar fraction of  
9 fish salvaged under Alternative 3 and the Second Basis of Comparison and a  
10 slightly reduce fraction salvaged in June under Alternative 3.

11 *Summary of Effects on Fall-Run Chinook Salmon*

12 The multiple model and analysis outputs described above characterize the  
13 anticipated conditions for fall-run Chinook Salmon and their response to change  
14 under Alternative 3 and the Second Basis of Comparison. For the purpose of  
15 analyzing effects on fall-run Chinook Salmon in the Sacramento River, greater  
16 reliance was placed on the outputs from the SALMOD model because it integrates  
17 the available information on temperature and flows to produce estimates of  
18 mortality for each life stage and an overall, integrated estimate of potential fall-  
19 run Chinook Salmon juvenile production. The output from SALMOD indicated  
20 that fall-run Chinook Salmon production would be similar in all water year types  
21 under Alternative 3 and the Second Basis of Comparison.

22 The analyses attempting to assess the effects on routing, entrainment, and salvage  
23 of juvenile salmonids in the Delta suggest that salvage (as an indicator of  
24 potential losses of juvenile salmon at the export facilities) of Sacramento  
25 River-origin Chinook Salmon generally would be similar under Alternative 3 and  
26 the Second Basis of Comparison.

27 In Clear Creek and the Feather and American rivers, the analysis of the effects of  
28 Alternative 3 and the Second Basis of Comparison for fall-run Chinook Salmon  
29 relied on the WUA analysis for habitat and water temperature model output for  
30 the rivers at various locations downstream of the CVP and SWP facilities. The  
31 WUA analysis indicated that the availability of spawning and rearing habitat in  
32 Clear Creek and spawning habitat in the Feather and American rivers would be  
33 similar under Alternative 3 and the Second Basis of Comparison. The  
34 temperature model outputs for each of the fall-run Chinook Salmon life stages  
35 suggest that thermal conditions and effects on fall-run Chinook Salmon in all of  
36 these streams generally would be similar under both scenarios. The water  
37 temperature threshold exceedance analysis that indicated that the water  
38 temperature thresholds for fall-run Chinook Salmon spawning and egg incubation  
39 would be exceeded slightly less frequently in the Feather River and Clear Creek  
40 under Alternative 3 and could reduce the potential for adverse effects on the fall-  
41 run Chinook Salmon populations in Clear Creek and the Feather River. Results of  
42 the analysis using Reclamation's salmon mortality model indicate that there  
43 would be little difference in fall-run Chinook Salmon egg mortality under  
44 Alternative 3 and the Second Basis of Comparison.

1 Overall, the results of the numerical models suggest the potential for less adverse  
2 effects on fall-run Chinook Salmon under Alternative 3 as compared to the  
3 Second Basis of Comparison. However, discerning a meaningful difference  
4 between these two scenarios based on the quantitative results is not possible  
5 because of the similarity in results (generally differences less than 5 percent) and  
6 the inherent uncertainty of the models. In addition, adverse effects of  
7 Alternative 3 could be offset by the potentially beneficial effects of the predator  
8 control program and ocean harvest restrictions. Thus, it is concluded that the  
9 potential for adverse effects on fall-run Chinook Salmon would be slightly less  
10 under Alternative 3 than under the Second Basis of Comparison.

#### 11 *Late Fall-Run Chinook Salmon*

##### 12 *Changes in Water Temperature*

13 Temperature conditions in the Sacramento River downstream of Keswick Dam  
14 for late fall-run Chinook Salmon under Alternative 3 and the Second Basis of  
15 Comparison generally would be similar, as described above for fall-run Chinook  
16 Salmon. The results from Reclamation's salmon mortality model reflect the  
17 similarities in temperature described above. For late fall-run Chinook Salmon in  
18 the Sacramento River, egg mortality would be similar under Alternative 3 and the  
19 Second Basis of Comparison (Appendix 9C, Table B-1).

##### 20 *Changes in Weighted Usable Area*

21 Modeling results indicate that there would be similar amounts of spawning habitat  
22 available for late fall-run Chinook Salmon in the Sacramento River from January  
23 through April under Alternative 3 as compared to the Second Basis of  
24 Comparison (Appendix 9E, Table C-14-5). There also would be similar amounts  
25 of suitable late fall-run Chinook Salmon fry rearing habitat available during April  
26 and May under Alternative 3 and the Second Basis of Comparison (Appendix 9E,  
27 Table C-15-5). Modeling results indicate that, there would generally be similar  
28 amounts of suitable juvenile rearing habitat available all year long under  
29 Alternative 3 and the Second Basis of Comparison (Appendix 9E, Table C-16-5).

##### 30 *Changes in SALMOD Output*

31 Results from the SALMOD model indicate that potential production under  
32 Alternative 3 would be similar under Alternative 3 and the Second Basis of  
33 Comparison in all water year types (Appendix 9D, Table B-2-21).

##### 34 *Changes in Delta Passage Model Output*

35 The Delta Passage Model predicted similar estimates of annual Delta survival  
36 across the 81-year time period for late fall-run Chinook Salmon between  
37 Alternative 3 and the Second Basis of Comparison (Appendix 9J). Median Delta  
38 survival would be 0.199 for both scenarios.

##### 39 *Changes in Delta Hydrodynamics*

40 The late fall-run Chinook Salmon migration period overlaps with the winter-run.  
41 See the section on hydrodynamic analysis for winter-run Chinook Salmon for  
42 potential effects on late fall-run Chinook Salmon.

1            *Changes in Junction Entrainment*

2    Entrainment probabilities for late fall-run Chinook Salmon are assumed to mimic  
3    that of winter-run Chinook Salmon due to the overlap in timing. See the section  
4    on winter-run Chinook Salmon entrainment for potential effects on late fall-run  
5    Chinook Salmon.

6            *Changes in Salvage*

7    Salvage of late fall-run Chinook Salmon is assumed to mimic that of winter-run  
8    Chinook Salmon due to overlap in timing. See the section on winter-run Chinook  
9    Salmon entrainment for potential effects on the late fall-run Chinook Salmon.

10           *Summary of Effects on Late Fall-Run Chinook Salmon*

11    The multiple model and analysis outputs described above characterize the  
12    anticipated conditions for late fall-run Chinook Salmon and their response to  
13    change under Alternative 3 and the Second Basis of Comparison. For the purpose  
14    of analyzing effects on late fall-run Chinook Salmon and developing conclusions,  
15    greater reliance was placed on the outputs from the SALMOD model because it  
16    integrates the available information on temperature and flows to produce  
17    estimates of mortality for each life stage and an overall, integrated estimate of  
18    potential fall-run Chinook Salmon juvenile production. The output from  
19    SALMOD suggested that late fall-run Chinook Salmon production would be  
20    similar under Alternative 3 and the Second Basis of Comparison.

21    Although, potential losses of juvenile salmon at the export facilities could be  
22    higher under Alternative 3, as suggested by the analysis of salvage, it is likely that  
23    effects on the late fall-run Chinook Salmon population would be similar under  
24    Alternative 3 and the Second Basis of Comparison.

25    Overall, the results of the numerical models suggest the potential for less adverse  
26    effects on late fall-run Chinook Salmon under Alternative 3 as compared to the  
27    Second Basis of Comparison. However, discerning a meaningful difference  
28    between these two scenarios based on the quantitative results is not possible  
29    because of the similarity in results (generally differences less than 5 percent) and  
30    the inherent uncertainty of the models. In addition, any adverse effects of  
31    Alternative 3 could be offset by the potentially beneficial effects resulting from  
32    predator control and ocean harvest restrictions. Thus, it is concluded that the  
33    effects on late fall-run Chinook Salmon would be similar under Alternative 3 and  
34    the Second Basis of Comparison.

35           *Steelhead*

36            *Changes in Water Temperature*

37    Water temperature conditions in the Sacramento River, Clear Creek, Feather  
38    River and American River under Alternative 3 and the Second Basis of  
39    Comparison would be same as those described above for fall-run Chinook  
40    Salmon. Temperature conditions in the Sacramento River, Clear Creek, Feather  
41    River, and American River would generally be similar (differences less than  
42    0.5°F) under Alternative 3 and the Second Basis of Comparison (Appendix 6B).

1 The frequency of exceeding temperature thresholds in the Sacramento, Feather,  
2 and American rivers for steelhead would be the same or nearly so (differences of  
3 up to 2 percent) for both Alternative 3 and the Second Basis of Comparison  
4 Exceedances.

5 *Changes in Weighted Usable Area*

6 Modeling results indicate that, in general, there would be similar amounts (less  
7 than 5 percent differences) of steelhead spawning habitat available in Clear Creek,  
8 and the Sacramento, Feather, and American rivers under Alternative 3 as  
9 compared to the Second Basis of Comparison.

10 *Summary of Effects on Steelhead*

11 The multiple model and analysis outputs described above characterize the  
12 anticipated conditions for steelhead and their response to change under  
13 Alternative 3 and the Second Basis of Comparison. The analysis of the effects of  
14 Alternative 3 and the Second Basis of Comparison for steelhead relied on the  
15 WUA analysis for habitat and water temperature model output for the rivers at  
16 various locations downstream of the CVP and SWP facilities. The WUA analysis  
17 indicated that the availability of steelhead spawning and rearing habitat in Clear  
18 Creek and steelhead spawning habitat in the Sacramento, Feather and American  
19 rivers would be similar under Alternative 3 and the Second Basis of Comparison.  
20 The temperature model outputs for each of the steelhead life stages indicated that  
21 the water temperature thresholds for steelhead spawning and egg incubation  
22 would be exceeded less frequently in the Feather River under Alternative 3.  
23 However, the water temperature threshold for steelhead rearing in the Feather  
24 River would be exceeded less frequently in some months and more frequently in  
25 others under Alternative 3. The water temperature threshold for steelhead rearing  
26 in the American River would also be exceeded more frequently in most months  
27 under Alternative 3. Because of the inherent uncertainty associated with the  
28 resolution of the temperature model (average monthly outputs), and the  
29 differences in the magnitude and direction of the temperature exceedances under  
30 Alternative 3, the extent of temperature-related effects on steelhead in the Feather  
31 and American rivers is uncertain.

32 Overall, the results of the numerical models suggest a slightly greater potential to  
33 result in adverse effects on steelhead under Alternative 3 as compared to the  
34 Second Basis of Comparison. However, discerning a meaningful difference  
35 between these two scenarios based on the quantitative results is not possible  
36 because of the similarity in results (generally differences less than 5 percent) and  
37 the inherent uncertainty of the models. In addition, any adverse effects of  
38 Alternative 3 could be offset by the potentially beneficial effects resulting from  
39 predator control and ocean harvest restrictions. Thus, it is concluded that the  
40 effects on steelhead would be similar under Alternative 3 and the Second Basis of  
41 Comparison.

1        *Sturgeon (green and white)*

2 Changes in operations that influence temperature and flow conditions could affect  
3 Green Sturgeon. The following describes those changes and their potential  
4 effects.

5            *Changes in Water Temperature*

6 The analysis of the effects of Alternative 3 and Second Basis of Comparison for  
7 sturgeon relied on water temperature model output for the Sacramento and  
8 Feather rivers at various locations downstream of Shasta Dam and the Thermalito  
9 complex. The temperature model outputs for each of these rivers suggest that  
10 thermal conditions and effects on sturgeon in the Sacramento and Feather rivers  
11 generally would be similar under both scenarios. This conclusion is supported by  
12 the water temperature threshold exceedance analysis that indicated that the water  
13 temperature thresholds for sturgeon spawning, incubation, and rearing would be  
14 exceeded slightly less frequently under Alternative 3 in the Sacramento River.  
15 The water temperature threshold for sturgeon spawning, incubation, and rearing  
16 also would be exceeded slightly less frequently in the Feather River.

17            *Changes in Delta Outflow*

18 As described in Appendix 9P, mean (March to July) Delta outflow was used an  
19 indicator of potential year class strength and the likelihood of producing a strong  
20 year class of sturgeon. The median value over the 82-year CalSim II modeling  
21 period of mean (March to July) Delta outflow was predicted to similar under the  
22 Alternative 3 and the Second Basis of Comparison. In addition, the likelihood of  
23 mean (March to July) Delta outflow exceeding the threshold of 50,000 cfs was the  
24 same under both alternatives.

25            *Summary of Effects on Sturgeon*

26 The slightly reduced frequency of exceedance of temperature thresholds under  
27 Alternative 3 could reduce the potential for adverse effects on sturgeon in the  
28 Sacramento and Feather rivers relative to the Second Basis of Comparison. The  
29 analysis based on Delta outflows suggests that Alternative 3 provides similar  
30 mean (March to July) outflows which would have similar effects on year class  
31 strength of juvenile sturgeon relative to the Second Basis of Comparison.  
32 Therefore, based primarily on the analysis of water temperatures, Alternative 3  
33 could be less likely to result in adverse effects on White Sturgeon than the Second  
34 Basis of Comparison.

35            *Delta Smelt*

36            *Changes in Proportional Entrainment*

37 As described in Appendix 9G, a proportional entrainment regression model  
38 (based on Kimmerer 2008, 2011) was used to simulate adult Delta Smelt  
39 entrainment, as influenced by OMR flow in December through March. Results  
40 indicate that the percentage of entrainment of migrating and spawning adult Delta  
41 Smelt under Alternative 3 would be 7.3 to 8.5 percent, depending on the water  
42 year type, with a long term average percent entrainment of 7.9 percent. Percent

1 entrainment of adult Delta Smelt under Alternative 3 would be similar to results  
2 under the Second Basis of Comparison.

3 As described in Appendix 9G, a proportional entrainment regression model  
4 (based on Kimmerer 2008) was used to simulate larval and early juvenile Delta  
5 Smelt entrainment, as influenced by OMR flow and location of X2 in March  
6 through June. Results indicate that the percentage of entrainment of larval and  
7 early juvenile Delta Smelt under Alternative 3 would be 5.6 to 20.5 percent,  
8 depending on the water year type, with a long term average percent entrainment  
9 of 12.7 percent, and highest entrainment under Critical water year conditions.  
10 Percent entrainment of larval and early juvenile Delta Smelt under Alternative 3  
11 would be similar to results under the Second Basis of Comparison.

#### 12 *Changes in Fall Abiotic Habitat Index*

13 The average September through December X2 position in km was used to  
14 evaluate the fall abiotic habitat availability for delta smelt under the Alternatives.  
15 X2 values simulated in the CalSim II model for each alternative were averaged  
16 over September through December, and compared. Results indicate that under  
17 the Second Basis of Comparison, the X2 position would range from 85.6 km to  
18 92.3 km, depending on the water year type, with a long term average X2 position  
19 of 88.1 km. The most eastward location of X2 is predicted under Critical water  
20 year conditions. The X2 positions predicted under Alternative 3 would be similar  
21 to predictions under the Second Basis of Comparison (only 0.1 to 0.3 km  
22 difference). Under Alternative 3, the long term average X2 position would be  
23 88.1 km, a location that does not provide for the advantageous overlap of the low  
24 salinity zone with Suisun Bay/Marsh.

#### 25 *Summary of Effects on Delta Smelt*

26 Overall, Alternative 3 likely would have similar effects on Delta Smelt, as  
27 compared to the Second Basis of Comparison with regard to estimated  
28 entrainment and predicted location of Fall X2. However, given the current  
29 condition of the Delta Smelt population, even small differences between  
30 alternatives may be important.

#### 31 *Longfin Smelt*

32 The effects of the Alternative 3 as compared to the Second Basis of Comparison  
33 were analyzed based on the direction and magnitude of OMR flows during the  
34 period (December through June) when adult, larvae, and young juvenile Longfin  
35 Smelt are present in the Delta in the vicinity of the export facilities  
36 (Appendix 5A). The analysis was augmented with calculated Longfin Smelt  
37 abundance index values (Appendix 9G) per Kimmerer et al. (2009), which is  
38 based on the assumptions that lower X2 values reflect higher flows and that  
39 transporting Longfin Smelt farther downstream leads to greater Longfin Smelt  
40 survival. The index value indicates the relative abundance of Longfin Smelt and  
41 not the calculated population.

42 As described in Appendix 5A, OMR flows would be negative in all months under  
43 both Alternative 3 and the Second Basis of Comparison. Flows under  
44 Alternative 3 generally would be less negative than under the Second Basis of



1 Comparison, except in June, July, and August, when OMR flows under  
2 Alternative 3 would be more negative by greater 25 percent in some months and  
3 year types. The increase in the magnitude of negative flows in June, July, and  
4 August under Alternative 3 could increase the likelihood of entrainment of  
5 Longfin Smelt at the export facilities.

6 Under Alternative 3, Longfin Smelt abundance index values range from 1,094  
7 under critical water year conditions to a high of 15,638 under wet water year  
8 conditions, with a long-term average value of 7,345 (see Appendix 9G). Under  
9 the Second Basis of Comparison, Longfin Smelt abundance index values range  
10 from 947 under critical water year conditions to a high of 15,822 under wet water  
11 year conditions, with a long-term average value of 7,257.

12 Results indicate that the Longfin Smelt abundance index values would be similar  
13 in wetter years and higher in drier water year types under Alternative 3 than they  
14 would be under the Second Basis of Comparison, with a long-term average index  
15 for Alternative 3 that is 1 similar to the long-term average index under the Second  
16 Basis of Comparison. The greatest increase in the Longfin Smelt abundance  
17 index occurs in critical years where it is 15.5 percent greater under Alternative 3  
18 than under the Second Basis of Comparison. For below normal, and dry water  
19 years, the Longfin Smelt abundance index values would be 9.7 and 13.8 percent  
20 higher, respectively, under Alternative 3 than under the Second Basis of  
21 Comparison. Based on the Longfin Smelt abundance indices, Alternative 3 likely  
22 would have a lower potential for adverse effects on Longfin Smelt, as compared  
23 to the Second Basis of Comparison. Given the current condition of the Longfin  
24 Smelt population, even these small differences between alternatives may be  
25 important.

#### 26 *Sacramento Splittail*

27 Under Alternative 3, flows entering the Yolo Bypass generally would similar to  
28 flows under the Second Basis of Comparison from December through March  
29 (Appendix 5A, Table C-26-5). Any differences likely would be insufficient to  
30 reduce potential Sacramento Splittail spawning habitat in the bypass. Given the  
31 relatively minor changes in flows into the Yolo Bypass, and the inherent  
32 uncertainty associated with the resolution of the CalSim II model (average  
33 monthly outputs), it is concluded that there would be no definitive difference in  
34 effects on Sacramento Splittail between Alternative 3 and the Second Basis of  
35 Comparison.

#### 36 *Reservoir Fishes*

37 The analysis of effects associated with changes in operation on reservoir fishes  
38 relied on evaluation of changes in available habitat (reservoir storage) and  
39 anticipated changes in black bass nesting success.

40 Alternative 3 as compared to the Second Basis of Comparison generally would  
41 result in similar (differences less than 5 percent) storage levels in CVP and SWP  
42 reservoirs during the March through June period (Appendix 5A).

1 In general, black bass nesting success also would be similar under Alternative 3  
2 and the Second Basis of Comparison. Nesting success of black bass would be  
3 high in March and April due to increasing water surface elevations. During May,  
4 the likelihood of high (>40 percent) nesting success would be similar in most of  
5 the reservoirs under Alternative 3 as compared to the Second Basis of  
6 Comparison. This pattern is reversed in June, with the likelihood of high nesting  
7 success being somewhat (5 to 7 percent) lower under Alternative 3  
8 (Appendix 9F). Most black bass spawning likely occurs prior to June, such that  
9 drawdowns during June would likely affect only a small proportion of the  
10 spawning population. Thus, it is concluded that effects on black bass nesting  
11 success would be similar under Alternative 3 and the Second Basis of  
12 Comparison.

### 13 *Other Species*

14 Several other fish species could be affected by changes in operations that  
15 influence temperature and flow. In general, lampreys, Striped Bass, American  
16 Shad, and Hardhead can tolerate higher temperatures than salmonids. Based on  
17 the similar water temperatures during their spawning and incubation period under  
18 Alternative 3, it is likely that thermal conditions for and effects on these other  
19 species in the Sacramento, Feather, and American rivers would be similar under  
20 Alternative 3 and the Second Basis of Comparison. Alternative 3 would result in  
21 a similar X2 position as compared to the Second Basis of Comparison during  
22 April, May, and June (Appendix 5A, Section C Table C-16-5). This similarity in  
23 the position of X2 would likely result in a similar survival index and habitat index  
24 as measured by salinity for Striped Bass and a similar abundance and habitat  
25 index for American Shad. Alternative 3 likely would have a similar potential for  
26 adverse effects on lampreys, American Shad, and Hardhead as the Second Basis  
27 of Comparison. However, the increased bag limits and ability of anglers to retain  
28 Striped Bass that are 12 inches in length versus 18 inches under Alternative 3  
29 could reduce the ability to meet the doubling goals for Striped Bass populations  
30 under the requirements of Section 3406(b)(1) of CVPIA. Overall, Alternative 3  
31 likely would have slightly greater potential for adverse effects on Striped Bass as  
32 compared to the Second Basis of Comparison, primarily due to the potential for  
33 adverse effects of changing the bag and size limits for Striped Bass under the  
34 predator control program.

### 35 *Stanislaus River/Lower San Joaquin River*

#### 36 *Fall-Run Chinook Salmon*

37 Changes in operations influence temperature and flow conditions that could affect  
38 fall-run Chinook Salmon in the Stanislaus River downstream of Goodwin Dam  
39 and in the San Joaquin River below Vernalis. The following describes those  
40 changes and their potential effects.

#### 41 *Changes in Water Temperature (Stanislaus River)*

42 Average monthly water temperatures in the Stanislaus River at Goodwin Dam  
43 under Alternative 3 generally would be similar to the Second Basis of Comparison  
44 but could be lower (up to 1.5°F) than under the Second Basis of Comparison in

1 September, October, and November of drier years (Appendix 6B, Table B-17-5).  
2 Downstream at Orange Blossom Bridge, average monthly water temperatures  
3 under Alternative 3 and the Second Basis of Comparison would generally be  
4 similar except from August through November of drier years when water  
5 temperatures could be up to up to 1.6°F cooler under Alternative 3 and in June  
6 when the average monthly water temperature could be 2.8°F warmer and up to  
7 4.3°F warmer in wet years under Alternative 3 as compared to the Second Basis  
8 of Comparison (Appendix 6B, Table B-18-5). This temperature pattern would  
9 continue downstream to the confluence with the San Joaquin River, although the  
10 magnitude of temperature differences under Alternative 3 (Appendix 6B,  
11 Table B-19-5) would be larger in June and water temperatures could be up to  
12 1.6°F cooler in April under Alternative 3 as compared to the Second Basis of  
13 Comparison. Lower fall water temperatures in drier years would reduce the  
14 likelihood of adverse effects on spawning fall-run Chinook Salmon.

15 *Changes in Exceedance of Water Temperature Thresholds*  
16 *(Stanislaus River)*

17 While specific water temperature thresholds for fall-run Chinook Salmon in the  
18 Stanislaus River are not established, temperatures generally suitable for fall-run  
19 Chinook Salmon spawning (56°F) would be exceeded in October (over 30 percent  
20 of the time) and November over 20 percent of the time in the Stanislaus River at  
21 Goodwin Dam under Alternative 3 (Appendix 6B, Table B-17-1). Similar  
22 exceedances would occur under the Second Basis of Comparison. Water  
23 temperatures for rearing generally would be below 56°F, except in May.

24 Downstream at Orange Blossom Bridge, water temperatures suitable for fall-run  
25 Chinook Salmon spawning would be exceeded frequently under both  
26 Alternative 3 and the Second Basis of Comparison during October and November,  
27 but the 56°F threshold would be exceeded 2 percent more frequently in October  
28 and 4 percent less frequently in November percent.

29 During January through May, rearing fall-run Chinook Salmon under  
30 Alternative 3 and the Second Basis of Comparison would be subjected to average  
31 monthly water temperatures that exceed 56°F, with water temperatures under  
32 Alternative 3 exceeding the threshold in April about 4 percent less frequently and  
33 about 7 percent more frequently in May than under the Second Basis of  
34 Comparison (Appendix 6B, Figure B-18-5).

35 *Changes in Egg Mortality (Stanislaus River)*

36 For fall-run Chinook Salmon in the Stanislaus River, egg mortality rates would be  
37 similar under both scenarios (Appendix 9C, Table B-8).

38 *Changes in Delta Hydrodynamics*

39 San Joaquin River-origin fall-run Chinook Salmon smolts are most abundant in  
40 the Delta during the months of April, May and June. Near the confluence of the  
41 San Joaquin River and the Mokelumne River, the median proportion of positive  
42 velocities would be similar to or slightly lower under Alternative 3 relative to the  
43 Second Basis of Comparison in the months when fall-run would be most abundant

1 (Appendix 9K). On Old River downstream of the facilities, the median  
 2 proportion of positive velocities would be slightly higher in April and May, and  
 3 similar in June under Alternative 3 relative to the Second Basis of Comparison.  
 4 In Old River upstream of the facilities, the median proportion of positive  
 5 velocities would be moderately higher under Alternative 3 in April and May, and  
 6 slightly lower in June. On the San Joaquin River downstream of the Head of Old  
 7 River, the median proportion of positive velocities would be slightly to  
 8 moderately lower under Alternative 3 relative to the Second Basis of Comparison  
 9 in April and May, respectively, and slightly lower in June.

#### 10 *Changes in Junction Entrainment*

11 Entrainment at the Georgiana Slough Junction under Alternative 3 would be  
 12 almost indistinguishable from the Second Basis of Comparison in April, May, and  
 13 June (Appendix 9L). At the Head of Old River junction in April and May,  
 14 entrainment would be much greater under Alternative 3 relative to the Second  
 15 Basis of Comparison (Appendix 9L). In June, entrainment would be similar  
 16 under each scenario. Patterns of entrainment would be similar at Turner Cut,  
 17 Columbia Cut, Middle River, and Old River. At these junctions, median  
 18 entrainment under Alternative 3 would be slightly to moderately lower in April  
 19 and May, and almost indistinguishable in June.

#### 20 *Summary of Effects on Fall-Run Chinook Salmon*

21 The analysis of temperatures indicates somewhat similar temperatures and a  
 22 similar likelihood of exceedance of suitable temperatures for spawning and  
 23 rearing of fall-run Chinook Salmon under Alternative 3 as compared to the  
 24 Second Basis of Comparison in the Stanislaus River below Goodwin Dam and in  
 25 the San Joaquin River at Vernalis. The effect of lower temperatures is reflected in  
 26 the similar overall mortality of fall-run Chinook Salmon eggs predicted by  
 27 Reclamation's salmon mortality model for fall-run in the Stanislaus River.

28 Overall, Alternative 3 likely would have similar effects on the fall-run Chinook  
 29 Salmon population in the San Joaquin River watershed as compared to the Second  
 30 Basis of Comparison. Alternative 3 could also provide beneficial effects to  
 31 juvenile fall-run Chinook Salmon as a result of trap and haul passage through the  
 32 Delta and ocean harvest restrictions. It remains uncertain, however, if predator  
 33 management actions under Alternative 3 would benefit fall-run Chinook Salmon.

#### 34 *Steelhead*

35 Changes in operations that influence temperature and flow conditions in the  
 36 Stanislaus River downstream of Goodwin Dam and the San Joaquin River below  
 37 Vernalis could affect steelhead. The following describes those changes and their  
 38 potential effects.

#### 39 *Changes in Water Temperature (Stanislaus River)*

40 Average monthly water temperatures in the Stanislaus River at Goodwin Dam  
 41 under Alternative 3 generally would be similar to the Second Basis of Comparison  
 42 but could be lower (up to 1.5°F) than under the Second Basis of Comparison in  
 43 September, October, and November of drier years. Downstream at Orange

1 Blossom Bridge, average monthly water temperatures under Alternative 3 and the  
2 Second Basis of Comparison would generally be similar except from August  
3 through November of drier years when water temperatures could be up to up to  
4 1.6°F cooler under Alternative 3 and in June when the average monthly water  
5 temperature could be 2.8°F warmer and up to 4.3°F warmer in drier years under  
6 Alternative 3 as compared to the Second Basis of Comparison. This temperature  
7 pattern would continue downstream to the confluence with the San Joaquin River,  
8 although the magnitude of temperature differences under Alternative 3 would be  
9 larger in June and water temperatures could be up to 1.6°F cooler in April under  
10 Alternative 3 as compared to the Second Basis of Comparison.

11 *Changes in Exceedance of Water Temperature Thresholds*  
12 *(Stanislaus River)*

13 Average monthly water temperatures in the Stanislaus River at Orange Blossom  
14 Bridge would frequently exceed the temperature threshold (56°F) established for  
15 adult steelhead migration under both Alternative 3 and the Second Basis of  
16 Comparison during October and November, with the threshold being exceeded  
17 2 percent more frequently in October and 4 percent less frequently in  
18 November percent. In January through May, the temperature threshold at Orange  
19 Blossom Bridge is 55°F, which is intended to support steelhead spawning. Under  
20 Alternative 3, this threshold would be exceeded under Alternative 3 about  
21 8 percent and 10 percent more frequently in March and May, respectively, than  
22 under the Second Basis of Comparison. However, the threshold would be  
23 exceeded 16 percent less frequently under Alternative 3 in April.

24 During June through November, the temperature threshold of 65°F established to  
25 support steelhead rearing would be exceeded under both Alternative 3 and the  
26 Second Basis of Comparison in all months but November, with the highest  
27 frequency of exceedance in July (19 percent under Alternative 3). The  
28 differences between Alternative 3 and the Second Basis of Comparison, however,  
29 would be variable depending on the month, with water temperatures under  
30 Alternative 3 exceeding the threshold 2 percent to 4 percent more frequently than  
31 under the Second Basis of Comparison in June and July and up to 4 percent less  
32 frequently from August to October.

33 Average monthly water temperatures also would exceed the threshold (52°F)  
34 established for smoltification at Knights Ferry from January through May under  
35 both Alternative 3 and the Second Basis of Comparison. Differences in the  
36 likelihood of threshold exceedance between scenarios would be small (up to  
37 3 percent) with the threshold being more likely to be exceeded in March and less  
38 likely to be exceeded in April and May. Farther downstream at Orange Blossom  
39 Bridge, the temperature threshold for smoltification is higher (57°F). Under  
40 Alternative 3, water temperatures would exceed the 57°F threshold about  
41 4 percent less frequently in April and about 7 percent more frequently than under  
42 the Second Basis of Comparison in May.

1                    *Changes in Delta Hydrodynamics*

2 San Joaquin River-origin steelhead generally move through the Delta during  
3 spring; however, there is less information on their timing than there is for  
4 Chinook salmon. Thus, hydrodynamics in the entire January through June period  
5 could have the potential to affect juvenile steelhead. For a description of potential  
6 hydrodynamic effects on steelhead, see the descriptions for winter-run Chinook  
7 Salmon in the Sacramento Basin and fall-run Chinook Salmon in the San Joaquin  
8 River basin, above.

9                    *Summary of Effects on Steelhead*

10 Given the frequency of exceedance under both Alternative 3 and the Second Basis  
11 of Comparison, water temperature conditions for steelhead in the Stanislaus River  
12 would likely be similar. The differences in temperature exceedance would be  
13 variable (both positive and negative) between Alternative 3 and the Second Basis  
14 of Comparison, with no clear benefit associated with either alternative.  
15 Discerning a meaningful difference between these two scenarios based on the  
16 quantitative results is not possible because of the similarity in results (generally  
17 differences less than 5 percent) and the inherent uncertainty of the models. Thus,  
18 it is concluded that the effects on steelhead would be similar under Alternative 3  
19 and the Second Basis of Comparison.

20                    *White Sturgeon*

21 Evidence of White Sturgeon spawning has been recorded in the San Joaquin River  
22 upstream of the confluence with the Stanislaus River. While flows in the San  
23 Joaquin River upstream of the Stanislaus River are expected to be similar under all  
24 alternatives, flow contributions from the Stanislaus River could influence water  
25 temperatures in the San Joaquin River where White Sturgeon eggs or larvae may  
26 occur during the spring and early summer. The magnitude of influence on water  
27 temperature would depend on the proportional flow contribution of the Stanislaus  
28 River and the temperatures in both the Stanislaus and San Joaquin rivers. The  
29 potential for an effect on White Sturgeon eggs and larvae would be influenced by  
30 the proportion of the population occurring in the San Joaquin River. In  
31 consideration of this uncertainty, it is not possible to distinguish potential effects  
32 on White Sturgeon between alternatives.

33                    *Reservoir Fishes*

34                    *Changes in Available Habitat (Storage)*

35 As described in Chapter 5, Surface Water Resources and Water Supplies, storage  
36 levels in New Melones Reservoir would be higher under Alternative 3 as  
37 compared to the Second Basis of Comparison, as summarized in Table 5.38, due  
38 to higher allocations of water supplies to CVP water service contractors, less  
39 fisheries flows, no water quality releases under SWRCB D-1641, and no  
40 Bay-Delta flow releases under SWRCB D-1641.

41 Storage in New Melones could be increased up to around 20 percent in some  
42 months of some water year types. Additional information related to monthly  
43 reservoir elevations is provided in Appendix 5A, CalSim II and DSM2 Modeling.  
44 It is anticipated that aquatic habitat within New Melones is not limiting; however,

1 storage volume is an indicator of how much habitat is available to fish species  
2 inhabiting these reservoirs. Therefore, the amount of habitat for reservoir fishes  
3 could be increased under Alternative 3 as compared to the Second Basis of  
4 Comparison.

5 *Changes in Black Bass Nesting Success*

6 Results of the bass nesting success analysis are presented in Appendix 9F,  
7 Reservoir Fish Analysis Documentation. For March, the likelihood of  
8 Largemouth Bass and Smallmouth Bass nest survival in New Melones being  
9 above 40 percent is similar under Alternative 3 and the Second Basis of  
10 Comparison. For April, the likelihood that nest survival of Largemouth Bass and  
11 Smallmouth Bass is between 40 and 100 percent is reasonably high (around  
12 80 percent) but is about 5 percent lower under Alternative 3 as compared to the  
13 Second Basis of Comparison. For May, the pattern is reversed with the likelihood  
14 of high nest survival being about 7 percent greater under Alternative 3. For June,  
15 the likelihood of survival being greater than 40 percent for Largemouth Bass and  
16 Smallmouth Bass in New Melones is about 38 percent greater under Alternative 3  
17 as compared to the Second Basis of Comparison. For Spotted Bass, nest survival  
18 from March through June is anticipated to be near 100 percent in every year under  
19 both Alternative 3 and the Second Basis of Comparison. Most black bass  
20 spawning likely occurs prior to June, such that drawdowns during June would  
21 likely affect only a small proportion of the spawning population. Thus, it is  
22 concluded that effects on black bass nesting success would be similar under  
23 Alternative 3 and the Second Basis of Comparison.

24 The analysis of black bass nest survival based on changes in water surface  
25 elevation during the spawning period indicated that the likelihood of high  
26 (>40 percent) nest survival in New Melones under Alternative 3 would be similar  
27 to or higher than under the Second Basis of Comparison. This suggests that  
28 conditions in New Melones could be more likely to support self-sustaining  
29 populations of black bass under Alternative 3 than under the Second Basis of  
30 Comparison.

31 *Other Species*

32 Changes in operations that influence temperature and flow conditions in the  
33 Stanislaus River downstream of Goodwin Dam and the San Joaquin River at  
34 Vernalis could affect other species such as lampreys, Hardhead, and Striped Bass.  
35 As described above, water temperatures would generally be similar under  
36 Alternative 3 and the Second Basis of Comparison. In general, lampreys, Striped  
37 Bass and Hardhead can tolerate higher temperatures than salmonids. Given the  
38 similar flows and temperatures during their spawning and incubation period, it is  
39 likely that the potential to affect these species in the Stanislaus and San Joaquin  
40 rivers would be similar under Alternative 3 and the Second Basis of Comparison.  
41 However, the increased bag limits and ability of anglers to retain Striped Bass that  
42 are 12 inches in length versus 18 inches under Alternative 3 could reduce the  
43 ability to meet the doubling goals for Striped Bass populations under the  
44 requirements of Section 3406(b)(1) of CVPIA.

1 *San Francisco Bay Area Region*2 *Killer Whale*

3 As described above for the comparison of Alternative 1 to the No Action  
4 Alternative, it is unlikely that the Chinook Salmon prey base of killer whales,  
5 supported heavily by hatchery production of fall-run Chinook Salmon, would be  
6 appreciably affected by any of the alternatives.

7 **9.4.3.5 Alternative 4**

8 The CVP and SWP operations under Alternative 4 are identical to the CVP and  
9 SWP operations under the Second Basis of Comparison and Alternative 1, as  
10 described in Chapter 3, Description of Alternatives. Alternative 4 also includes  
11 the following items that are not included in the No Action Alternative or the  
12 Second Basis of Comparison and would affect fish and aquatic resources.

- 13 • Implement predator control programs for black bass, Striped Bass, and  
14 Pikeminnow to protect salmonids and Delta Smelt as follows:
  - 15 – Black bass catch limit changed to allow catch of 12-inch fish with a bag  
16 limit of 10
  - 17 – Striped Bass catch limit changed to allow catch of 12-inch fish with a bag  
18 limit of 5
  - 19 – Establish a Pikeminnow sport-fishing reward program with a 8-inch limit  
20 at \$2/fish
- 21 • Establish a trap and haul program for juvenile salmonids entering the Delta  
22 from the San Joaquin River in March through June as follows:
  - 23 – Begin operation of downstream migrant fish traps upstream of the Head of  
24 Old River on the San Joaquin River
  - 25 – “Barge” all captured juvenile salmonids through the Delta, release at  
26 Chipps Island.
  - 27 – Tag subset of fish in order to quantify effectiveness of the program
  - 28 – Attempt to capture 10 percent to 20 percent of outmigrating juvenile  
29 salmonids
- 30 • Work with Pacific Fisheries Management Council, CDFW, and NMFS to  
31 impose salmon harvest restrictions to reduce by-catch of winter-run and  
32 spring-run Chinook Salmon to less than 10 percent of age-3 cohort in all years

33 As described in Chapter 4, Approach to Environmental Analysis, Alternative 4 is  
34 compared to the No Action Alternative and the Second Basis of Comparison.

35 **9.4.3.5.1 Alternative 4 Compared to the No Action Alternative**36 *Trinity River Region*

37 The CVP and SWP operations under Alternative 4 are identical to the CVP and  
38 SWP operations under the Second Basis of Comparison and Alternative 1.  
39 Therefore, changes in aquatic resources at Trinity Lake and along the Trinity



1 River and lower Klamath River under Alternative 4 as compared to the No Action  
2 Alternative would be the same as the impacts described in Section 10.4.4.2.1,  
3 Alternative 1 Compared to the No Action Alternative.

4 *Central Valley Region and Stanislaus River*

5 The CVP and SWP operations under Alternative 4 are identical to the CVP and  
6 SWP operations under the Second Basis of Comparison and Alternative 1.  
7 Therefore, changes in aquatic habitat conditions at CVP and SWP reservoirs, in  
8 the rivers downstream of the reservoirs, and in the Delta under Alternative 4 as  
9 compared to the No Action Alternative would be the same as the impacts  
10 described in Section 9.4.3.2.1, Alternative 1 Compared to the No Action  
11 Alternative.

12 Conditions related to salmonid survival could be improved under Alternative 4 as  
13 compared to the No Action Alternative due to implementation of changes in  
14 Striped Bass bag limits for predator control and changes in PMFC/NMFS harvest  
15 limits. However, these benefits would not likely exceed those described for the  
16 No Action Alternative, particularly in consideration of the provision of fish  
17 passage upstream of Shasta and Folsom dams to address long-term temperature  
18 challenges on listed salmonids caused by climate change.

19 Conditions for Striped Bass under Alternative 4 could be influenced by  
20 implementation of a predator control program that reduces the size restrictions  
21 and increases the catch limit for Striped Bass taken in the sport fishery. This also  
22 could reduce the ability to meet the doubling goals for Striped Bass populations  
23 under the requirements of Section 3406(b)(1) of CVPIA.

24 *San Francisco Bay Area Region*

25 *Killer Whale*

26 As described above the comparison of Alternative 1 to the No Action Alternative,  
27 it is unlikely that the Chinook Salmon prey base of killer whales, supported  
28 heavily by hatchery production of fall-run Chinook Salmon, would be appreciably  
29 affected by any of the alternatives.

30 **9.4.3.5.2 Alternative 4 Compared to the Second Basis of Comparison**

31 *Trinity River Region*

32 The CVP and SWP operations under Alternative 4 are identical to the CVP and  
33 SWP operations under the Second Basis of Comparison and Alternative 1.  
34 Therefore, aquatic resources conditions at Trinity Lake and along the Trinity  
35 River and lower Klamath River under Alternative 4 be the same as under the  
36 Second Basis of Comparison.

37 *Central Valley Region and Stanislaus River*

38 The CVP and SWP operations under Alternative 4 are identical to the CVP and  
39 SWP operations under the Second Basis of Comparison and Alternative 1.  
40 Therefore, changes in aquatic habitat conditions at CVP and SWP reservoirs, in  
41 the rivers downstream of the reservoirs, and in the Delta due to operations under

1 Alternative 4 would be the same as described for the Second Basis of  
2 Comparison.

3 Conditions related to salmonid survival could be improved under Alternative 4 as  
4 compared to the Second Basis of Comparison due to implementation of the Trap  
5 and Haul Program, changes in bag limits, and changes in PMFC/NMFS harvest  
6 limits. Conditions related to year class strength of juvenile sturgeon would be the  
7 same under the Alternative 4 relative to the Second Basis of Comparison due to  
8 similar reductions in mean (March to July) Delta outflow. Conditions for Striped  
9 Bass under Alternative 4 would be the same as those described above for the  
10 comparison to the No Action Alternative.

11 However, it should be noted that the changes in ocean harvest limits under  
12 Alternative 4 could be inconsistent with NMFS' fisheries management framework  
13 for reducing the impact of ocean salmon fishery on winter-run Chinook Salmon  
14 for the Pacific Coast Salmon Fishery Management Plan (National Marine  
15 Fisheries Service 2012). The framework consists of two components. The first  
16 component specifies that the previous standards for winter-run Chinook Salmon  
17 regarding minimum size limits and seasonal windows south of Point Arena for  
18 both the commercial and recreational fisheries will continue to remain in effect at  
19 all times regardless of abundance estimates or impact rate limit. The second  
20 component is based on the population status of winter-run Chinook Salmon  
21 where, during periods of relatively low abundance, the proposed structure of  
22 fishing management measures each year for winter-run Chinook Salmon south of  
23 Point Arena must be equal to or less than the maximum allowable impact rate  
24 (MAIR) specified annually. The fishery control rule and tiered approach for  
25 managing impacts to winter-run Chinook Salmon in the ocean salmon fishery  
26 include: (1) if the geometric mean of the most recent 3 years of spawning return  
27 estimates is less than 500, the MAIR is zero percent; and (2) if the geometric  
28 mean of the most recent 3 years of spawning return estimates is between 500 and  
29 4,000, the MAIR is between 10 percent and 20 percent, increasing linearly.

30 If Alternative 4 were selected, Reclamation would be required to re-consult with  
31 NMFS regarding all aspects of the alternative that could result in the take of listed  
32 salmonids before implementation, including the provisions of the proposed  
33 changes in harvest limits.

#### 34 *Killer Whale*

35 As described above for the comparison of Alternative 1 to the No Action  
36 Alternative, it is unlikely that the Chinook Salmon prey base of killer whales,  
37 supported heavily by hatchery production of fall-run Chinook Salmon, would be  
38 appreciably affected by any of the alternatives.

#### 39 **9.4.3.6 Alternative 5**

40 As described in Chapter 3, Description of Alternatives, CVP and SWP operations  
41 under Alternative 5 are similar to the No Action Alternative with modified OMR  
42 flow criteria and New Melones Reservoir operations. As described in Chapter 4,  
43 Approach to Environmental Analysis, Alternative 5 is compared to the No Action  
44 Alternative and the Second Basis of Comparison.

1 Alternative 5 also includes the Delta Cross Channel Temporary Closure Multi-  
2 year Study. As noted in the Finding of No Significant Impact (FONSI) document  
3 from Reclamation (Reclamation, 2012), this study proposes closing the DCC for  
4 up to 10 days during the first half of October from 2012 through 2016. The  
5 FONSI also notes that the DCC closure would not cause any adverse effects to the  
6 native aquatic and fisheries. Therefore, the effects of this study are not  
7 considered any further in the impact analyses for Alternative 5 below.

#### 8 **9.4.3.6.1 Alternative 5 Compared to the No Action Alternative**

9 Because of the considerable similarities between Alternative 5 and the No Action  
10 Alternative, the analysis below combines species within some regions where to  
11 reduce repetition.

##### 12 *Trinity River Region*

13 *Coho Salmon, Spring-run Chinook Salmon, Fall-run Chinook Salmon,*  
14 *Steelhead, and Green Sturgeon*

15 Average monthly water temperature in the Trinity River at Lewiston Dam under  
16 Alternative 5 would be similar to water temperatures under the No Action  
17 Alternative (less than 0.5°F differences) in all months (Appendix 6B,  
18 Table B-1-3). Similarly, the differences in the frequency with which  
19 Alternative 5 and the No Action Alternative would exceed established  
20 temperature thresholds also would be small (up to 1 or 2 percent) (Appendix 9N).  
21 These temperature results are reflected in the egg mortality results for fall-run  
22 Chinook Salmon in the Trinity River, which indicate similar mortality under  
23 Alternative 5 and the No Action Alternative (Appendix 9C, Table B-5).

24 The minor differences in temperature and mortality results suggest that conditions  
25 for Coho Salmon, spring-run Chinook Salmon, fall-run Chinook Salmon,  
26 steelhead and Green Sturgeon in the Trinity River generally would be similar  
27 under Alternative 5 and the No Action Alternative. Given the similarity of the  
28 results and the inherent uncertainty associated with the resolution of the  
29 temperature model (average monthly outputs), it is concluded that Alternative 5  
30 and the No Action Alternative are likely to have similar effects on salmonids and  
31 sturgeon in the Trinity River.

##### 32 *Reservoir Fishes*

33 Reservoir fishes in Trinity Lake would be exposed to relatively minor differences  
34 in storage (less than 5 percent) under Alternative 5 (Appendix 5A) as compared to  
35 the No Action Alternative and these relatively small differences likely would have  
36 little effect on the amount of habitat available for these species. Black bass  
37 nesting survival would be similar under Alternative 5 and the No Action  
38 Alternative (Appendix 9F). The minor differences in storage and similar nesting  
39 success suggest that effects on reservoir fishes in Trinity Lake would be similar  
40 under Alternative 5 and the No Action Alternative.

1        *Other Species*

2        The minor differences in average monthly water temperatures described above for  
3        salmonids apply to Pacific Lamprey and Eulachon. These minor differences  
4        suggest that conditions for aquatic species in the Trinity River and Klamath River  
5        downstream of the confluence generally would be similar under Alternative 5 and  
6        the No Action Alternative. Given the similarity of the results and the inherent  
7        uncertainty associated with the resolution of the temperature model (average  
8        monthly outputs), it is concluded that Alternative 5 and the No Action  
9        Alternative are likely to have similar effects on the lamprey and Eulachon in the  
10       Trinity River.

11       *Sacramento River System*

12         *Winter-run Chinook Salmon*

13       Changes in operations that influence temperature and flow conditions in the  
14       Sacramento River downstream of Keswick Dam could affect winter-run Chinook  
15       Salmon. The following describes those changes and their potential effects.

16             *Changes in Water Temperature*

17       Monthly water temperature in the Sacramento River at Keswick Dam under  
18       Alternative 5 and the No Action Alternative would be similar (differences of less  
19       than 0.5°F) (Appendix 6B, Table B-5-3). Differences in the frequency of  
20       exceeding temperature thresholds under Alternative 5 and the No Action  
21       Alternative also would be small (less than 3 percent) (Appendix 9N). The  
22       differences in water temperatures and temperature threshold exceedances  
23       predicted at locations in the downstream reaches are similar to those predicted at  
24       Keswick Dam. Egg mortality is anticipated to be similar under Alternative 5 and  
25       the No Action Alternative (Appendix 9C, Table B-4).

26             *Changes in Weighted Usable Area*

27       The WUA results for winter-run Chinook Salmon spawning habitat between  
28       Keswick Dam and Battle Creek indicated that available spawning habitat under  
29       Alternative 5 and the No Action Alternative would be similar (less than 5 percent  
30       difference) (Appendix 9E, Table C-17-3). The results were similar for fry and  
31       juvenile rearing (Appendix 9E, Table C-18-3 and Table C-19-3).

32             *Changes in SALMOD Output*

33       SALMOD results indicated that potential juvenile production under Alternative 5  
34       would be the similar to the No Action Alternative in all water year types  
35       (Appendix 9D, Table B-4-11).

36             *Changes in Delta Passage Model Output*

37       The Delta Passage Model predicted similar estimates of annual Delta survival  
38       across the 81-year time period for winter-run Chinook Salmon between  
39       Alternative 5 and the No Action Alternative (Appendix 9J). Median Delta  
40       survival was 0.35 for Alternative 5 and 0.349 for the No Action Alternative.

1            *Changes in Delta Hydrodynamics*

2 Winter-run Chinook Salmon smolts are most abundant in the Delta during  
3 January, February and March. On the Sacramento River near the confluence of  
4 Georgiana Slough, the median proportion of positive velocities under  
5 Alternative 5 were indistinguishable from the No Action Alternative in January,  
6 February and March (Appendix 9K). On the San Joaquin River near the  
7 Mokelumne River confluence, the median proportion of positive velocities also  
8 was indistinguishable between these two scenarios. In Old River, both upstream  
9 and downstream of the facilities, the median proportion of positive velocities was  
10 indistinguishable in the months when winter run Chinook Salmon are present. On  
11 the San Joaquin River downstream of the Head of Old River, there was no  
12 discernable difference in the median proportion of positive velocities between  
13 these two scenarios.

14            *Changes in Junction Entrainment*

15 For all junctions examined, the median entrainment probabilities under both  
16 Alternative 5 and the No Action Alternative were almost indistinguishable  
17 (Appendix 9L).

18            *Changes in Salvage*

19 There were no discernable differences in predicted salvage between Alternative 5  
20 and No Action Alternative (Appendix 9M).

21            *Changes in Oncorhynchus Bayesian Analysis Output*

22 Escapement and Delta survival was modeled by the OBAN model for winter-run  
23 Chinook salmon. Escapement was similar under Alternative 5 as compared to the  
24 No Action Alternative (Appendix 9I) as was through-Delta survival.

25            *Changes in Interactive Object-Oriented Simulation Output*

26 The IOS model predicted similar adult escapement trajectories for winter-run  
27 Chinook Salmon between Alternative 5 and the No Action Alternative across the  
28 81 water years (Appendix 9H). Alternative 5 median adult escapement was  
29 3,545 and No Action Alternative median escapement was 3,935.

30 Similar to adult escapement, the IOS model predicted similar egg survival for  
31 winter-run Chinook Salmon between Alternative 5 and the No Action  
32 Alternative across the 81 water years (Appendix 9H). Median egg survival was  
33 0.989 for Alternative 5 and 0.990 for the No Action Alternative.

34            *Summary of Effects on Winter-Run Chinook Salmon*

35 The analysis of temperatures suggested that the frequency of temperature  
36 threshold exceedance under Alternative 5 would be similar to the No Action  
37 Alternative. This was reflected in Reclamation's salmon mortality model results,  
38 which predicted egg mortality would be similar under Alternative 5 and the No  
39 Action Alternative. The analysis of flow changes under Alternative 5 suggested  
40 that availability of spawning habitat for winter-run Chinook Salmon would  
41 similar under Alternative 5 and the No Action Alternative; SALMOD also  
42 indicated that there would be similar juvenile production under these two  
43 alternatives. Through Delta survival of juvenile winter-run Chinook Salmon

1 would be the same under both Alternative 5 and the No Action Alternative as  
 2 indicated by the DPM and the OBAN results. Median adult escapement to the  
 3 Sacramento River would be similar under Alternative 5 and the No Action  
 4 Alternative as indicated by the IOS and OBAN model results. Additional  
 5 analyses attempting to assess the effects on routing, entrainment and salvage of  
 6 juvenile salmonids in the Delta all indicate the effects would be similar between  
 7 Alternative 5 and the No Action Alternative.

8 Given the similarity of the results and the inherent uncertainty associated with the  
 9 resolution of the models, it is concluded that Alternative 5 and the No Action  
 10 Alternative are likely to have similar effects on the winter-run Chinook Salmon in  
 11 the Sacramento River and Delta.

12 *Spring-run Chinook Salmon, Fall-run Chinook Salmon, Late Fall-run*  
 13 *Chinook Salmon, Steelhead, Green Sturgeon and White Sturgeon*  
 14 *Changes in Water Temperature*

15 Average monthly water temperatures in the Sacramento River under Alternative 5  
 16 and the No Action Alternative would be similar (differences of less than 0.5°F)  
 17 (Appendix 6B, Table B-5-3). Differences in the frequency of exceeding  
 18 temperature thresholds under Alternative 5 and the No Action Alternative would  
 19 be relatively small (differences less than 2 percent) for the spring-run, fall-run,  
 20 and late fall-run Chinook Salmon, steelhead, and sturgeon in the Sacramento  
 21 River (Appendix 9N).

22 In Clear Creek, average monthly water temperatures at Igo under Alternative 5  
 23 relative to the No Action Alternative would be similar (differences less than  
 24 0.5°F) (Appendix 6B, Table B-3-3). The frequency of exceeding temperature  
 25 thresholds for spring-run Chinook Salmon rearing also would be small  
 26 (differences of up to 1 percent) (Appendix 9N).

27 In the Feather River, average monthly water temperatures in the low flow channel  
 28 under Alternative 5 relative to the No Action Alternative would be similar  
 29 (differences less than 0.5°F) (Appendix 6B, Table B-20-3). Water temperatures at  
 30 the downstream location also would be similar. Changes in the frequency of  
 31 exceeding temperature thresholds would be relatively small (differences of  
 32 2 percent or less) between the two scenarios for the fall-run Chinook Salmon,  
 33 spring-run Chinook Salmon, steelhead, and Green Sturgeon.

34 In the American River at Watt Avenue, average monthly water temperatures  
 35 under Alternative 5 and the No Action Alternative would be similar (differences  
 36 less than 0.5°F) (Appendix 6B, Table B-13-3). Changes in the frequency of  
 37 exceeding temperature thresholds would be small (differences of 1 percent or  
 38 less) between the two scenarios for fall-run Chinook Salmon and steelhead.

39 Egg mortality for all races Chinook Salmon within the Sacramento River system  
 40 was predicted to be similar under Alternative 5 and the No Action  
 41 Alternative (Appendix 9C, Tables B-1, B-6 and B-7).

1            *Changes in SALMOD Output*

2 SALMOD results indicated that potential spring-run Chinook Salmon juvenile  
3 production under Alternative 5 would be the similar to the No Action  
4 Alternative in all water year types (Appendix 9D, Table B-3-11).

5            *Changes in Delta Passage Model Output*

6 The Delta Passage Model predicted similar estimates of annual Delta survival  
7 across the 81-year time period for spring-run, fall-run and late fall-run Chinook  
8 Salmon between Alternative 5 and the No Action Alternative (Appendix 9J).

9            *Changes in Delta Hydrodynamics*

10 As described in Appendix 9K, the median proportion of time that velocity was  
11 positive at various junctions in the Delta were projected to be similar under  
12 Alternative 5 compared to the No Action Alternative.

13           *Changes in Junction Entrainment*

14 As described in Appendix 9L, median entrainment at various junctions is  
15 indistinguishable or lower under Alternative 5 compared to the No Action  
16 Alternative for fall-run, late fall-run, and spring-run Chinook Salmon.

17           *Changes in Salvage*

18 As described in Appendix 9M, salvage of migrating spring-run, late-fall run and  
19 fall-run smolts is similar or lower under Alternative 5 compared to the No Action  
20 Alternative.

21           *Changes in Delta Outflow*

22 As described in Appendix 9P, mean (March to July) Delta outflow was used an  
23 indicator of potential year class strength and the likelihood of producing a strong  
24 year class of sturgeon. The median value over the 82-year CalSim II modeling  
25 period of mean (March to July) Delta outflow was predicted to be similar under  
26 the Alternative 5 and the No Action Alternative. In addition, the likelihood of  
27 mean (March to July) Delta outflow exceeding the threshold of 50,000 cfs was the  
28 same under both alternatives.

29           *Summary of Effects on Spring-run Chinook Salmon, Fall-run Chinook*  
30           *Salmon, Late Fall-run Chinook Salmon, Steelhead, Green Sturgeon and*  
31           *White Sturgeon*

32 The analysis of temperatures indicates similar temperatures and likelihood of  
33 exceedance of temperature thresholds under Alternative 5 as compared to the No  
34 Action Alternative in the Clear Creek, and the Sacramento, Feather, and  
35 American rivers. This was reflected in Reclamation's salmon mortality model  
36 results for the fall-run on the Sacramento, Feather and American rivers which  
37 predicted similar Chinook Salmon mortalities under Alternative 5 and the No  
38 Action Alternative. There would be no change in flows in Clear Creek and  
39 Feather River low flow channel. Flows are expected to be similar in Sacramento  
40 River and American River. Flows in May in the Feather River are reduced  
41 (Appendix 5A). However, most of the spawning habitat in the Feather River is in  
42 the low flow channel; therefore, this reduction in May flow would only have

1 minor effect on the availability of the habitat. SALMOD results indicate that the  
2 potential production for the fall-run, late fall-run and spring-run Chinook Salmon  
3 on the Sacramento River would be similar. Delta survival is expected to be  
4 similar as indicated by the Delta Passage Model and OBAN results, and the  
5 entrainment risk would be lower based on the expected changes in OMR flows  
6 under Alternative 5. Additional analyses attempting to assess the effects on  
7 routing, entrainment and salvage of juvenile salmonids in the Delta all indicate  
8 the effects would be similar under Alternative 5 and the No Action Alternative.  
9 The analysis based on Delta outflows suggests that Alternative 5 provides similar  
10 mean (March to July) outflows which would have similar effects on year class  
11 strength of juvenile sturgeon relative to the No Action Alternative.

12 Given the similarity of the results and the inherent uncertainty associated with the  
13 resolution of the models, it is concluded that Alternative 5 and the No Action  
14 Alternative are likely to have similar effects on salmonids and sturgeon in the  
15 Sacramento River and Delta.

#### 16 *Delta Smelt*

17 A proportional entrainment regression model (based on Kimmerer 2008, 2011)  
18 was used to simulate adult Delta Smelt entrainment, as influenced by OMR flow  
19 in December through March. Results indicate that the percentage of entrainment  
20 of migrating and spawning adult Delta Smelt under Alternative 5 will be nearly  
21 identical to the results estimated for the No Action Alternative in all water  
22 year types.

23 A proportional entrainment regression model (based on Kimmerer 2008) also was  
24 used to simulate larval and early juvenile Delta Smelt entrainment, as influenced  
25 by OMR flow and location of X2 in March through June. Results indicate that  
26 the percentage of entrainment of larval and early juvenile Delta Smelt under  
27 Alternative 5 would be similar to that estimated for the No Action Alternative.

28 The average September through December X2 position in km was used to  
29 evaluate the fall abiotic habitat availability for delta smelt under the Alternatives.  
30 X2 values simulated in the CalSim II model for each alternative were averaged  
31 over September through December, and compared. Results indicate that fall X2  
32 values under Alternative 5 would be nearly identical to the No Action Alternative.

33 Given the similarity of the results and the inherent uncertainty associated with the  
34 resolution of the models, it is concluded that Alternative 5 and the No Action  
35 Alternative are likely to have similar effects on Delta Smelt.

#### 36 *Longfin Smelt*

37 The effects of the Alternative 5 as compared to the No Action Alternative were  
38 analyzed based on the direction and magnitude of OMR flows during the period  
39 (December through June) when adult, larvae, and young juvenile Longfin Smelt  
40 are present in the Delta in the vicinity of the export facilities (Appendix 5A). The  
41 analysis was augmented with calculated Longfin Smelt abundance index values  
42 (Appendix 9G) per Kimmerer et al. (2009), which is based on the assumptions  
43 that lower X2 values reflect higher flows and that transporting Longfin Smelt



1 farther downstream leads to greater Longfin Smelt survival. The index value  
2 indicates the relative abundance of Longfin Smelt and not the calculated  
3 population.

4 OMR flows generally would be negative in all months under both scenarios,  
5 except in April and May when the long-term average would positive. Flows  
6 under Alternative 5 during these two months would be more positive than under  
7 the No Action Alternative, especially in dry and critical years when OMR flows  
8 under Alternative 5 would be positive and flows under the No Action  
9 Alternative would be negative. Differences in OMR flow during April and May  
10 under Alternative 5 would up to about 1,350 cfs more positive than under the No  
11 Action Alternative.

12 Longfin Smelt abundance index values were calculated for long-term average  
13 conditions and for each water year type for the different alternatives (see  
14 Appendix 9G). Under Alternative 5, Longfin Smelt abundance index values  
15 range from 1,204 under critical water year conditions to a high of 16,683 under  
16 wet water year conditions, with a long-term average value of 8,015  
17 (Appendix 9G). Under the No Action Alternative, Longfin Smelt abundance  
18 index values range from 1,147 under critical water year conditions to a high of  
19 16,635 under wet water year conditions, with a long-term average value of 7,951.

20 Results indicate that the Longfin Smelt abundance index values would be similar  
21 in all but critical years under Alternative 5 than they would be under the No  
22 Action Alternative. In critical water years, the Longfin Smelt abundance index  
23 value would be about 5 percent higher under Alternative 5 than it would be under  
24 the No Action Alternative.

25 Given the similarity of the results and the inherent uncertainty associated with the  
26 resolution of the models, it is concluded that Alternative 5 and the No Action  
27 Alternative are likely to have similar effects on Longfin Smelt.

28 *Sacramento Splittail*

29 Under Alternative 5, flows entering the Yolo Bypass over the Fremont Weir  
30 generally would be similar to the No Action Alternative (Appendix 5A,  
31 Table C-26-3), thus providing similar value to Sacramento Splittail because of the  
32 similar area of potential habitat (inundation) and the similar frequency of  
33 inundation. Given the relatively minor changes in flows into the Yolo Bypass,  
34 and the inherent uncertainty associated with the resolution of the CalSim II model  
35 (average monthly outputs), it is concluded that there would be no definitive  
36 difference in effects on Sacramento Splittail between Alternative 5 and the No  
37 Action Alternative.

38 *Reservoir Fishes*

39 The analysis of effects associated with changes in operation on reservoir fishes  
40 relied on evaluation of changes in available habitat (reservoir storage) and  
41 anticipated changes in black bass nesting success.

1 Changes in CVP and SWP water supplies and operations under Alternative 5 as  
2 compared to the No Action Alternative generally would result in similar reservoir  
3 storage in CVP and SWP reservoirs in the Central Valley Region (Appendix 5A).  
4 Storage levels in Shasta Lake, Lake Oroville, and Folsom Lake would be similar  
5 under Alternative 5 as compared to the No Action Alternative. Additional  
6 information related to monthly reservoir elevations is provided in Appendix 5A,  
7 CalSim II and DSM2 Modeling.

8 In general, black bass nesting success would be similar under Alternative 5 and  
9 the No Action Alternative (Appendix 9F). Nesting success of black bass would  
10 be high in March and April due to increasing water surface elevations. During  
11 May and June, the likelihood of high (>40 percent) nesting success would be  
12 similar in most of the reservoirs under Alternative 5 as compared to the No Action  
13 Alternative (Appendix 9F). Therefore, it is concluded that the effects on black  
14 bass species would be similar under both Alternative 5 and the No Action  
15 Alternative.

#### 16 *Other Species*

17 Several other fish species could be affected by changes in operations that  
18 influence temperature and flow. In general, lampreys, Striped Bass, American  
19 Shad, and Hardhead can tolerate higher temperatures than salmonids. Based on  
20 the generally similar water temperatures during their spawning and incubation  
21 period under Alternative 5, it is likely that thermal conditions for and effects on  
22 these other species in the Sacramento, Feather, and American rivers would be  
23 similar under Alternative 5 and the No Action Alternative. Alternative 5 would  
24 result in a similar X2 position as compared to the No Action Alternative during  
25 April, May, and June (Appendix 5A, Section C Table C-16-3). This similarity in  
26 the position of X2 would likely result in a similar survival index and habitat index  
27 as measured by salinity for Striped Bass and a similar abundance and habitat  
28 index for American Shad. Alternative 5 likely would have a similar potential for  
29 adverse effects on lampreys, American Shad, and Hardhead as the Second Basis  
30 of Comparison. Overall, the potential for effects on lamprey, Striped Bass,  
31 American Shad, and Hardhead would be similar under Alternative 5 and the No  
32 Action Alternative.

#### 33 *Stanislaus River/Lower San Joaquin River*

##### 34 *Fall-Run Chinook Salmon and Steelhead*

##### 35 *Changes in Water Temperature*

36 Monthly average temperatures in the Stanislaus River at Goodwin under  
37 Alternative 5 would be similar (less than 0.5°F differences) to the No Action  
38 Alternative in most of the months and water years. From August through  
39 November, water temperatures under Alternative 5 could be somewhat (0.6°F to  
40 1.6°F) warmer, particularly in drier water years. This pattern in temperature  
41 changes under Alternative 5 was also predicted downstream at Orange Blossom  
42 Bridge. However, the differences are smaller at the San Joaquin River confluence  
43 and water temperatures in April and May could be up to 2.1°F cooler under  
44 Alternative 5.

1 The frequency of exceedance of temperature thresholds for steelhead adult  
2 migration in the fall months, steelhead smoltification thresholds in April and May  
3 at Knights Ferry, and steelhead rearing in summer and fall months are higher  
4 under (by up to 8 percent) under Alternative 5 as compared to the No Action  
5 Alternative. Frequency of exceedance of thresholds for steelhead spawning and  
6 smoltification at Orange Blossom Bridge in March through May are lower by up  
7 to 11 percent under Alternative 5 compared to the No Action Alternative.

8 While specific water temperature thresholds for fall-run Chinook Salmon in the  
9 Stanislaus River are not established, temperatures generally suitable for fall-run  
10 Chinook Salmon spawning (56°F) would be exceeded in October and November  
11 up to 3 percent more frequently under Alternative 5 compared to the No Action  
12 Alternative, in the Stanislaus River at Orange Blossom Bridge. During May and  
13 June, the 56°F threshold for fall-run rearing is exceeded less frequently (by up to  
14 10 percent) under Alternative 5 compared to the No Action Alternative.

15 These changes in temperatures are not reflected in Reclamation's salmon  
16 mortality model results for the fall-run Chinook Salmon in the Stanislaus River.  
17 As shown in Appendix 9C, the long-term average egg mortality rate is predicted  
18 to be around 8.5 percent, with higher mortality rates (in excess of 16 percent)  
19 occurring in critical dry years under Alternative 5. Overall, egg mortality is  
20 predicted to be similar under Alternative 5 and the No Action Alternative.

#### 21 *Changes in Delta Hydrodynamics*

22 San Joaquin River-origin fall run Chinook salmon smolts are most abundant in the  
23 Delta during the months of April, May and June. San Joaquin River-origin  
24 steelhead generally move through the Delta during spring however there is less  
25 information on their timing relative to Chinook salmon. Thus, hydrodynamics in  
26 the entire January through June period could have the potential to affect juvenile  
27 steelhead. Near the confluence of the San Joaquin River and the Mokelumne  
28 River, the proportion of positive velocities was slightly higher under Alternative 5  
29 relative to the No Action Alternative in January and February and almost  
30 indistinguishable from March through June (Appendix 9K). On Old River  
31 upstream and downstream of the facilities, the median proportion of positive  
32 velocities was similar under Alternative 5 and the No Action Alternative in all  
33 months. On the San Joaquin River downstream of the Head of Old River, the  
34 median proportion of positive velocities was similar under Alternative 5 and the  
35 No Action Alternative in all months.

#### 36 *Changes in Entrainment at Junctions*

37 As described in Appendix 9L, median entrainment at various junctions is  
38 indistinguishable or lower under Alternative 5 compared to the No Action  
39 Alternative for fall-run Chinook Salmon.

#### 40 *Summary of Effects on Fall-Run Chinook Salmon and Steelhead*

41 The analysis of temperatures indicates somewhat higher temperatures in some  
42 water year types and a higher likelihood of exceedance of suitable temperatures  
43 for spawning, and lower likelihood of exceeding suitable temperature for rearing  
44 of fall-run Chinook Salmon under Alternative 5 as compared to the No Action

1 Alternative in the Stanislaus River below Goodwin Dam. The effect of higher  
2 temperatures is not reflected in overall mortality of fall-run Chinook Salmon eggs  
3 predicted by Reclamation's salmon mortality model for fall-run Chinook Salmon  
4 in the Stanislaus River. The frequency of exceedance of temperature thresholds  
5 for steelhead smoltification and rearing could be more stressful under  
6 Alternative 5 compared to the No Action Alternative. However, the higher flows  
7 in April and May and lower temperatures in April and May under Alternative 5  
8 may benefit steelhead spawning.

9 Given the variability in the results and the inherent uncertainty associated with the  
10 resolution of the models, it is concluded that Alternative 5 and the No Action  
11 Alternative are likely to have similar effects on fall-run Chinook Salmon and  
12 steelhead in the Stanislaus and lower San Joaquin rivers.

### 13 *White Sturgeon*

14 Evidence of White Sturgeon spawning has been recorded in the San Joaquin River  
15 upstream of the confluence with the Stanislaus River. While flows in the San  
16 Joaquin River upstream of the Stanislaus River are expected to be similar under all  
17 alternatives, flow contributions from the Stanislaus River could influence water  
18 temperatures in the San Joaquin River where White Sturgeon eggs or larvae may  
19 occur during the spring and early summer. The magnitude of influence on water  
20 temperature would depend on the proportional flow contribution of the Stanislaus  
21 River and the temperatures in both the Stanislaus and San Joaquin rivers. The  
22 potential for an effect on White Sturgeon eggs and larvae would be influenced by  
23 the proportion of the population occurring in the San Joaquin River. In  
24 consideration of this uncertainty, it is not possible to distinguish potential effects  
25 on White Sturgeon between alternatives.

### 26 *Reservoir Fishes*

27 Storage levels in New Melones Reservoir would be similar (within 5 percent) for  
28 Alternative 5 as compared to the No Action Alternative (Appendix 5A).

29 Results of the bass nesting success analysis indicate that for March, the likelihood  
30 of Largemouth Bass and Smallmouth Bass nest survival in New Melones being  
31 above 40 percent is 100 percent under both Alternative 5 and the No Action  
32 Alternative. For April, the likelihood that nest survival of Largemouth Bass and  
33 Smallmouth Bass is between 40 and 100 percent is predicted to be reasonably  
34 high but is somewhat (about 13 percent) lower under Alternative 5 as compared to  
35 the No Action Alternative. For May, the difference between alternatives is less  
36 with the likelihood of high nest survival being about 5 percent less under  
37 Alternative 5. For June, the likelihood of survival being greater than 40 percent  
38 for Largemouth Bass and Smallmouth Bass in New Melones is similar under  
39 Alternative 5 and the No Action Alternative. For Spotted Bass, nest survival in  
40 March is anticipated to be near 100 percent in every year under both Alternative 5  
41 and the No Action Alternative. The likelihood of Spotted Bass nest survival  
42 being greater than 40 percent is about 7 percent less under Alternative 5 than  
43 under the No Action Alternative in April, but is still reasonably high (greater than  
44 90 percent). During May, the likelihood of high (>40 percent) Spotted Bass nest

1 survival is about 5 percent lower under Alternative 5 as compared to the No  
2 Action Alternative. During June, Spotted Bass nest survival would be greater  
3 than 40 percent in every year under Alternative 5 as compared to approximately  
4 98 percent of the years under the No Action Alternative.

5 Overall, the analysis suggests that conditions under Alternative 5 have the  
6 potential to negatively influence black bass nesting success, especially in April  
7 and May, by comparison to the No Action Alternative. However, nesting success  
8 under Alternative 5 would still exceed 40 percent most of the time under both  
9 alternatives. Therefore, it is concluded that there would be no definitive  
10 difference in effects on reservoir fish between Alternative 5 and the No Action  
11 Alternative.

12 *Other Species*

13 Changes in operations that influence temperature and flow conditions in the  
14 Stanislaus River downstream of Goodwin Dam and the San Joaquin River at  
15 Vernalis could affect other fishes such as lampreys, Hardhead, and Striped Bass.

16 Monthly average temperatures in the Stanislaus River at Goodwin under  
17 Alternative 5 would be similar (less than 0.5°F differences) to the No Action  
18 Alternative in most of the months and water years. From August through  
19 November, water temperatures under Alternative 5 could be somewhat (0.6°F to  
20 1.6°F) warmer, particularly in drier water years. This pattern in temperature  
21 changes under Alternative 5 was also predicted downstream at Orange Blossom  
22 Bridge. However, the differences are smaller at the San Joaquin River confluence  
23 and water temperatures in April and May could be up to 2.1°F cooler under  
24 Alternative 5.

25 In general, lamprey species can tolerate higher temperatures than salmonids, up to  
26 around 72°F during their entire life history. Because lamprey ammocoetes remain  
27 in the river for several years, any substantial flow reductions or temperature  
28 increases could result in adverse effects on larval lamprey.

29 In general, Striped Bass and Hardhead also can tolerate higher temperatures than  
30 salmonids. Given the similar flows and generally similar temperatures during  
31 their spawning and incubation period, it is likely that the potential to affect  
32 Striped Bass and Hardhead in the Stanislaus and San Joaquin rivers would be  
33 similar under Alternative 5 and the No Action Alternative.

34 Given the similarity of the results and the inherent uncertainty associated with the  
35 resolution of the models, it is concluded that Alternative 5 and the No Action  
36 Alternative are likely to have similar effects on lampreys, Hardhead, and Striped  
37 Bass in the Stanislaus and lower San Joaquin rivers. No definitive difference  
38 between Alternative 5 and the No Action Alternative could be discerned.

1 *San Francisco Bay Area Region*

2 *Killer Whale*

3 As described above for the comparison of Alternative 1 to the No Action  
4 Alternative, it is unlikely that the Chinook Salmon prey base of killer whales,  
5 supported heavily by hatchery production of fall-run Chinook Salmon, would be  
6 appreciably affected by any of the alternatives.

7 **9.4.3.6.1 Alternative 5 Compared to the Second Basis of Comparison**

8 As described in Chapter 3, Description of Alternatives, CVP and SWP operations  
9 under Alternative 5 are similar to the No Action Alternative with modified OMR  
10 flow criteria and New Melones Reservoir operations. Therefore, the comparison  
11 of Alternative 5 to the Second Basis of Comparison would be similar to the  
12 comparison of No Action Alternative to Second Basis of Comparison described  
13 above in Section 9.4.4.1, No Action Alternative.

14 *Trinity River Region*

15 *Coho Salmon, Spring-run Chinook Salmon, Fall-run Chinook Salmon, and*  
16 *Steelhead*

17 Monthly water temperature in the Trinity River at Lewiston Dam under  
18 Alternative 5 generally would be similar (less than 0.5°F differences) to the  
19 temperatures that would occur under the Second Basis of Comparison  
20 (Appendix 6B, Table B-1-6), with the exception of drier years when temperatures  
21 under Alternative 5 could be as much as 2.2°F cooler in November and 1.5°F  
22 warmer in December. Average monthly water temperatures could be slightly (up  
23 to 0.6°F) higher under Alternative 5 during July and August and lower (up to  
24 0.7°F) in September in some water year types. The slightly lower September  
25 temperatures under Alternative 5 may result in slightly better conditions than  
26 under the Second Basis of Comparison for spring-run Chinook Salmon spawning.  
27 Similarly, temperature conditions under Alternative 5 could be slightly better than  
28 the Second Basis of Comparison for fall-run Chinook Salmon spawning because  
29 of the reduced temperatures in November during critical dry years.

30 Under Alternative 5, water temperature thresholds for Coho Salmon, fall-run  
31 Chinook Salmon, and steelhead would be exceeded slightly more frequently (less  
32 than 1 percent), whereas thresholds for spring-run Chinook Salmon would be  
33 exceeded less frequently (up to 4 percent) in August in September  
34 (Appendix 9N).

35 These temperature results are not entirely reflected in the egg mortality results for  
36 fall-run Chinook Salmon, which indicate similar levels of egg mortality under  
37 Alternative 5 compared to the Second Basis of Comparison (Appendix 9C,  
38 Table B-5).

39 The minor changes in water temperatures and mortality suggest that conditions  
40 for Coho Salmon, fall-run Chinook Salmon, and steelhead in the Trinity River  
41 would be similar under both Alternative 5 and the Second Basis of Comparison.  
42 However, the slight reduction in threshold exceedances for spring-run Chinook

1 Salmon spawning under Alternative 5, although small, could reduce the potential  
2 for adverse impacts in the Trinity River under Alternative 5.

3 In addition, implementation of a Hatchery Management Plan under Alternative 5  
4 could reduce the impacts of hatchery Chinook Salmon on natural Chinook  
5 Salmon in the Trinity River and increase the genetic diversity and diversity of  
6 run-timing for these stocks relative to the Second Basis of Comparison, but the  
7 potential magnitude of these benefits is uncertain. Thus, given these relatively  
8 minor changes in temperature and temperature threshold exceedance, the inherent  
9 uncertainty associated with the resolution of the temperature model (average  
10 monthly outputs), and the uncertainty of the hatchery benefits, it is concluded that  
11 Alternative 5 and Second Basis of Comparison are likely to have similar effects  
12 on Chinook Salmon and steelhead in the Trinity River.

### 13 *Reservoir Fishes*

14 The analysis of effects associated with changes in operation on reservoir fishes  
15 relied on evaluation of changes in available habitat (reservoir storage) and  
16 anticipated changes in black bass nesting success.

17 Black bass species in Trinity Lake would be exposed to minor differences in  
18 storage under both Alternative 5 and the Second Basis of Comparison, and these  
19 relatively small differences would have negligible effect on nest survival. The  
20 nest survival under Alternative 5 would be generally similar to Second Basis of  
21 Comparison for Largemouth Bass, Smallmouth Bass, and Spotted Bass  
22 (Appendix 9F). These negligible differences in nest survival suggest that  
23 conditions for reservoir species in Trinity Lake would be similar under  
24 Alternative 5 and the Second Basis of Comparison.

### 25 *Other Species*

26 The minor differences in average monthly water temperatures described above for  
27 salmonids apply to Pacific Lamprey, Eulachon, and other aquatic species in the  
28 Trinity River. These minor differences suggest that conditions for aquatic species  
29 in the Trinity River and Klamath River downstream of the confluence generally  
30 would be similar under Alternative 5 and the Second Basis of Comparison.

### 31 *Sacramento River System*

#### 32 *Winter-run Chinook Salmon*

33 Changes in operations that influence temperature and flow conditions in the  
34 Sacramento River downstream of Keswick Dam could affect winter-run Chinook  
35 Salmon. The following describes those changes and their potential effects.

#### 36 *Changes in Water Temperature*

37 Monthly water temperature in the Sacramento River at Keswick Dam under  
38 Alternative 5 and the Second Basis of Comparison generally would be similar  
39 (differences less than 0.5°F). Average monthly water temperatures in September  
40 under Alternative 5 would be lower (up to 0.9°F) in wetter years and higher (up to  
41 1.2°F) in drier years (Appendix 6B). Similarly, water temperatures in October of  
42 critical years could be 0.9°F warmer under Alternative 5. A similar temperature  
43 pattern generally would be exhibited downstream at Ball's Ferry, Jelly's Ferry,

1 and Bend Bridge, with average monthly temperature differences in September  
2 increasing (up to 2.8°F cooler at Bend Bridge) in September during the wetter  
3 years and up to 0.8°F warmer in critical years (Appendix 6B).

#### 4 *Changes in Exceedances of Water Temperature Thresholds*

5 With the exception of April, average monthly water temperatures under both  
6 Alternative 5 and Second Basis of Comparison would show exceedances of the  
7 water temperature threshold of 56°F established in the Sacramento River at Ball's  
8 Ferry for winter-run Chinook Salmon spawning and egg incubation in every  
9 month, with exceedances under both as high as about 41 percent and 54 percent,  
10 respectively, in some months (Appendix 9N). Under Alternative 5, the  
11 temperature threshold generally would be exceeded more frequently than under  
12 the Second Basis of Comparison (by about 1 percent to 3 percent) in the April  
13 through August period, with the temperature threshold in September exceeded  
14 about 11 percent less frequently under Alternative 5 than under the Second Basis  
15 of Comparison. Farther downstream at Bend Bridge, the frequency of  
16 exceedances would increase, with exceedances under both Alternative 5 and the  
17 Second Basis of Comparison as high as about 90 percent in some months. Under  
18 Alternative 5, temperature exceedances generally would be more frequent (by up  
19 to 10 percent) than under the Second Basis of Comparison, with the exception of  
20 September, when exceedances under Alternative 5 would be about 30 percent less  
21 frequent under Alternative 5.

#### 22 *Changes in Egg Mortality*

23 The temperatures described above for the Sacramento River below Keswick Dam  
24 are reflected in the analysis of egg mortality using the Reclamation Salmon  
25 Survival Model (Appendix 9C). For winter-run Chinook Salmon in the  
26 Sacramento River, the long-term average egg mortality rate is predicted to be  
27 relatively low (around 5 percent), with higher mortality rates (exceeding  
28 20 percent) occurring in critical dry years under Alternative 5. Overall, egg  
29 mortality would be similar under Alternative 5 and the Second Basis of  
30 Comparison (Appendix 9C, Table B-4).

#### 31 *Changes in Weighted Usable Area*

32 As an indicator of the amount of suitable spawning habitat for winter-run Chinook  
33 Salmon between Keswick Dam and Battle Creek, modeling results indicate that,  
34 in general, there would be similar amounts of spawning habitat available from  
35 May through September under Alternative 5 as compared to the Second Basis of  
36 Comparison (Appendix 9E, Table C-17-6). Modeling results indicate that, in  
37 general, there would be similar amounts of suitable fry rearing habitat available  
38 from June through October under Alternative 5 and the Second Basis of  
39 Comparison (Appendix 9E, Table C-18-6). Similar to the results for fry rearing  
40 WUA, modeling results indicate that there would be similar amounts of suitable  
41 juvenile rearing habitat available during the juvenile rearing period under  
42 Alternative 5 and the Second Basis of Comparison (Appendix 9E, Table C-19-6).



1            *Changes in SALMOD Output*

2 SALMOD results indicate that potential juvenile production would be the same  
3 under Alternative 5 and the Second Basis of Comparison (Appendix 9D,  
4 Table B-4-26).

5            *Changes in Delta Passage Model Output*

6 The Delta Passage Model predicted similar estimates of annual Delta survival  
7 across the 81 water year time period for winter-run Chinook Salmon between  
8 Alternative 5 and the Second Basis of Comparison Alternative (Appendix 9J).  
9 Median Delta survival was 0.350 for Alternative 5 and 0.352 for the Second Basis  
10 of Comparison Alternative. Overall, there would be little change in through-Delta  
11 survival for emigrating juvenile winter-run Chinook Salmon under Alternative 5  
12 as compared to the Second Basis of Comparison.

13           *Changes in Delta Hydrodynamics*

14 Winter run smolts are most abundant in the Delta during the months of January  
15 February and March. On the Sacramento River near the confluence of Georgiana  
16 Slough, the median proportion of positive velocities under Alternative 5 was  
17 indistinguishable from the Second Basis of Comparison in January, February, and  
18 March (Appendix 9K). On the San Joaquin River near the Mokelumne River  
19 confluence, the median proportion of positive velocities was slightly greater under  
20 Alternative 5 relative to Second Basis of Comparison in January and February and  
21 similar in March. In Old River downstream of the facilities, the median  
22 proportion of positive velocities was substantially higher under Alternative 5  
23 during January and moderately higher in February. Values in March were almost  
24 indistinguishable between scenarios. On Old River upstream of the facilities, the  
25 median proportion of positive velocities was moderately lower in January and  
26 February and slightly lower in March under Alternative 5 relative to Second Basis  
27 of Comparison. On the San Joaquin River downstream of Head of Old River, the  
28 median proportion of positive velocities was similar for both scenarios in January,  
29 February and March.

30           *Changes in Junction Entrainment*

31 At the junction of Georgiana Slough and the Sacramento River, median  
32 entrainment under Alternative 5 and the Second Basis of Comparison was  
33 essentially indistinguishable in January, February and March (Appendix 9L).  
34 Entrainment at the Head of Old River junction was similar to slightly lower under  
35 Alternative 5 relative to Second Basis of Comparison during the period of winter  
36 run Chinook Salmon migration through the Delta (January, February, and March).  
37 For the Turner Cut junction, median entrainment under Alternative 5 was slightly  
38 lower in January and February relative to Second Basis of Comparison. In  
39 March, the difference in entrainment between scenarios was similar. At the  
40 Columbia Cut, Middle River and Old River junctions, patterns in entrainment  
41 between Alternative 5 and Second Basis of Comparison were similar. At these  
42 junctions, median entrainment was slightly to moderately lower under  
43 Alternative 5 during January and February and values were more similar in  
44 March.

1            *Changes in Salvage*

2 Salvage of winter-run Chinook salmon is predicted to be substantially lower  
3 under Alternative 5 relative to the Second Basis of Comparison in January and  
4 February (Appendix 9M). In March, predicted salvage was only moderately  
5 lower under Alternative 5 relative to Second Basis of Comparison.

6            *Changes in Oncorhynchus Bayesian Analysis Output*

7 Escapement of winter-run Chinook Salmon and Delta survival was modeled by  
8 the Oncorhynchus Bayesian Analysis (OBAN) model for winter-run Chinook  
9 salmon. Escapement was generally higher under Alternative 5 as compared to the  
10 Second Basis alternative (Appendix 9I). The median abundance under  
11 Alternative 5 was higher the Second Basis of Comparison. Median delta survival  
12 was approximately 15 percent higher under Alternative 5 as compared to the  
13 Second Basis of Comparison.

14           *Changes in Interactive Object-Oriented Simulation Output*

15 The IOS model predicted similar adult escapement trajectories for Winter-Run  
16 Chinook salmon between Alternative 5 and the Second Basis of Comparison  
17 Alternative across the 81 water years (Appendix 9H). Alternative 5 median adult  
18 escapement was 3,545 and Second Basis of Comparison Alternative median  
19 escapement was 4,042).

20 Similar to adult escapement, the IOS model predicted similar egg survival for  
21 Winter-Run Chinook salmon between Alternative 5 and the Second Basis of  
22 Comparison Alternative across the 81 water years (Appendix 9H). Median egg  
23 survival was 0.989 for Alternative 5 and 0.987 for the Second Basis of  
24 Comparison Alternative).

25           *Summary of Effects on Winter-Run Chinook Salmon*

26 The analysis of temperatures indicates somewhat higher temperatures and greater  
27 likelihood of exceedance of thresholds under Alternative 5 as compared to the  
28 Second Basis of Comparison. This is not reflected in the similar survival of  
29 winter-run Chinook Salmon eggs predicted by Reclamation's salmon mortality  
30 model. Flow changes under Alternative 5 would have small effects on the  
31 availability of spawning and rearing habitat for winter-run Chinook Salmon as  
32 indicated by the WUA analysis and the decrease in flow (habitat)-related  
33 mortality predicted by SALMOD under Alternative 5. Through Delta survival of  
34 juvenile winter-run Chinook Salmon would be the same under both Alternative 5  
35 and Second Basis of Comparison as indicated by the DPM results; the OBAN  
36 results suggest that Delta survival could be higher under Alternative 5.  
37 Entrainment may also be reduced under Alternative 5 as indicated by the salvage  
38 analysis based on OMR flows. Median adult escapement to the Sacramento River  
39 could be reduced slightly under Alternative 5 as indicated by the IOS model  
40 results which incorporate temperature, flow, and mortality effects on each life  
41 stage over the entire life cycle of winter-run Chinook Salmon. However, the  
42 OBAN model results indicate an increase in escapement over a more limited time  
43 period (1971 to 2002).

1 The model results suggest that effects on winter-run Chinook Salmon would be  
2 similar under both Alternative 5 and Second Basis of Comparison, with a small  
3 likelihood that winter-run Chinook Salmon escapement would be higher under the  
4 Alternative 5. Positive effects, however, likely would be greater because of the  
5 potential benefits of providing fish passage under Alternative 5 intended to  
6 address the limited availability of suitable habitat for winter-run Chinook Salmon  
7 in the Sacramento River reaches downstream of Keswick Dam. This potential  
8 beneficial effect and its magnitude would depend on the success of the fish  
9 passage program. In addition, benefits to winter-run Chinook Salmon may accrue  
10 under Alternative 5 as a result actions intended to increase the efficiency of the  
11 Tracy and Skinner Fish Collection Facilities to improve the overall salvage  
12 survival of listed salmonids, including winter-run Chinook Salmon.

13 Overall, the quantitative results from the numerical models suggest that operation  
14 under Alternative 5 would be less likely to result in adverse effects on winter-run  
15 Chinook Salmon than would the Second Basis of Comparison. In consideration  
16 of the potentially beneficial effects resulting from actions under the Alternative 5  
17 that are not included in the numerical models (see Appendix 5A, Section B),  
18 however, Alternative 5 has a much greater potential to address the long-term  
19 sustainability of winter-run Chinook Salmon than does the Second Basis of  
20 Comparison. Alternative 5 includes provisions for fish passage upstream of  
21 Shasta Dam to address long-term temperature increases associated with climate  
22 change; the Second Basis of Comparison does not. Even though the success of  
23 fish passage is uncertain, it is concluded that the potential for adverse effects on  
24 winter-run Chinook Salmon under Alternative 5 would clearly be less than those  
25 under the Second Basis of Comparison, principally because the Second Basis of  
26 Comparison does not include a strategy to address water temperatures critical to  
27 winter-run Chinook Salmon sustainability over the long term with climate change  
28 by 2030.

### 29 *Spring-run Chinook Salmon*

30 Changes in operations that influence temperature and flow conditions in the  
31 Sacramento River downstream of Keswick Dam, Clear Creek downstream of  
32 Whiskeytown Dam, and Feather River downstream of Oroville Dam could affect  
33 spring-run Chinook Salmon. The following describes those changes and their  
34 potential effects.

### 35 *Changes in Water Temperature*

36 Changes in water temperature that could affect spring-run Chinook Salmon could  
37 occur in the Sacramento River, Clear Creek, and Feather River. The following  
38 describes temperature conditions in those water bodies.

### 39 *Sacramento River*

40 Monthly water temperature in the Sacramento River at Keswick Dam under  
41 Alternative 5 and the Second Basis of Comparison generally would be similar  
42 (differences less than 0.5°F). Average monthly water temperatures in September  
43 under Alternative 5 would be lower (up to 0.9°F) in wetter years and higher (up to  
44 1.2°F) in drier years. Similarly, water temperatures in October of critical years

1 could be 0.9°F warmer under Alternative 5. A similar temperature pattern  
 2 generally would be exhibited downstream at Ball's Ferry, Jelly's Ferry, Bend  
 3 Bridge and Red Bluff, with average monthly temperature differences in  
 4 September progressively increasing (up to 3.2°F cooler at Red Bluff) during the  
 5 wetter years (Appendix 6B, Table B-9-6).

#### 6 *Clear Creek*

7 Average monthly water temperatures in Clear Creek at Igo under  
 8 Alternative relative to the Second Basis of Comparison are generally predicted to  
 9 be similar (less than 0.5°F differences) (Appendix 6B, Table B-3-6). Average  
 10 monthly water temperatures during May under Alternative 5 would be up to 0.8°F  
 11 lower than under the Second Basis of Comparison in all but critical water years.  
 12 The lower water temperatures in May associated with Alternative 5 reflect the  
 13 effects of additional water discharged from Whiskeytown Dam to meet the spring  
 14 attraction flow requirements to promote attraction of spring-run Chinook Salmon  
 15 into the creek. While the reduction in May water temperatures indicated by the  
 16 modeling could improve thermal conditions for spring-run Chinook Salmon, the  
 17 duration of the two pulse flows may not be of sufficient duration (3 days each) to  
 18 provide temperature benefits.

#### 19 *Feather River*

20 Long-term average monthly water temperature in the Feather River at the low  
 21 flow channel under Alternative 5 relative to the Second Basis of Comparison  
 22 generally would be similar (less than 0.5°F differences). Water temperatures  
 23 could be up to 1.5°F warmer in November and December of some water year  
 24 types and up to 1.2°F cooler in September of wetter years (Appendix 6B,  
 25 Table B-20-6) under Alternative 5. Although temperatures in the river would  
 26 become progressively higher in the downstream direction, the differences between  
 27 Alternative 5 and Second Basis of Comparison exhibit a similar pattern at the  
 28 downstream locations (Robinson Riffle and Gridley Bridge), with water  
 29 temperature differences under Alternative 5 generally increasing in most water  
 30 year types relative to the Second Basis of Comparison at the confluence with  
 31 Sacramento River (Appendix 6B, Table B-23-6). Water temperatures under  
 32 Alternative 5 could be somewhat (0.8°F to 1.6°F) cooler on average and up to  
 33 3.9°F cooler (September) at the confluence with Sacramento River from July to  
 34 September in wetter years.

#### 35 *Changes in Exceedances of Water Temperature Thresholds*

36 Changes in water temperature could result in the exceedance of established water  
 37 temperature thresholds for spring-run Chinook Salmon in the Sacramento River,  
 38 Clear Creek, and Feather River. The following describes the extent of those  
 39 exceedance for each of those water bodies.

#### 40 *Sacramento River*

41 Average monthly water temperatures under both Alternative 5 and Second Basis  
 42 of Comparison would show exceedances of the water temperature threshold of  
 43 56°F established in the Sacramento River at Red Bluff for spring-run Chinook  
 44 Salmon (egg incubation) in October, November, and again in April. The

1 exceedances would occur at the greatest frequency in October, with 80 percent  
2 and 79 percent for Alternative 5 and Second Basis of Comparison, respectively.  
3 Temperature thresholds would be exceeded less frequently in November  
4 (7 percent) and not exceeded at all during December through March. As water  
5 temperatures warm in the spring, the thresholds would be exceeded in April by  
6 14 percent and 13 percent under Alternative 5 and Second Basis of Comparison.  
7 In the warmer months when exceedances occur (October, November, and April),  
8 temperature thresholds generally would be exceeded more frequently (by up to  
9 2 percent in October) under Alternative 5 than under the Second Basis of  
10 Comparison (Appendix 9N, Table 9N.B.1).

11 *Clear Creek*

12 Average monthly water temperatures under both Alternative 5 and Second Basis  
13 of Comparison would not exceed the water temperature threshold of 60°F  
14 established in Clear Creek at Igo for spring-run Chinook Salmon pre-spawning  
15 and rearing in June through August. However, Alternative 5 and Second Basis of  
16 Comparison would exceed the water temperature threshold of 56°F established  
17 for spawning in September and October about 10 percent to 15 percent of the  
18 time. The differences between Alternative 5 and Second Basis of Comparison are  
19 small, with Alternative 5 exceeding thresholds about 1 percent more frequently  
20 than under the Second Basis of Comparison in September and about 2 percent  
21 more frequently in October (Appendix 9N).

22 *Feather River*

23 Average monthly water temperatures under both Alternative 5 and Second Basis  
24 of Comparison would exceed the water temperature threshold of 56°F established  
25 in the Feather River at Robinson Riffle for spring-run Chinook Salmon egg  
26 incubation and rearing (Appendix 9N) during some months, particularly in  
27 October and November, and March and April, when temperature thresholds could  
28 be exceeded frequently. The frequency of exceedance was highest (about  
29 98 percent) in October, a month in which average monthly water could get as high  
30 as about 68°F. However, water temperatures under Alternative 5 would exceed  
31 temperature thresholds less than 2 percent more frequently than the Second Basis  
32 of Comparison in October, November, and December, and about 1 percent less  
33 frequently in March. The established water temperature threshold of 63°F for  
34 rearing during May through August would be exceeded often under both  
35 Alternative 5 and Second Basis of Comparison in May (57 percent and  
36 51 percent, respectively) and June (97 percent for both), but not at all in July and  
37 August.

38 *Changes in Egg Mortality*

39 These temperature differences described above are reflected in the analysis of egg  
40 mortality using the Reclamation salmon mortality model (Appendix 9C). For  
41 spring-run Chinook Salmon in the Sacramento River, the long-term average egg  
42 mortality rate is predicted to be relatively high (exceeding 20 percent), with high  
43 mortality rates (exceeding 80 percent) occurring in critical dry years. In critical  
44 dry years the average egg mortality rate would be 13.1 percent greater under  
45 Alternative 5 than under the Second Basis of Comparison (Appendix 9C,

1 Table B-3). Overall, egg mortality under Alternative 5 and the Second Basis of  
2 Comparison would be similar, except in critical dry water years.

3 *Changes in Weighted Usable Area*

4 Weighted usable area curves are available for spring-run Chinook Salmon in  
5 Clear Creek. As described above, flows in Clear Creek below Whiskeytown Dam  
6 are not anticipated to differ under Alternative 5 relative to the Second Basis of  
7 Comparison except in May due to the release of spring attraction flows in  
8 accordance with the 2009 NMFS BO. Therefore, there would be no change in the  
9 amount of potentially suitable spawning and rearing habitat for spring-run  
10 Chinook Salmon (as indexed by WUA) available under Alternative 5 as compared  
11 to the Second Basis of Comparison.

12 *Changes in SALMOD Output*

13 SALMOD results indicate that potential spring-run juvenile production would be  
14 similar under Alternative 5 and the Second Basis of Comparison, except in critical  
15 dry years when production could be 14 percent lower under Alternative 5 than  
16 under the Second Basis of Comparison (Appendix 9D).

17 *Changes in Delta Passage Model Output*

18 The Delta Passage Model predicted similar estimates of annual Delta survival  
19 across the 81 water year time period for spring-run between Alternative 5 and the  
20 Second Basis of Comparison (Appendix 9J). Median Delta survival was 0.296 for  
21 Alternative 5 and 0.286 for the Second Basis of Comparison. Overall, there  
22 would be little change in through-Delta survival by emigrating juvenile spring-run  
23 Chinook Salmon under Alternative 5 as compared to the Second Basis of  
24 Comparison.

25 *Changes in Delta Hydrodynamics*

26 Spring run Chinook salmon are most abundant in the Delta from March through  
27 May. Near the junction of Georgiana Slough, the median proportion of time that  
28 velocity was positive was similar in March and April and slightly lower in May  
29 under Alternative 5 relative to the Second Basis of Comparison (Appendix 9K).  
30 Near the confluence of the San Joaquin River and the Mokelumne River, the  
31 median proportion of positive velocities was similar in March and slightly to  
32 moderately higher under Alternative 5 relative to the Second Basis of Comparison  
33 in April and May. In the San Joaquin River downstream of the Head of Old River  
34 the median proportion of positive velocities was slightly to moderately higher  
35 under Alternative 5 relative to Second Basis of Comparison in April and May,  
36 respectively, whereas there was little difference between these scenarios in  
37 March. In Old River upstream of the facilities the median proportion of positive  
38 velocities was slightly higher in April and May under Alternative 5 relative to  
39 Second Basis of Comparison and slightly lower in March. In Old River  
40 downstream of the facilities, the median proportion of positive velocities was  
41 substantially higher under Alternative 5 relative to Second Basis of Comparison  
42 in April and May and more similar in March.

1                    *Changes in Junction Entrainment*

2    At the junction of Georgiana Slough and the Sacramento River, median  
3    entrainment under Alternative 5 was slightly lower than under the Second Basis  
4    of Comparison in April and May but essentially indistinguishable in March  
5    (Appendix 9L). Median entrainment at the Head of Old River junction was  
6    substantially higher under Alternative 5 relative to Second Basis of Comparison  
7    during the months of April and May and similar in March. For the Turner Cut  
8    junction, median entrainment under Alternative 5 was moderately lower in April  
9    and May relative to Second Basis of Comparison and more similar in March. At  
10   the Columbia Cut, Middle River and Old River junctions, entrainment under  
11   Alternative 5 was slightly lower than Second Basis of Comparison in March and  
12   became moderately to substantially lower in April and May.

13                   *Changes in Salvage*

14   Salvage of spring run Chinook salmon was predicted to be substantially lower  
15   under Alternative 5 relative the Second Basis of Comparison during April and  
16   May and only slightly lower in the month of March (Appendix 9M).

17                   *Summary of Effects on Spring-Run Chinook Salmon*

18   The multiple model and analysis outputs described above characterize the  
19   anticipated conditions for spring-run Chinook Salmon and their response to  
20   change under Alternative 5 as compared to the Second Basis of Comparison. For  
21   the purpose of analyzing effects on spring-run Chinook Salmon in the Sacramento  
22   River, greater reliance was placed on the outputs from the SALMOD model  
23   because it integrates the available information on temperature and flows to  
24   produce estimates of mortality for each life stage and an overall, integrated  
25   estimate of potential spring-run Chinook Salmon juvenile production. The output  
26   from SALMOD indicated that spring-run Chinook Salmon production in the  
27   Sacramento River would be similar under Alternative 5 and the Second Basis of  
28   Comparison, except in critical dry years. The analyses attempting to assess the  
29   effects on routing, entrainment, and salvage of juvenile salmonids in the Delta  
30   suggest that salvage (as an indicator of potential losses of juvenile salmon at the  
31   export facilities) of Sacramento River-origin Chinook Salmon is predicted to be  
32   lower under Alternative 5 relative to the Second Basis of Comparison in every  
33   month.

34   In Clear Creek and the Feather River, the analysis of the effects of Alternative 5  
35   and Second Basis of Comparison for spring-run Chinook Salmon relied on water  
36   temperature output for Clear Creek at Igo, and in the Feather River low flow  
37   channel and downstream of the Thermalito complex. The analysis of  
38   temperatures indicates somewhat higher temperatures and greater likelihood of  
39   exceedance of thresholds under Alternative 5 as compared to the Second Basis of  
40   Comparison in the Feather River. There would be little change in flows or  
41   temperatures in Clear Creek under Alternative 5 relative to the Second Basis of  
42   Comparison. The effect of slightly increased temperatures is not reflected in the  
43   similar overall survival of spring-run Chinook Salmon eggs predicted by  
44   Reclamation's salmon mortality model for spring-run in the Sacramento River. In

1 drier years, the likelihood of adverse temperature effects would be increased  
2 under Alternative 5 as compared to the Second Basis of Comparison.

3 Flow changes under Alternative 5 would likely have small effects due to changes  
4 in the availability of spawning and rearing habitat for spring-run Chinook Salmon  
5 in the Sacramento River as indicated by the decrease in flow (habitat)-related  
6 mortality predicted by SALMOD under Alternative 5. Through Delta survival of  
7 juvenile spring-run Chinook Salmon would be the same under both Alternative 5  
8 and Second Basis of Comparison as indicated by the DPM results and entrainment  
9 could be reduced as indicated by the salvage analysis.

10 The numerical model results suggest that, overall, Alternative 5 likely would have  
11 similar or somewhat greater adverse effects on the spring-run Chinook Salmon  
12 population in the Sacramento River watershed as compared to the Second Basis of  
13 Comparison, particularly in drier water year types. This potential distinction  
14 between the two scenarios, however, may be offset by the benefits of  
15 implementation of fish passage under Alternative 5 intended to address the  
16 limited availability of suitable habitat for spring-run Chinook Salmon in the  
17 Sacramento River reaches downstream of Keswick Dam. This beneficial effect  
18 and its magnitude would depend on the success of the fish passage program. In  
19 addition, spring-run Chinook Salmon may benefit from actions under  
20 Alternative 5 intended to increase the efficiency of the Tracy and Skinner Fish  
21 Collection Facilities to improve the overall salvage survival of listed salmonids,  
22 including spring-run Chinook Salmon.

23 Thus, it is concluded that the potential for adverse effects on spring-run Chinook  
24 Salmon under Alternative 5 suggested by the results of the numerical models  
25 would likely be offset by the potential benefits of the actions that are not included  
26 in the numerical models, principally because the Second Basis of Comparison  
27 does not include a strategy to address water temperatures critical to spring-run  
28 Chinook Salmon sustainability over the long term with climate change by 2030.  
29 On balance and over the long term, the adverse effects on spring-run Chinook  
30 Salmon under Alternative 5 would be less than those under the Second Basis of  
31 Comparison.

### 32 *Fall-Run Chinook Salmon*

33 Changes in operations that influence temperature and flow conditions in the  
34 Sacramento River downstream of Keswick Dam, Clear Creek downstream of  
35 Whiskeytown Dam, Feather River downstream of Oroville Dam and American  
36 River below Nimbus could affect fall-run Chinook Salmon. The following  
37 describes those changes and their potential effects.

### 38 *Changes in Water Temperature*

39 Changes in water temperature could affect fall-run Chinook Salmon in the  
40 Sacramento, Feather, and American rivers, and Clear Creek. The following  
41 describes temperature conditions in those water bodies.



1                    *Sacramento River*

2 Monthly water temperature in the Sacramento River at Keswick Dam under  
3 Alternative 5 and the Second Basis of Comparison generally would be similar  
4 (differences less than 0.5°F). Average monthly water temperatures in September  
5 under Alternative 5 would be lower (up to 0.9°F) in wetter years and higher (up to  
6 1.2°F) in drier years. Similarly, water temperatures in October of critical years  
7 could be 0.9°F warmer under Alternative 5. A similar pattern in temperatures  
8 generally would be exhibited at downstream locations along the Sacramento River  
9 (i.e., Ball's Ferry Jelly's Ferry, Bend Bridge, Red Bluff, Hamilton City, and  
10 Knights Landing), with differences in average monthly temperatures at Knights  
11 Landing progressively increasing (up to 1.0°F warmer) in June and up to up to  
12 4.6°F cooler in September of wetter years under Alternative 5 relative to the  
13 Second Basis of Comparison.

14                    *Clear Creek*

15 Average monthly water temperatures in Clear Creek at Igo under  
16 Alternative relative to the Second Basis of Comparison are generally predicted to  
17 be similar (less than 0.5°F differences) (Appendix 6B, Table B-3-6). Average  
18 monthly water temperatures during May under Alternative 5 would be up to 0.8°F  
19 lower than under the Second Basis of Comparison in all but critical water years.  
20 The lower water temperatures in May associated with Alternative 5 reflect the  
21 effects of additional water discharged from Whiskeytown Dam to meet the spring  
22 attraction flow requirements to promote attraction of spring-run Chinook Salmon  
23 into the creek. While the reduction in May water temperatures indicated by the  
24 modeling could improve thermal conditions for fall-run Chinook Salmon, the  
25 duration of the two pulse flows may not be of sufficient duration (3 days each) to  
26 provide temperature benefits.

27                    *Feather River*

28 Long-term average monthly water temperature in the Feather River at the low  
29 flow channel under Alternative 5 relative to the Second Basis of Comparison  
30 generally would be similar (less than 0.5°F differences). Water temperatures  
31 could be up to 1.5°F warmer in November and December of some water year  
32 types and up to 1.2°F cooler in September of wetter years. Although temperatures  
33 in the river would become progressively higher in the downstream direction, the  
34 differences between Alternative 5 and Second Basis of Comparison exhibit a  
35 similar pattern at the downstream locations (Robinson Riffle and Gridley Bridge),  
36 with water temperature differences under Alternative 5 generally increasing in  
37 most water year types relative to the Second Basis of Comparison at the  
38 confluence with Sacramento River (Appendix 6B, Table B-23-6). Water  
39 temperatures under Alternative 5 could be somewhat (0.8°F to 1.6°F) cooler on  
40 average and up to 3.9°F cooler (September) at the confluence with Sacramento  
41 River from July to September in wetter years.

1 *American River*

2 Average monthly water temperatures in the American River at Nimbus Dam  
3 under Alternative 5 generally would be similar (differences less than 0.5°F) to the  
4 Second Basis of Comparison, with the exception of during June and August of  
5 below normal water years, when temperatures under Alternative 5 could be as  
6 much as 0.9°F higher. This pattern generally would persist downstream to Watt  
7 Avenue and the mouth, although temperatures under Alternative 5 would be up to  
8 1.6°F and 2.1°F higher, respectively, than under the Second Basis of Comparison  
9 in June. In addition, average monthly water temperatures at the mouth under  
10 Alternative 5 generally would be lower than under the Second Basis of  
11 Comparison in September, especially in wetter water year types when water  
12 temperatures under Alternative 5 could be up to 1.7°F cooler.

13 *Changes in Exceedances of Water Temperature Thresholds*

14 Changes in water temperature could result in the exceedance of water  
15 temperatures that are protective of fall-run Chinook Salmon in the Sacramento  
16 River, Clear Creek, Feather River, and American River. The following describes  
17 the extent of those exceedances for each of those water bodies.

18 *Sacramento River*

19 Average monthly water temperatures under both Alternative 5 and Second Basis  
20 of Comparison would exceed the water temperature threshold of 56°F established  
21 in the Sacramento River at Red Bluff for fall-run Chinook Salmon spawning and  
22 egg incubation (Table temperature targets) during some months, particularly in  
23 October, November, and April, when temperature thresholds would be exceeded.  
24 The frequency of exceedance would be greatest in October, a month in which  
25 average monthly water temperature could get as high as about 64°F. In October,  
26 average monthly water temperatures under Alternative 5 and Second Basis of  
27 Comparison would exceed the threshold 82 percent and 79 percent of the time,  
28 respectively. The differences in the frequency of exceedances between  
29 Alternative 5 and Second Basis of Comparison would be small. Water  
30 temperatures under Alternative 5 would exceed temperature thresholds about  
31 2 percent more frequently than under the Second Basis of Comparison in October,  
32 1 percent less frequently in November, and 1 percent more frequently in April.

33 *Clear Creek*

34 Fall-run Chinook Salmon spawning in lower Clear Creek typically occurs during  
35 October through December (USFWS 2015). Average monthly water  
36 temperatures at Igo during this period generally would be below 56°F, except in  
37 October. Under Alternative 5, the 56°F threshold would be exceeded in October  
38 about 12 percent of the time as compared to 10 percent under the Second Basis of  
39 Comparison. At the confluence with the Sacramento River, average monthly  
40 water temperatures in October would be warmer, with 56°F exceeded nearly  
41 20 percent of the time under Alternative 5 and somewhat (about 8 percent) less  
42 frequently under the Second Basis of Comparison. During November and  
43 December, average monthly water temperatures generally would remain below  
44 56°F at both locations.

1 For fall-run Chinook Salmon rearing (January through September), the  
2 exceedances described previously for spring-run Chinook Salmon would apply,  
3 with the average monthly temperatures remaining below the 60°F threshold  
4 except in September when temperatures could increase to over 60°F. During  
5 September, water temperatures under Alternative 5 would exceed 56°F about  
6 3 percent more frequently than under the Second Basis of Comparison.  
7 Downstream at the mouth, the average monthly temperatures would exceed 56°F  
8 more frequently, especially in July and August, when it always would be  
9 exceeded and average monthly temperatures would approach 64°F under both  
10 scenarios in September.

11 Under Alternative 5, temperature conditions at Igo would be slightly warmer than  
12 under the Second Basis of Comparison. Average monthly water temperatures  
13 likely mask daily temperatures excursions that could exceed important thresholds.  
14 Therefore, while the differences in threshold exceedance are relatively minor, the  
15 likelihood of adverse effects on fall-run Chinook Salmon in Clear Creek under  
16 Alternative 5 would likely be greater than under the Second Basis of Comparison.

17 *Feather River*

18 Average monthly water temperatures under both Alternative 5 and Second Basis  
19 of Comparison would exceed the water temperature threshold of 56°F established  
20 in the Feather River at Gridley Bridge for fall-run Chinook Salmon spawning and  
21 egg incubation during some months, particularly in October, November, March,  
22 and April, when temperature thresholds would be exceeded frequently  
23 (Appendix 9N). The frequency of exceedance would be greatest in October,  
24 when average monthly temperatures under both Alternative 5 and Second Basis of  
25 Comparison would be above the threshold in nearly every year. The magnitude of  
26 the exceedances would be high as well, with average monthly temperatures in  
27 October reaching about 68°F. Similarly, the threshold would be exceeded under  
28 both Alternative 5 and the Second Basis of Comparison about 85 percent of the  
29 time in April. The differences in threshold exceedance between Alternative 5 and  
30 Second Basis of Comparison, would be small, with water temperatures under  
31 Alternative 5 generally exceeding temperature thresholds about 1-2 percent more  
32 frequently than the Second Basis of Comparison during the October through April  
33 period. However, average monthly water temperatures likely mask daily  
34 temperatures excursions that could exceed important thresholds. Therefore, while  
35 the differences in threshold exceedance are relatively minor, the likelihood of  
36 adverse effects on fall-run Chinook Salmon in the Feather River under  
37 Alternative 5 would likely be greater than under the Second Basis of Comparison.

38 *Changes in Egg Mortality*

39 Water temperatures influence the viability of incubating fall-run Chinook Salmon  
40 eggs. The following describes the differences in egg mortality for the  
41 Sacramento, Feather, and American rivers.

1                    *Sacramento River*

2 For fall-run Chinook Salmon in the Sacramento River, the long-term average egg  
3 mortality rate is predicted to be around 17 percent, with higher mortality rates (in  
4 excess of 35 percent) occurring in critical dry years under Alternative 5. Overall,  
5 egg mortality would be similar under Alternative 5 and the Second Basis of  
6 Comparison (Appendix 9C, Table B-1).

7                    *Feather River*

8 For fall-run Chinook Salmon in the Feather River, the long-term average egg  
9 mortality rate is predicted to be relatively low (around 7 percent), with higher  
10 mortality rates (around 14 percent) occurring in critical dry years under  
11 Alternative 5. Overall, egg mortality would be similar under Alternative 5 and  
12 the Second Basis of Comparison (Appendix 9C, Table B-7).

13                    *American River*

14 For fall-run Chinook Salmon in the American River, the long-term average egg  
15 mortality rate is predicted to range from approximately 23 to 25 percent in all  
16 water year types under Alternative 5. Overall, egg mortality would be similar  
17 under Alternative 5 and the Second Basis of Comparison (Appendix 9C,  
18 Table B-6).

19                    *Changes in Weighted Usable Area*

20 Weighted usable area, which is influenced by flow, is a measure of habitat  
21 suitability. The following describes changes in WUA for fall-run Chinook  
22 Salmon in the Sacramento, Feather, and American rivers and Clear Creek.

23                    *Sacramento River*

24 As an indicator of the amount of suitable spawning habitat for fall-run Chinook  
25 Salmon between Keswick Dam and Battle Creek, modeling results indicate that,  
26 in general, there would be lesser amounts of spawning habitat available in  
27 September and November under Alternative 5 as compared to the Second Basis of  
28 Comparison (Appendix 9E, Table C-11-6). The decrease in long-term average  
29 spawning WUA during September (prior to the peak spawning period) would be  
30 relatively large (more than 20 percent), with a smaller decrease in November  
31 (around 6 percent). The latter month is during the peak spawning period for fall-  
32 run Chinook Salmon. Results for the reach from Battle Creek to Deer Creek  
33 show the same pattern for changes in WUA for spawning fall-run Chinook  
34 Salmon between Alternative 5 and the Second Basis of Comparison  
35 (Appendix 9E, Table C-10-6). Overall, spawning habitat availability would be  
36 slightly lower under Alternative 5 relative to the Second Basis of Comparison.

37 Modeling results indicate that, in general, there would be similar amounts of  
38 suitable fry rearing habitat available from December to March under Alternative 5  
39 and the Second Basis of Comparison (Appendix 9E, Table C-12-6). Similar to  
40 the results for fry rearing WUA, modeling results indicate that, there would be  
41 similar amounts of suitable juvenile rearing habitat available during the juvenile  
42 rearing period under Alternative 5 and the Second Basis of Comparison  
43 (Appendix 9E, Table C-13-6).

1 *Clear Creek*

2 As described above, flows in Clear Creek below Whiskeytown Dam are not  
3 anticipated to differ under Alternative 5 relative to the Second Basis of  
4 Comparison except in May due to the release of spring attraction flows in  
5 accordance with the 2009 NMFS BO. Therefore, there would be no change in the  
6 amount of potentially suitable spawning and rearing habitat for fall-run Chinook  
7 Salmon (as indexed by WUA) available under Alternative 5 as compared to the  
8 Second Basis of Comparison.

9 *Feather River*

10 As described above, Flows in the low flow channel of the Feather River are not  
11 anticipated to differ under Alternative 5 relative to the Second Basis of  
12 Comparison. Therefore, there would be no change in the amount of potentially  
13 suitable spawning habitat for fall-run Chinook Salmon (as indexed by WUA)  
14 available under Alternative 5 as compared to the Second Basis of Comparison.  
15 The majority of spawning activity by fall-run Chinook Salmon in the Feather  
16 River occurs in this reach with a lesser amount of spawning occurring  
17 downstream of the Thermalito Complex.

18 Modeling results indicate that, in general, there would be a lesser amount of  
19 spawning habitat available in September (20 percent less) and greater amounts of  
20 incubation habitat available in February (6 percent more) under Alternative 5 as  
21 compared to the Second Basis of Comparison; fall-run spawning WUA may be  
22 slightly (around 5 percent) increased in October (the peak spawning month) for  
23 fall-run Chinook Salmon in this reach (Appendix 9E, Table C-24-6). The  
24 decrease in long-term average spawning WUA during September would occur  
25 prior to the peak spawning period. Overall, spawning and incubation habitat  
26 availability would be similar under Alternative 5 relative to the Second Basis of  
27 Comparison.

28 *American River*

29 Modeling results indicate that, in general, there would be similar amounts of  
30 spawning habitat available for fall-run Chinook Salmon in the American River  
31 from October through December under Alternative 5 and the Second Basis of  
32 Comparison (Appendix 9E, Table C-25-6).

33 *Changes in SALMOD Output*

34 SALMOD results indicate that potential fall-run juvenile production would be  
35 similar under Alternative 5 and the Second Basis of Comparison, except in critical  
36 dry years when production could be 7 percent lower under Alternative 5 than  
37 under the Second Basis of Comparison (Appendix 9D, Table B-1-26).

38 *Changes in Delta Passage Model Output*

39 The Delta Passage Model predicted similar estimates of annual Delta survival  
40 across the 81 water year time period for Fall-run between Alternative 5 and the  
41 Second Basis of Comparison Alternative (Appendix 9J). Median Delta survival  
42 was 0.248 for Alternative 5 and 0.245 for the Second Basis of Comparison.  
43 Overall, there would be little change in through-Delta survival by emigrating

1 juvenile fall-run Chinook Salmon under Alternative 5 as compared to the Second  
2 Basis of Comparison.

3 *Changes in Delta Hydrodynamics*

4 Fall run Chinook salmon smolts are most abundant in the Delta during the months  
5 of April, May and June. At the junction of Georgiana Slough and the Sacramento  
6 River, the median proportion of positive velocities was slightly lower under  
7 Alternative 5 relative to the Second Basis of Comparison in May and June  
8 (Appendix 9K). The median proportion of positive velocities for Alternative 5  
9 was similar in April. Near the confluence of the San Joaquin River and the  
10 Mokelumne River, the median proportion of positive velocities was slightly to  
11 moderately higher under Alternative 5 relative to Second Basis of Comparison in  
12 April and May, respectively, whereas values in June were similar. On Old River  
13 downstream of the facilities, the median proportion of positive velocities was  
14 substantially higher in April and May and slightly higher in June under  
15 Alternative 5 relative to Second Basis of Comparison. In Old River upstream of  
16 the facilities, the median proportion of positive velocities was slightly higher  
17 under Alternative 5 April and May and slightly lower in June. On the San  
18 Joaquin River downstream of the Head of Old River, the median proportion of  
19 positive velocities was slightly to moderately lower under Alternative 5 relative to  
20 Second Basis of Comparison in April and May, respectively, and similar in June.

21 *Changes in Junction Entrainment*

22 At the junction of Georgiana Slough and the Sacramento River, median  
23 entrainment under Alternative 5 was slightly lower than the Second Basis of  
24 Comparison in June but essentially indistinguishable in all other months  
25 (Appendix 9L). Median entrainment at the Head of Old River junction was  
26 considerably higher under Alternative 5 relative to Second Basis of Comparison  
27 during the months of April and May and slightly lower in June. For the Turner  
28 Cut junction, median entrainment under Alternative 5 was moderately lower in  
29 April and May relative to Second Basis of Comparison and slightly lower in June.  
30 At the Columbia Cut junction, median entrainment under Alternative 5 was  
31 slightly lower in June relative to the Second Basis of Comparison. Median  
32 entrainment was substantially lower under Alternative 5 relative to Second Basis  
33 of Comparison in April and May. A similar pattern of entrainment under  
34 Alternative 5 relative to Second Basis of Comparison was observed at the Middle  
35 River and Old River junctions.

36 *Changes in Salvage*

37 Salvage of Sacramento River-origin fall run was predicted to be substantially  
38 lower under Alternative 5 relative to the Second Basis of Comparison in April and  
39 May (Appendix 9M). During the month of June, salvage was moderately lower  
40 under Alternative 5.

41 *Summary of Effects on Fall-Run Chinook Salmon*

42 The multiple model and analysis outputs described above characterize the  
43 anticipated conditions for fall-run Chinook Salmon and their response to change  
44 under Alternative 5 as compared to the Second Basis of Comparison. For the

1 purpose of analyzing effects on fall-run Chinook Salmon in the Sacramento River,  
2 greater reliance was placed on the outputs from the SALMOD model because it  
3 integrates the available information on water temperature and flows to produce  
4 estimates of mortality for each life stage and an overall, integrated estimate of  
5 potential fall-run Chinook Salmon juvenile production. The output from  
6 SALMOD indicated that fall-run Chinook Salmon production would be similar  
7 under Alternative 5 and the Second Basis of Comparison, except in critical  
8 dry years.

9 In Clear Creek and the Feather and American rivers, the analysis of the effects of  
10 Alternative 5 and Second Basis of Comparison for fall-run Chinook Salmon relied  
11 on the water temperature model output for the rivers at various locations  
12 downstream of the CVP and SWP facilities. The analysis of temperatures  
13 indicates similar temperatures and slightly greater likelihood of exceedance of  
14 thresholds under Alternative 5 as compared to the Second Basis of Comparison in  
15 the Feather River. There would be little change in flows or temperatures in Clear  
16 Creek under Alternative 5 relative to the Second Basis of Comparison. The effect  
17 of slightly increased temperatures is not reflected in the similar overall survival of  
18 fall-run Chinook Salmon eggs predicted by Reclamation's salmon mortality  
19 model for fall-run in the Feather and American rivers. In drier years, the  
20 likelihood of adverse temperature effects would be increased under Alternative 5  
21 as compared to the Second Basis of Comparison.

22 Flow changes under Alternative 5 would likely have small effects on the  
23 availability of spawning and rearing habitat for fall-run Chinook Salmon in the  
24 Sacramento River system as indicated by the similarity in spawning WUA in the  
25 Sacramento, Feather, and American rivers under Alternative 5 and the Second  
26 Basis of Comparison. Fry and juvenile rearing WUA would be similar in the  
27 Sacramento River and this is reflected in the similarity in flow (habitat)-related  
28 mortality predicted by SALMOD under Alternative 5.

29 Through-Delta survival of juvenile fall-run Chinook Salmon would be similar  
30 under both Alternative 5 and Second Basis of Comparison as indicated by the  
31 DPM results and entrainment could be reduced as indicated by the OMR flow  
32 analysis. Overall, Alternative 5 likely would have similar or slightly greater  
33 adverse effects on the fall-run Chinook Salmon population in the Sacramento  
34 River watershed as compared to the Second Basis of Comparison, particularly in  
35 drier water year types.

36 Additional actions implemented under Alternative 5 could help improve  
37 conditions for fall-run Chinook Salmon relative to the Second Basis of  
38 Comparison, such as structural improvements for temperature management in the  
39 American River and actions intended to increase the efficiency of the Tracy and  
40 Skinner Fish Collection Facilities to improve the overall salvage survival of  
41 salmonids, including fall-run Chinook Salmon. The implementation of fish  
42 passage under Alternative 5 intended to address the limited availability of suitable  
43 habitat for winter-run and spring-run Chinook Salmon in the Sacramento River  
44 reaches downstream of Shasta Dam is unlikely to benefit fall-run Chinook  
45 Salmon unless passage is provided for adult fall-run Chinook Salmon. The

1 effects of providing similar fish passage at Folsom Dam would also be uncertain  
2 for the same reason.

3 Overall, the results of the numerical models suggest the potential for greater  
4 adverse effects on fall-run Chinook Salmon under Alternative 5 as compared to  
5 the Second Basis of Comparison. However, discerning a meaningful difference  
6 between these two scenarios based on the quantitative results is difficult because  
7 of the similarity in results (generally differences less than 5 percent), the inherent  
8 uncertainty of the models, and the potential for offsetting benefits. Thus, it is  
9 concluded that the effects on fall-run Chinook Salmon would be similar under  
10 Alternative 5 and the Second Basis of Comparison.

#### 11 *Late Fall-Run Chinook Salmon*

12 Changes in operations that influence temperature and flow conditions in the  
13 Sacramento River downstream of Keswick Dam could affect late fall-run Chinook  
14 Salmon. The following describes those changes and their potential effects.

#### 15 *Changes in Water Temperature*

16 Monthly water temperature in the Sacramento River at Keswick Dam under  
17 Alternative and the Second Basis of Comparison generally would be similar  
18 (differences less than 0.5°F). Average monthly water temperatures in September  
19 under Alternative 5 would be lower (up to 0.9°F) in wetter years and higher (up to  
20 1.2°F) in drier years. Similarly, water temperatures in October of critical years  
21 could be 0.9°F warmer under Alternative 5. A similar temperature pattern  
22 generally would be exhibited downstream at Ball's Ferry, Jelly's Ferry, Bend  
23 Bridge and Red Bluff, with average monthly temperatures in September  
24 progressively increasing (up to 3.2°F cooler at Red Bluff) during the wetter years.

#### 25 *Changes in Exceedances of Water Temperature Thresholds*

26 Average monthly water temperatures under both Alternative 5 and Second Basis  
27 of Comparison would exceed the water temperature threshold of 56°F established  
28 in the Sacramento River at Red Bluff during some months, particularly in  
29 October, November, and April. The frequency of exceedance would be greatest  
30 in October, a month in which average monthly water could get as high as about  
31 64°F. In October, average monthly water temperatures under Alternative 5 and  
32 Second Basis of Comparison would exceed the threshold 80 percent and  
33 79 percent of the time, respectively. Water temperatures under Alternative 5  
34 would exceed temperature thresholds about 2 percent more frequently than under  
35 the Second Basis of Comparison in October, 1 percent less frequently in  
36 November, and 1 percent more frequently in April.

#### 37 *Changes in Egg Mortality*

38 For late fall-run Chinook Salmon in the Sacramento River, the long-term average  
39 egg mortality rate is predicted to range from approximately 2.4 to nearly 5 percent  
40 in all water year types under Alternative 5. Overall, egg mortality would be  
41 similar under Alternative 5 and the Second Basis of Comparison (Appendix 9C,  
42 Table B-2).



1            *Changes in Weighted Usable Area*

2     Modeling results indicate that there would be similar amounts of spawning habitat  
3     available for late fall-run Chinook Salmon in the Sacramento River from January  
4     through April under Alternative 5 and the Second Basis of Comparison  
5     (Appendix 9E, Table C-14-6). Modeling results indicate that, in general, there  
6     would be similar amounts of suitable late fall-run Chinook Salmon fry rearing  
7     habitat available under Alternative 5 and the Second Basis of Comparison  
8     (Appendix 9E, Table C-15-6).

9     A substantial fraction of late fall run Chinook Salmon juveniles oversummer in  
10    the Sacramento River before emigrating, which allows them to avoid predation  
11    through both their larger size and greater swimming ability. One implication of  
12    this life history strategy is that rearing habitat is most likely the limiting factor for  
13    late-fall-run Chinook Salmon, especially if availability of cool water determines  
14    the downstream extent of spawning habitat for late-fall-run salmon. Modeling  
15    results indicate that, there would be reduced amounts of suitable juvenile rearing  
16    habitat available in September (12 percent less) and November (8 percent less  
17    under Alternative 5 as compared to the Second Basis of Comparison. In other  
18    months the amount the amount of late fall-run Chinook Salmon juvenile rearing  
19    WUA would be similar under Alternative 5 and the Second Basis of Comparison  
20    (Appendix 9E, Table C-16-6).

21           *Changes in SALMOD Output*

22    SALMOD results indicate that potential juvenile production would be similar  
23    under Alternative 5 and the Second Basis of Comparison (Appendix 9D,  
24    Table B-2-26).

25           *Changes in Delta Passage Model Output*

26    For Late-Fall-Run, Delta survival was predicted to be slightly higher for  
27    Alternative 5 versus the Second Basis of Comparison for all 81 water years  
28    simulated by the Delta Passage Model (Appendix 9J). Median Delta survival  
29    across all years was 0.243 for Alternative 5 and 0.199 for the Second Basis of  
30    Comparison. Overall, there would be a slight increase in through-Delta survival  
31    for emigrating juvenile late fall-run Chinook Salmon under Alternative 5 as  
32    compared to the Second Basis of Comparison.

33           *Changes in Delta Hydrodynamics*

34    The late fall-run Chinook migration period overlaps with that of winter-run  
35    Chinook Salmon and they are most abundant in the Delta during the months of  
36    January February and March. On the Sacramento River near the confluence of  
37    Georgiana Slough, the median proportion of positive velocities under  
38    Alternative 5 was indistinguishable from the Second Basis of Comparison in  
39    January, February and March (Appendix 9K). On the San Joaquin River near the  
40    Mokelumne River confluence, the median proportion of positive velocities was  
41    slightly greater under Alternative 5 relative to Second Basis of Comparison in  
42    January and February and similar in March. In Old River downstream of the  
43    facilities, the median proportion of positive velocities was substantially higher  
44    under Alternative 5 during January and moderately higher in February. Values in

1 March were almost indistinguishable between scenarios. On Old River upstream  
2 of the facilities, the median proportion of positive velocities was moderately  
3 lower in January and February and slightly lower in March under Alternative 5  
4 relative to Second Basis of Comparison. On the San Joaquin River downstream  
5 of Head of Old River, the median proportion of positive velocities was similar for  
6 both scenarios in January, February and March.

#### 7 *Changes in Junction Entrainment*

8 At the junction of Georgiana Slough and the Sacramento River, median  
9 entrainment under Alternative 5 and the Second Basis of Comparison in January  
10 was essentially indistinguishable in January, February and March (Appendix 9L).  
11 Entrainment at the Head of Old River junction was similar to slightly lower under  
12 Alternative 5 relative to Second Basis of Comparison. For the Turner Cut  
13 junction, median entrainment under Alternative 5 was slightly lower in January  
14 and February relative to Second Basis of Comparison. In March, the difference in  
15 entrainment between scenarios was similar. At the Columbia Cut, Middle River  
16 and Old River junctions, patterns in entrainment between Alternative 5 and the  
17 Second Basis of Comparison were similar. At these junctions, entrainment was  
18 moderately lower under Alternative 5 during January and February and values  
19 were more similar in March.

#### 20 *Changes in Salvage*

21 Salvage of late fall-run Chinook salmon is predicted to be substantially lower  
22 under Alternative 5 relative to the Second Basis of Comparison in January and  
23 February (Appendix 9M). In March salvage was only moderately lower under  
24 Alternative 5 relative to Second Basis of Comparison.

#### 25 *Summary of Effects on Late Fall-Run Chinook Salmon*

26 The multiple model and analysis outputs described above characterize the  
27 anticipated conditions for late fall-run Chinook Salmon and their response to  
28 change under Alternative 5 as compared to the Second Basis of Comparison. For  
29 the purpose of analyzing effects on late fall-run Chinook Salmon in the  
30 Sacramento River, greater reliance was placed on the outputs from the SALMOD  
31 model because it integrates the available information on temperature and flows to  
32 produce estimates of mortality for each life stage and an overall, integrated  
33 estimate of potential late fall-run Chinook Salmon juvenile production. The  
34 output from SALMOD indicated that late fall-run Chinook Salmon production  
35 would be similar under Alternative 5 and the Second Basis of Comparison. The  
36 analyses attempting to assess the effects on routing, entrainment, and salvage of  
37 juvenile salmonids in the Delta suggest that salvage (as an indicator of potential  
38 losses of juvenile salmon at the export facilities) of Sacramento River-origin  
39 Chinook Salmon is predicted to be lower under Alternative 5 relative to the  
40 Second Basis of Comparison in every month.

41 These model results suggest that overall, Alternative 5 is likely to have less  
42 adverse effect on late fall-run Chinook Salmon in the Sacramento River as  
43 compared to the Second Basis of Comparison. Potential benefits may be  
44 enhanced under Alternative 5 by actions intended to increase the efficiency of the

1 Tracy and Skinner Fish Collection Facilities to improve the overall salvage  
2 survival of salmonids, including late fall-run Chinook Salmon. Thus, it is  
3 concluded that the potential for adverse effects on late fall-run Chinook Salmon  
4 would be less under Alternative 5 relative to the Second Basis of Comparison.

5 *Steelhead*

6 Changes in operations that influence temperature and flow conditions that could  
7 affect steelhead. The following describes those changes and their potential  
8 effects.

9 *Changes in Water Temperature*

10 Changes in water temperature could affect steelhead in the Sacramento, Feather,  
11 and American rivers, and Clear Creek. The following describes temperature  
12 conditions in those water bodies.

13 *Sacramento River*

14 Monthly water temperature in the Sacramento River at Keswick Dam under  
15 Alternative 5 and the Second Basis of Comparison generally would be similar  
16 (differences less than 0.5°F). Average monthly water temperatures in September  
17 under Alternative 5 would be lower (up to 0.9°F) in wetter years and higher (up to  
18 1.2°F) in drier years. Similarly, water temperatures in October of critical years  
19 could be 0.9°F warmer under Alternative 5. A similar temperature pattern  
20 generally would be exhibited downstream at Ball's Ferry, Jelly's Ferry, Bend  
21 Bridge and Red Bluff, with average monthly temperatures in September  
22 progressively increasing (up to 3.2°F cooler at Red Bluff) during the wetter years  
23 (Appendix 6B, Table B-9-6).

24 *Clear Creek*

25 Average monthly water temperatures in Clear Creek at Igo under  
26 Alternative relative to the Second Basis of Comparison are generally predicted to  
27 be similar (less than 0.5°F differences) (Appendix 6B, Table B-3-6). Average  
28 monthly water temperatures during May under Alternative 5 would be up to 0.8°F  
29 lower than under the Second Basis of Comparison in all but critical water years.

30 *Feather River*

31 Long-term average monthly water temperature in the Feather River at the low  
32 flow channel under Alternative 5 relative to the Second Basis of Comparison  
33 generally would be similar (less than 0.5°F differences). Water temperatures  
34 could be up to 1.5°F warmer in November and December of some water year  
35 types and up to 1.2°F cooler in September of wetter years. Although temperatures  
36 in the river would become progressively higher in the downstream direction, the  
37 differences between Alternative 5 and Second Basis of Comparison exhibit a  
38 similar pattern at the downstream locations (Robinson Riffle and Gridley Bridge),  
39 with water temperature differences under Alternative 5 generally increasing in  
40 most water year types relative to the Second Basis of Comparison at the  
41 confluence with Sacramento. Water temperatures under Alternative 5 could be  
42 somewhat (0.8°F to 1.6°F) cooler on average and up to 3.9°F cooler (September)  
43 at the confluence with Sacramento River from July to September in wetter years.

1 *American River*

2 Average monthly water temperatures in the American River at Nimbus Dam  
 3 under Alternative 5 generally would be similar (differences less than 0.5°F) to the  
 4 Second Basis of Comparison, with the exception of during June and August of  
 5 below normal years, when temperatures under Alternative 5 could be as much as  
 6 0.9°F higher. This pattern generally would persist downstream to Watt Avenue  
 7 and the mouth, although temperatures under Alternative 5 would be up to 1.6°F  
 8 and 2.1°F higher, respectively, than under the Second Basis of Comparison in  
 9 June. In addition, average monthly water temperatures at the mouth generally  
 10 would be lower than the Second Basis of Comparison in September, especially in  
 11 wetter water year types when Alternative 5 could be up to 1.7°F cooler.

12 *Changes in Exceedances of Water Temperature Thresholds*

13 Changes in water temperature could result in the exceedance of established water  
 14 temperature thresholds for steelhead in the Sacramento River, Clear Creek, and  
 15 Feather River. The following describes the extent of those exceedance for each of  
 16 those streams.

17 *Sacramento River*

18 As described in the life history accounts (Appendix), steelhead spawning in the  
 19 mainstem Sacramento River generally occurs in the upper reaches from Keswick  
 20 Dam downstream to near Balls Ferry, with most spawning concentrated near  
 21 Redding. Most steelhead, however, spawn in tributaries to the Sacramento River.  
 22 Spawning generally takes place in the January through March period when water  
 23 temperatures in the river generally do not exceed 52°F under either Alternative 5  
 24 or Second Basis of Comparison. While there are no established temperature  
 25 thresholds for steelhead rearing in the mainstem Sacramento River, average  
 26 monthly temperatures when fry and juvenile steelhead are in the river would  
 27 generally remain below 56°F at Balls Ferry except in August and September  
 28 when this temperature would be exceeded at least 40 percent of the time under  
 29 both the No Action Alternative and Second Basis of Comparison. However,  
 30 water temperatures in the Sacramento River at Balls Ferry would exceed 56°F  
 31 about 10 percent more often in September under the Second Basis of Comparison  
 32 compared to Alternative 5. Overall, thermal conditions for steelhead in the  
 33 Sacramento River would be similar under Alternative 5 and the Second Basis of  
 34 Comparison.

35 *Clear Creek*

36 While there are no established temperature thresholds for steelhead spawning in  
 37 Clear Creek, average monthly water temperatures in the river generally would not  
 38 exceed 48°F during the spawning period (December to April) under either  
 39 Alternative 5 or Second Basis of Comparison. Similarly, while there are no  
 40 established temperature thresholds for steelhead rearing in Clear Creek, average  
 41 monthly temperatures in throughout the year would not exceed 56°F at Igo.  
 42 Overall, thermal conditions for steelhead in Clear Creek would be similar under  
 43 Alternative 5 and the Second Basis of Comparison.

1                    *Feather River*

2 Average monthly water temperatures under both Alternative 5 and the Second  
3 Basis of Comparison would on occasion exceed the water temperature threshold  
4 of 56°F established in the Feather River at Robinson Riffle for steelhead  
5 spawning and incubation during some months, particularly in October and  
6 November, and March and April, when temperature thresholds could be exceeded  
7 frequently (Appendix 9N). There would be a 1 percent exceedance of the 56°F  
8 threshold in December and no exceedances of the 56°F threshold in January and  
9 February under both Alternative 5 and the Second Basis of Comparison.  
10 However, the differences in the frequency of exceedance between Alternative 5  
11 and Second Basis of Comparison during March and April would be relatively  
12 small with water temperatures under Alternative 5 exceeding the threshold about  
13 1 percent more frequently in March and the same exceedance frequency  
14 (75 percent) as the Second Basis of Comparison in April.

15 The established water temperature threshold of 63°F for rearing from May  
16 through August would be exceeded often under both Alternative 5 and Second  
17 Basis of Comparison in May and June, but not at all in July and August. Water  
18 temperatures under Alternative 5 would exceed the rearing temperature threshold  
19 about 6 percent more frequently than under the Second Basis of Comparison in  
20 May, but no more frequently in June. Temperature conditions in the Feather  
21 River under Alternative 5 could be more likely to result in adverse effects on  
22 steelhead spawning and rearing than under the Second Basis of Comparison  
23 because of the slightly increased frequency of exceedance of the 56°F spawning  
24 threshold in March and the somewhat increased frequency of exceedance of the  
25 63°F rearing threshold in May.

26                    *American River*

27 In the American River, the water temperature threshold for steelhead rearing  
28 (May through October) is 65°F at the Watt Avenue Bridge. Average monthly  
29 water temperatures would exceed this threshold often under both Alternative 5  
30 and Second Basis of Comparison, especially in the July through September period  
31 when the threshold is exceeded nearly all of the time. In addition, the magnitude  
32 of the exceedance would be high, with average monthly water temperatures  
33 sometimes higher than 76°F. The differences in exceedance frequency between  
34 Alternative 5 and Second Basis of Comparison, however, would be relatively  
35 small (differences within 1 percent), except in September, when average monthly  
36 water temperatures under Alternative 5 would exceed 65°F about 6 percent less  
37 frequently than under the Second Basis of Comparison. Temperature conditions  
38 in the American River under Alternative 5 could increase the likelihood of  
39 adverse effects on steelhead rearing than under the Second Basis of Comparison  
40 because of the increased frequency of exceedance of the 65°F rearing threshold in  
41 some months.

42                    *Changes in Weighted Usable Area*

43 The following describes changes in WUA for steelhead in the Sacramento,  
44 Feather, and American rivers and Clear Creek.

1 *Sacramento River*

2 Modeling results indicate that, in general, there would be similar amounts of  
3 suitable steelhead spawning habitat available from December through March  
4 under Alternative 5 as compared to the Second Basis of Comparison  
5 (Appendix 9E, Table C-20-6).

6 *Clear Creek*

7 As described above, flows in Clear Creek below Whiskeytown Dam are not  
8 anticipated to differ under Alternative 5 relative to the Second Basis of  
9 Comparison except in May due to the release of spring attraction flows in  
10 accordance with the 2009 NMFS BO. Therefore, there would be no change in the  
11 amount of potentially suitable spawning and rearing habitat for steelhead (as  
12 indexed by WUA) available under Alternative 5 as compared to the Second Basis  
13 of Comparison.

14 *Feather River*

15 As described above, Flows in the low flow channel of the Feather River are not  
16 anticipated to differ under Alternative 5 relative to the Second Basis of  
17 Comparison. Therefore, there would be no change in the amount of potentially  
18 suitable spawning habitat for steelhead (as indexed by WUA) available under  
19 Alternative 5 as compared to the Second Basis of Comparison. The majority of  
20 spawning activity by steelhead in the Feather River occurs in this reach with a  
21 lesser amount of spawning occurring downstream of the Thermalito Complex.

22 Modeling results indicate that, in general, there would be similar amounts of  
23 spawning habitat for steelhead in the Feather River below Thermalito available  
24 from December through April under Alternative 5 and the Second Basis of  
25 Comparison.

26 *American River*

27 Modeling results indicate that, in general, there would be similar amounts of  
28 spawning habitat for steelhead in the American River downstream of Nimbus  
29 Dam available from December through April under Alternative 5 and the Second  
30 Basis of Comparison.

31 *Changes in Delta Hydrodynamics*

32 Sacramento River-origin steelhead generally move through the Delta during  
33 spring however there is less information on their timing relative to Chinook  
34 salmon. Thus, hydrodynamics in the entire January through June period have the  
35 potential to affect juvenile steelhead.

36 On the Sacramento River near the confluence of Georgiana Slough, the median  
37 proportion of positive velocities under Alternative 5 was moderately lower  
38 relative to the Second Basis of Comparison from January to April and slightly  
39 lower in May and June (Appendix 9K). On the San Joaquin River near the  
40 Mokelumne River confluence, the median proportion of positive velocities was  
41 slightly greater under Alternative 5 relative to Second Basis of Comparison in  
42 January, February, April and May and similar in March and June. In Old River  
43 downstream of the facilities, the median proportion of positive velocities was  
44 substantially higher under Alternative 5 during January, April, and May and

1 moderately higher in February. Values in March and June were almost  
2 indistinguishable between scenarios. On Old River upstream of the facilities, the  
3 median proportion of positive velocities was moderately lower in January and  
4 February, slightly lower March and June, and slightly higher in April and May  
5 under Alternative 5 relative to Second Basis of Comparison. On the San Joaquin  
6 River downstream of Head of Old River, the median proportion of positive  
7 velocities was similar for both scenarios in January, February, March and June,  
8 but slightly to moderately lower in April and May.

9 *Summary of Effects on Steelhead*

10 The multiple model and analysis outputs described above characterize the  
11 anticipated conditions for steelhead and their response to change under  
12 Alternative 5 as compared to the Second Basis of Comparison. The analysis of  
13 the effects of Alternative and Second Basis of Comparison for steelhead relied on  
14 the WUA analysis for habitat and water temperature model output for the rivers at  
15 various locations downstream of the CVP and SWP facilities. The WUA analysis  
16 indicated that the availability of steelhead spawning and rearing habitat in Clear  
17 Creek and steelhead spawning habitat in the Sacramento, Feather and American  
18 rivers would be similar under Alternative 5 and the Second Basis of Comparison.  
19 The analysis of temperatures indicates somewhat higher temperatures and greater  
20 likelihood of exceedance of thresholds under Alternative 5 as compared to the  
21 Second Basis of Comparison in the Sacramento and Feather rivers. In drier years,  
22 the likelihood of adverse temperature effects would be increased under  
23 Alternative 5 as compared to the Second Basis of Comparison. There would be  
24 little change in flows or temperatures in Clear Creek under Alternative 5 relative  
25 to the Second Basis of Comparison.

26 These numerical model results suggest that overall, effects on steelhead could be  
27 slightly more adverse under Alternative 5 than under the Second Basis of  
28 Comparison, particularly in the Feather and American rivers. However,  
29 implementation of a fish passage program under Alternative 5 intended to address  
30 the limited availability of suitable habitat for steelhead in the Sacramento River  
31 reaches downstream of Keswick Dam and in the American River could provide a  
32 benefit to Central Valley steelhead in the Sacramento and American rivers. This  
33 is particularly important in light of anticipated increases in water temperature  
34 associated with climate change in 2030. In addition to fish passage, preparation  
35 and implementation of an HGMP for steelhead at the Nimbus Fish Hatchery and  
36 actions under Alternative 5 intended to increase the efficiency of the Tracy and  
37 Skinner Fish Collection Facilities could benefit steelhead under Alternative 5 in  
38 comparison to the Second Basis of Comparison. Thus, on balance and over the  
39 long term, the adverse effects on steelhead under Alternative 5 would be less than  
40 those under the Second Basis of Comparison.

41 *Green Sturgeon*

42 Changes in operations that influence temperature and flow conditions could affect  
43 Green Sturgeon. The following describes those changes and their potential  
44 effects.

1                    *Changes in Water Temperature*

2    Changes in water temperature could affect Green Sturgeon in the Sacramento and  
3    Feather rivers. The following describes temperature conditions in those water  
4    bodies.

5                    *Sacramento River*

6    Monthly water temperature in the Sacramento River at Keswick Dam under  
7    Alternative and the Second Basis of Comparison generally would be similar  
8    (differences less than 0.5°F). Average monthly water temperatures in September  
9    under Alternative 5 would be lower (up to 0.9°F) in wetter years and higher (up to  
10    1.2°F) in drier years. Similarly, water temperatures in October of critical years  
11    could be 0.9°F warmer under Alternative 5. (Appendix 6B). A similar pattern in  
12    temperatures generally would be exhibited at downstream locations along the  
13    Sacramento River (i.e., Ball's Ferry Jelly's Ferry, Bend Bridge, Red Bluff,  
14    Hamilton City, and Knights Landing), with differences in average monthly  
15    temperatures at Knights Landing progressively increasing (up to 1.0°F warmer) in  
16    June and up to up to 4.6°F cooler in September of wetter years under  
17    Alternative 5 relative to the Second Basis of Comparison.

18                   *Feather River*

19    Long-term average monthly water temperature in the Feather River at the low  
20    flow channel under Alternative 5 relative to the Second Basis of Comparison  
21    generally would be similar (less than 0.5°F differences). Water temperatures  
22    could be up to 1.5°F warmer in November and December of some water year  
23    types and up to 1.2°F cooler in September of wetter years. Although temperatures  
24    in the river would become progressively higher in the downstream direction, the  
25    differences between Alternative 5 and Second Basis of Comparison exhibit a  
26    similar pattern at the downstream locations (Robinson Riffle and Gridley Bridge),  
27    with water temperature differences under Alternative 5 generally increasing in  
28    most water year types relative to the Second Basis of Comparison at the  
29    confluence with Sacramento. Water temperatures under Alternative 5 could be  
30    somewhat (0.8°F to 1.6°F) cooler on average and up to 3.9°F cooler (September)  
31    at the confluence with Sacramento River from July to September in wetter years.

32                   *Changes in Exceedances of Water Temperature Thresholds*

33    Changes in water temperature could result in the exceedance of established water  
34    temperature thresholds for Green Sturgeon in the Sacramento and Feather rivers.  
35    The following describes the extent of those exceedance for each of those rivers.

36                   *Sacramento River*

37    Average monthly water temperatures in the Sacramento River at Bend Bridge  
38    under both Alternative 5 and Second Basis of Comparison would exceed the  
39    water temperature threshold of 63°F established for Green Sturgeon larval rearing  
40    in August and September, with exceedances under Alternative 5 occurring about  
41    7 percent of the time in August and about 12 percent of the time in September.  
42    This is 1 to 2 percent more frequently than under the Second Basis of  
43    Comparison. Average monthly water temperatures at Bend Bridge could be as  
44    high as about 73°F during this period. Temperature conditions in the Sacramento



1 River under Alternative 5 could be more likely to result in adverse effects on  
2 Green Sturgeon rearing than under the Second Basis of Comparison because of  
3 the slightly increased frequency of exceedance of the 63°F threshold in August  
4 and September.

5 *Feather River*

6 Average monthly water temperatures in the Feather River at Gridley Bridge under  
7 both Alternative 5 and Second Basis of Comparison would exceed the water  
8 temperature threshold of 64°F established for Green Sturgeon spawning,  
9 incubation, and rearing in May, June, and September; no exceedances under either  
10 scenarios would occur in July and August. The frequency of exceedances would  
11 be high, with both Alternative 5 and Second Basis of Comparison exceeding the  
12 threshold in June nearly 100 percent of the time. The magnitude of the  
13 exceedance also would be substantial, with average monthly temperatures higher  
14 than 72°F in June, and higher than 75°F in July and August. Water temperatures  
15 under Alternative 5 would exceed the threshold about 7 percent more frequently  
16 in May than under the Second Basis of Comparison and about 33 percent less  
17 frequently in September. Temperature conditions in the Feather River under  
18 Alternative 5 could be more likely to result in adverse effects on Green Sturgeon  
19 rearing than under the Second Basis of Comparison because of the increased  
20 frequency of exceedance of the 64°F threshold in May. The reduction in  
21 exceedance frequency in September may have less effect on rearing Green  
22 Sturgeon as many juvenile sturgeon may have migrated downstream to the lower  
23 Sacramento River and Delta by this time.

24 *Changes in Delta Outflow*

25 As described in Appendix 9P, mean (March to July) Delta outflow was used an  
26 indicator of potential year class strength and the likelihood of producing a strong  
27 year class of sturgeon. The median value over the 82-year CalSim II modeling  
28 period of mean (March to July) Delta outflow was predicted to be 16 percent  
29 higher under Alternative 5 than under the Second Basis of Comparison. In  
30 addition, the likelihood of mean (March to July) Delta outflow exceeding the  
31 threshold of 50,000 cfs was the same under both alternatives.

32 *Summary of Effects on Green Sturgeon*

33 The temperature threshold analysis in the Sacramento and Feather rivers both  
34 suggest that average monthly water temperatures under Alternative 5 would  
35 exceed thresholds for Green Sturgeon more frequently than under the Second  
36 Basis of Comparison, although the frequency of exceedance would be relatively  
37 small (1-2 percent). However, average monthly water temperatures likely mask  
38 daily temperatures excursions that could exceed important thresholds. Therefore,  
39 while the differences in threshold exceedance are relatively minor, the likelihood  
40 of adverse effects on Green Sturgeon under Alternative 5 would likely be greater  
41 than under the Second Basis of Comparison. The analysis based on Delta  
42 outflows suggests that Alternative 5 provides higher mean (March to July)  
43 outflows which could result in stronger year classes of juvenile sturgeon relative  
44 to the Second Basis of Comparison. However, early life stage survival in the

1 natal rivers is crucial in development of a strong year class; therefore, based  
2 primarily on the analysis of water temperatures, Alternative 5 could be more  
3 likely to result in adverse effects on Green Sturgeon than the Second Basis of  
4 Comparison.

#### 5 *White Sturgeon*

6 Changes in water temperature conditions in the Sacramento and Feather rivers  
7 would be the same as those described above for Green Sturgeon.

8 The water temperature threshold established for White Sturgeon spawning and  
9 egg incubation in the Sacramento River at Hamilton City is 61°F from March  
10 through June. Although there would be no exceedances of the threshold in March  
11 and April, water temperatures under both Alternative 5 and Second Basis of  
12 Comparison would exceed this threshold in May and June. The average monthly  
13 water temperatures in May under Alternative 5 would exceed this threshold about  
14 56 percent of the time (about 7 percent more frequently than under the Second  
15 Basis of Comparison). In June, the temperature under Alternative 5 would exceed  
16 the threshold about 87 percent of the time (about 13 percent more frequently than  
17 the Second Basis of Comparison). Average monthly water temperatures during  
18 May and June under Alternative 5 would as high as about 65°F.

19 Changes in Delta outflows would be the same as those described above for Green  
20 Sturgeon. Mean (March to July) Delta outflow was predicted to be 13 percent  
21 higher under the No Action Alternative than under the Second Basis of  
22 Comparison. In addition, the likelihood of mean (March to July) Delta outflow  
23 exceeding the threshold of 50,000 cfs was the same under both alternatives.

#### 24 *Summary of Effects on White Sturgeon*

25 The increased frequency of exceedance of water temperature thresholds under  
26 Alternative 5 could increase the potential for adverse effects on White Sturgeon  
27 relative to the Second Basis of Comparison. The analysis based on Delta  
28 outflows suggests that the No Action Alternative provides higher mean (March to  
29 July) outflows which could result in stronger year classes of juvenile sturgeon  
30 relative to the Second Basis of Comparison. However, early life stage survival in  
31 the natal rivers is crucial in development of a strong year class; therefore, based  
32 primarily on the analysis of water temperatures, Alternative could be more likely  
33 to result in adverse effects on White Sturgeon than the Second Basis of  
34 Comparison.

#### 35 *Delta Smelt*

36 The potential effects of the No Action Alternative as compared to the Second  
37 Basis of Comparison were analyzed based on differences in proportional  
38 entrainment and the fall abiotic index as described below.

39 As described in Appendix 9G, a proportional entrainment regression model  
40 (based on Kimmerer 2008, 2011) was used to simulate adult Delta Smelt  
41 entrainment, as influenced by OMR flow in December through March. Results  
42 indicate that the percentage of entrainment of migrating and spawning adult Delta  
43 Smelt under Alternative 5 would be 7 to 8.3 percent, depending on the water year

1 type, with a long-term average percent entrainment of 7.6 percent. Percent  
2 entrainment of adult Delta Smelt under Alternative 5 would be similar to results  
3 under Second Basis of Comparison. Under the Second Basis of Comparison, the  
4 long-term average entrainment would be 9 percent.

5 A proportional entrainment regression model (based on Kimmerer 2008) also was  
6 used to simulate larval and early juvenile Delta Smelt entrainment, as influenced  
7 by OMR flow and location of X2 in March through June. Results indicate that  
8 the percentage of entrainment of larval and early juvenile Delta Smelt under  
9 Alternative 5 would be 1.3 to 19.3 percent, depending on the water year type, with  
10 a long term average percent entrainment of 8.6 percent, and highest entrainment  
11 under Critical water year conditions. Percent entrainment of larval and early  
12 juvenile Delta Smelt under Alternative 5 would be lower than results under the  
13 Second Basis of Comparison by up to 9.4 percent. Under the Second Basis of  
14 Comparison, the long-term average percent entrainment would be 15.5 percent,  
15 and highest entrainment would occur under critical dry water year conditions, at  
16 23.6 percent.

17 The predicted position of Fall X2 (in September through December) is used as an  
18 indicator of fall abiotic habitat index for Delta Smelt. Feyrer et al. (2010) used  
19 X2 location as an indicator of the extent of habitat available with suitable salinity  
20 for the rearing of older juvenile Delta Smelt. Feyrer et al. (2010) concluded that  
21 when X2 is located downstream (west) of the confluence of the Sacramento and  
22 San Joaquin Rivers, at a distance of 70 to 80 km from the Golden Gate Bridge,  
23 there is a larger area of suitable habitat. The overlap of the low salinity zone (or  
24 X2) with the Suisun Bay/Marsh results in a two-fold increase in the habitat index  
25 (Feyrer et al. 2010).

26 The average September through December X2 position in km was used to  
27 evaluate the fall abiotic habitat availability for Delta Smelt under the Alternatives.  
28 X2 values simulated in the CalSim II model for each Alternative were averaged  
29 over September through December, and compared. Results indicate that under  
30 the No Action Alternative, the X2 position would range from 75.8 km to 92.3 km,  
31 depending on the water year type, with a long term average X2 position of 84 km.  
32 The most eastward location of X2 is predicted under Critical water year  
33 conditions. The X2 positions predicted under Alternative 5 would be similar to  
34 results under the Second Basis of Comparison in drier water year types. In wetter  
35 years, the X2 location would be further west under Alternative 5 than under the  
36 Second Basis of Comparison, by 6.1 to 9.8 km.

37 Overall, Alternative 5 likely would result in better conditions for Delta Smelt than  
38 would the Second Basis of Comparison, primarily due to lower percentage  
39 entrainment for larval and juvenile life stages, and more favorable location of Fall  
40 X2 in wetter years, and on average. Given the current condition of the Delta  
41 Smelt population, even small differences between alternatives may be important.

1        *Longfin Smelt*

2        The effects of the Alternative 5 as compared to the Second Basis of Comparison  
3        were analyzed based on the direction and magnitude of OMR flows during the  
4        period (December through June) when adult, larvae, and young juvenile Longfin  
5        Smelt are present in the Delta in the vicinity of the export facilities  
6        (Appendix 5A). The analysis was augmented with calculated Longfin Smelt  
7        abundance index values (Appendix 9G) per Kimmerer et al. (2009), which is  
8        based on the assumptions that lower X2 values reflect higher flows and that  
9        transporting Longfin Smelt farther downstream leads to greater Longfin Smelt  
10       survival. The index value indicates the relative abundance of Longfin Smelt and  
11       not the calculated population.

12       Under Alternative 5, Longfin Smelt abundance index values range from  
13       1,204 under critical water year conditions to a high of 16,683 under wet water  
14       year conditions, with a long-term average value of 8,015. Under the Second Basis  
15       of Comparison, Longfin Smelt abundance index values range from 947 under  
16       critical water year conditions to a high of 15,822 under wet water year conditions,  
17       with a long-term average value of 7,257.

18       Results indicate that the Longfin Smelt abundance index values would be greater  
19       in every water year type under Alternative 5 than under the Second Basis of  
20       Comparison, with a long-term average index for Alternative 5 that is about  
21       10 percent higher than the long term average index for the Second Basis of  
22       Comparison. For below normal, dry, and critical water years, the Longfin Smelt  
23       abundance index values would be over 20 percent greater under Alternative 5 than  
24       under the Second Basis of Comparison, with the greatest difference (30.8 percent)  
25       predicted under dry conditions.

26       Overall, based on the lower frequency and magnitude of negative OMR flows and  
27       the higher Longfin Smelt abundance index values, especially in dry and critical  
28       years, Alternative 5 would be likely have a lower potential for adverse effects on  
29       the Longfin Smelt population as compared to the Second Basis of Comparison.

30       *Sacramento Splittail*

31       Under Alternative 5, flows entering the Yolo Bypass over the Fremont Weir  
32       generally would be slightly lower compared to the Second Basis of Comparison  
33       (Appendix 5A, Table C-26-6), thus potentially providing lower value to  
34       Sacramento Splittail because of the lower area of potential habitat (inundation)  
35       and the lower frequency of inundation. Given the relatively minor changes in  
36       flows into the Yolo Bypass, and the inherent uncertainty associated with the  
37       resolution of the CalSim II model (average monthly outputs), it is concluded that  
38       no definitive difference in effects on Sacramento Splittail between Alternative 5  
39       and the Second Basis of Comparison could be discerned.

1        *Reservoir Fishes*

2            *Changes in Available Habitat (Storage)*

3        As described in Chapter 5, Surface Water Resources and Water Supplies, changes  
4        in CVP and SWP water supplies and operations under Alternative 5 as compared  
5        to the Second Basis of Comparison generally would result in lower reservoir  
6        storage in CVP and SWP reservoirs in the Central Valley Region. Storage levels  
7        in Shasta Lake, Lake Oroville, and Folsom Lake would be lower under  
8        Alternative 5 as compared to the Second Basis of Comparison in the fall and  
9        winter months due to the inclusion of Fall X2 criteria under Alternative 5.

10       The highest reductions in Shasta Lake and Lake Oroville storage could be in  
11       excess of 20 percent. Storage in Folsom Lake could be reduced up to around  
12       10 percent in some months of some water year types. Additional information  
13       related to monthly reservoir elevations is provided in Appendix 5A, CalSim II and  
14       DSM2 Modeling. The reduction in reservoir storage under Alternative 5 may  
15       suggest that the amount of habitat for reservoir fishes could be reduced under  
16       Alternative 5 as compared to the Second Basis of Comparison. However, it is  
17       anticipated that aquatic habitat within the CVP and SWP water supply reservoirs  
18       is not limiting, such that this potential reduction in habitat may have little adverse  
19       effect on reservoir fishes.

20            *Changes in Black Bass Nesting Success*

21       Black bass nest survival in CVP and SWP reservoirs is anticipated to be near  
22       100 percent in March and April due to increasing reservoir elevations. For May,  
23       the likelihood of nest survival for Largemouth Bass in Lake Shasta being in the  
24       40 to 100 percent range is about 2 percent higher under Alternative 5 as compared  
25       to the Second Basis of Comparison. For June, the likelihood of nest survival  
26       being greater than 40 percent for Largemouth Bass is similar (within 1 percent)  
27       under Alternative 5 and Second Basis of Comparison; however, nest survival of  
28       greater than 40 percent is likely only in about 20 percent of the years evaluated.  
29       The likelihood of nest survival for Smallmouth Bass in Lake Shasta exhibits  
30       nearly the same pattern. For Spotted Bass, the likelihood of nest survival being  
31       greater than 40 percent is high (100 percent) in May under both Alternative 5 and  
32       the Second Basis of Comparison. For June, Spotted Bass nest survival would be  
33       less than for May due to greater daily reductions in water surface elevation as  
34       Shasta Lake is drawn down. The likelihood of survival being greater than  
35       40 percent is higher (by about 12 percent) under Alternative 5 as compared to the  
36       Second Basis of Comparison.

37       For May and June, the likelihood of nest survival for Largemouth Bass in Lake  
38       Oroville being in the 40 to 100 percent range is higher under Alternative 5 as  
39       compared to the Second Basis of Comparison, about 13 percent higher in May  
40       and about 4 percent higher in June. However, June nest survival of greater than  
41       40 percent is likely only in about 40 percent of the years evaluated. The  
42       likelihood of nest survival for Smallmouth Bass in Lake Oroville exhibits nearly  
43       the same pattern. For Spotted Bass, the likelihood of nest survival being greater  
44       than 40 percent is 100 percent in May under Alternative 5 as compared to about  
45       94 percent under the Second Basis of Comparison. For June, Spotted Bass

1 survival would be less than for May due to greater daily reductions in water  
 2 surface elevation as Lake Oroville is drawn down. The likelihood of survival  
 3 being greater than 40 percent is substantially higher (on the order of 20 percent)  
 4 under Alternative 5 as compared to the Second Basis of Comparison.

5 Black bass nest survival in Folsom Lake is near 100 percent in March, April, and  
 6 May due to increasing reservoir elevations. For June, the likelihood of nest  
 7 survival for Largemouth Bass and Smallmouth Bass in Folsom Lake being in the  
 8 40 to 100 percent range is somewhat (around 7 percent) higher under  
 9 Alternative 5 than under the Second Basis of Comparison. For Spotted Bass, nest  
 10 survival for June would be less than for May due to greater daily reductions in  
 11 water surface elevation. However, the likelihood of survival being greater than  
 12 40 percent is similar under Alternative 5 as compared to the Second Basis of  
 13 Comparison.

#### 14 *Summary of Effects on Reservoir Fishes*

15 Reservoir storage is anticipated to be reduced under Alternative 5 relative to the  
 16 Second Basis of Comparison and this reduction could affect the amount of warm  
 17 and cold water habitat available within the reservoirs. However, it is unlikely that  
 18 aquatic habitat within the CVP and SWP water supply reservoirs is limiting.

19 The analysis of black bass nest survival based on changes in water surface  
 20 elevation during the spawning period indicated that the likelihood of high  
 21 (>40 percent) nest survival in most of the reservoirs under Alternative 5 would be  
 22 similar under Alternative 5 and the Second Basis of Comparison. Overall, the  
 23 results of the habitat and nest survival analysis suggest that effects on reservoir  
 24 fishes would be similar under the No Action Alternative and the Second Basis of  
 25 Comparison.

#### 26 *Other Species*

27 Several other fish species could be affected by changes in operations that  
 28 influence temperature and flow. The following describes the extent of these  
 29 changes and the potential effects on these species.

#### 30 *Pacific Lamprey*

31 Little information is available on factors that influence populations of Pacific  
 32 Lamprey in the Sacramento River, but they are likely affected by many of the  
 33 same factors as salmon and steelhead because of the parallels in their life cycles.

#### 34 *Changes in Water Temperature*

35 The following describes anticipated changes in average monthly water  
 36 temperature in the Sacramento, Feather, and American rivers and the potential for  
 37 those changes to affect Pacific Lamprey.

#### 38 *Sacramento River*

39 Monthly water temperature in the Sacramento River at Keswick Dam under  
 40 Alternative 5 and the Second Basis of Comparison generally would be similar  
 41 (differences less than 0.5°F). Average monthly water temperatures in September  
 42 under Alternative 5 would be lower (up to 0.9°F) in wetter years and higher (up to  
 43 1.2°F) in drier years. Similarly, water temperatures in October of critical years

1 could be 0.9°F warmer under Alternative 5 (Appendix 6B, Table 5-5-6). A  
2 similar pattern in temperatures generally would be exhibited at downstream  
3 locations along the Sacramento River (i.e., Ball's Ferry Jelly's Ferry, Bend  
4 Bridge, Red Bluff, Hamilton City, and Knights Landing), with differences in  
5 average monthly temperatures at Knights Landing progressively increasing (up to  
6 1.0°F warmer) in June and up to up to 4.6°F cooler in September of wetter years  
7 under Alternative 5 relative to the Second Basis of Comparison. Given the  
8 generally minor differences in flows and water temperatures between  
9 Alternative 5 and the Second Basis of Comparison, it is anticipated that the effect  
10 on Pacific Lamprey in the Sacramento River generally would be the same under  
11 both scenarios.

12 *Feather River*

13 Long-term average monthly water temperature in the Feather River at the low  
14 flow channel under Alternative 5 relative to the Second Basis of Comparison  
15 generally would be similar (less than 0.5°F differences). Water temperatures  
16 could be up to 1.5°F warmer in November and December of some water year  
17 types and up to 1.2°F cooler in September of wetter years. Although temperatures  
18 in the river would become progressively higher in the downstream direction, the  
19 differences between Alternative 5 and Second Basis of Comparison exhibit a  
20 similar pattern at the downstream locations (Robinson Riffle and Gridley Bridge),  
21 with water temperature differences under Alternative 5 generally increasing in  
22 most water year types relative to the Second Basis of Comparison at the  
23 confluence with Sacramento. Water temperatures under Alternative 5 could be  
24 somewhat (0.8°F to 1.6°F) cooler on average and up to 3.9°F cooler (September)  
25 at the confluence with Sacramento River from July to September in wetter years.

26 Due to the similarity of water temperatures under Alternative 5 and Second Basis  
27 of Comparison from January through August, there would be little difference in  
28 potential effects on Pacific Lamprey adults during their upstream migration.

29 *American River*

30 Average monthly water temperatures in the American River at Nimbus Dam  
31 under Alternative 5 generally would be similar (differences less than 0.5°F) to the  
32 Second Basis of Comparison, with the exception of during June and August of  
33 below normal years, when temperatures under Alternative 5 could be as much as  
34 0.9°F higher. This pattern generally would persist downstream to Watt Avenue  
35 and the mouth, although temperatures under Alternative 5 would be up to 1.6°F  
36 and 2.1°F higher, respectively, than under the Second Basis of Comparison in  
37 June. Due to the similarity of water temperatures under Alternative 5 and Second  
38 Basis of Comparison from January through May, there would be little difference  
39 in potential effects on Pacific Lamprey adults during their upstream migration.  
40 The higher water temperatures during June and August may increase the  
41 likelihood of adverse effects on Pacific Lamprey during their holding, and  
42 spawning periods.

1                    *Summary of Effects on Pacific Lamprey*

2 In general, Pacific Lamprey can tolerate higher temperatures than salmonids, up  
3 to around 72°F during their entire life history. Because lamprey ammocoetes  
4 remain in the river for several years, any substantial flow reductions or  
5 temperature increases could result in adverse effects on larval larvae. Given  
6 similarity in water temperatures during their spawning and incubation period, it is  
7 likely that Alternative 5 would have a similar potential to affect Pacific Lamprey  
8 in the Sacramento, Feather, and American rivers than would the Second Basis of  
9 Comparison. This conclusion likely applies to other species of lamprey that  
10 inhabit these rivers (e.g., River Lamprey).

11                    *Striped Bass, American Shad, and Hardhead*

12 Changes in operations influence temperature and flow conditions that could affect  
13 Striped Bass, American Shad, and Hardhead. The following describes those  
14 changes and their potential effects.

15                    *Changes in Water Temperature*

16 Changes in water temperature that affect Striped Bass, American Shad, and  
17 Hardhead could occur in the Sacramento, Feather, and American rivers. The  
18 following describes temperature conditions in those water bodies.

19                    *Sacramento River*

20 As described above for lampreys, monthly water temperature in the Sacramento  
21 River at Keswick Dam under Alternative and the Second Basis of Comparison  
22 generally would be similar (within about 0.5°F). Average monthly water  
23 temperatures in September under Alternative 5 would be lower (up to 0.9°F) in  
24 wetter years and higher (up to 1.2°F) in drier years. Similarly, water temperatures  
25 in October of critical years could be 0.9°F warmer under Alternative 5  
26 (Appendix 6B, Table 5-5-6). A similar temperature pattern generally would be  
27 exhibited downstream at Ball's Ferry, Jelly's Ferry, and Bend Bridge, with  
28 average monthly temperatures in June progressively increasing by a small margin  
29 under Alternative 5 relative to the Second Basis of Comparison.

30                    *Feather River*

31 Long-term average monthly water temperature in the Feather River at the low  
32 flow channel under Alternative 5 relative to the Second Basis of Comparison  
33 generally would be similar (less than 0.5°F differences). Water temperatures  
34 could be up to 1.5°F warmer in November and December of some water year  
35 types and up to 1.2°F cooler in September of wetter years. Although temperatures  
36 in the river would become progressively higher in the downstream direction, the  
37 differences between Alternative 5 and Second Basis of Comparison exhibit a  
38 similar pattern at the downstream locations (Robinson Riffle and Gridley Bridge),  
39 with water temperature differences under Alternative 5 generally increasing in  
40 most water year types relative to the Second Basis of Comparison at the  
41 confluence with the Sacramento River. Water temperatures under Alternative 5  
42 could be somewhat (0.8°F to 1.6°F) cooler on average and up to 3.9°F cooler  
43 (September) at the confluence with Sacramento River from July to September in  
44 wetter years.



1 *American River*

2 Average monthly water temperatures in the American River at Nimbus Dam  
3 under Alternative 5 generally would be similar (differences less than 0.5°F) to the  
4 Second Basis of Comparison, with the exception of during June and August of  
5 below normal years, when differences under Alternative 5 could be as much as  
6 0.9°F higher. This pattern generally would persist downstream to Watt Avenue  
7 and the mouth, although temperatures under Alternative 5 would be up to 1.6°F  
8 and 2.1°F higher, respectively, than under the Second Basis of Comparison in  
9 June.

10 *Changes in Position of X2*

11 Alternative 5 would result in a more westward X2 position as compared to the  
12 Second Basis of Comparison during April and May, with similar values in June  
13 (Appendix 5A, Section C Table C-16-6). Based on Kimmerer (2002) and  
14 Kimmerer et al. (2009), this change in X2 would likely increase the survival index  
15 and the habitat index as measured by salinity for Striped Bass and abundance and  
16 habitat index for American Shad.

17 *Summary of Effects on Striped Bass, American Shad, and Hardhead*

18 Because Striped Bass, American Shad, and Hardhead can tolerate higher  
19 temperatures than salmonids, it is unlikely that the slightly increased temperatures  
20 during some months under Alternative 5 would have substantial adverse effects  
21 on these species in the American River. Given the generally minor differences in  
22 water temperatures between Alternative 5 and the Second Basis of Comparison, it  
23 is anticipated that the effect of water temperatures on Striped Bass, American  
24 Shad, and Hardhead generally would be the same under both scenarios. Overall,  
25 Alternative 5 likely would have similar effects on Hardhead and a slightly lower  
26 potential for adverse effects on Striped Bass and American Shad as compared to  
27 the Second Basis of Comparison, primarily due to the potential for increased  
28 survival for these two species during larval and juvenile life stages, and more  
29 favorable location of Spring X2 on average.

30 *Stanislaus River/Lower San Joaquin River*

31 *Fall-Run Chinook Salmon*

32 Changes in operations influence temperature and flow conditions that could affect  
33 fall-run Chinook Salmon in the Stanislaus River downstream of Goodwin Dam  
34 and in the San Joaquin River below Vernalis. The following describes those  
35 changes and their potential effects.

36 *Changes in Water Temperature (Stanislaus River)*

37 Average monthly water temperatures in the Stanislaus River at Goodwin Dam  
38 under Alternative 5 and Second Basis of Comparison generally would be similar  
39 (differences less than 0.5°F), except in August through October when long-term  
40 average monthly temperatures could be up to 1.0°F warmer than under the Second  
41 Basis of Comparison. These differences would be of higher magnitude in drier  
42 years with average monthly water temperatures in September as much as 1.9°F  
43 warmer under Alternative 5 as compared to the Second Basis of Comparison  
44 (Appendix 6B, Table B-17-6).

1 Downstream at Orange Blossom Bridge, average monthly water temperatures in  
 2 October and April under Alternative 5 would be lower in all water year types than  
 3 the Second Basis of Comparison by as much as 1.4°F in October and 1.6°F in  
 4 April. In most other months, long-term average monthly water temperatures  
 5 under Alternative 5 generally would be similar to water temperatures under the  
 6 Second Basis of Comparison. Water temperatures under Alternative 5 could be  
 7 up to 1.3°F warmer in drier years from July to September than under the Second  
 8 Basis of Comparison. (Appendix 6B, Table B-18-6).

9 Downstream at the confluence with the San Joaquin River, average monthly water  
 10 temperatures in October, April and May would be lower by 2.0°F in October,  
 11 1.9°F in April and 0.6°F in May. Differences in water temperatures between  
 12 Alternative 5 and the Second Basis of Comparison would be even greater in these  
 13 months in some water year types. In most other months, long-term average  
 14 monthly water temperatures under Alternative 5 generally would be similar, but  
 15 could be somewhat higher (up to 1.1°F) in June, compared to the Second Basis of  
 16 Comparison (Appendix 6B, Table B-19-6).

17 *Changes in Exceedance of Water Temperature Thresholds*  
 18 *(Stanislaus River)*

19 While specific water temperature thresholds for fall-run Chinook Salmon in the  
 20 Stanislaus River are not established, temperatures generally suitable for fall-run  
 21 Chinook Salmon spawning (56°F) would be exceeded in October and November  
 22 over 30 percent of the time in the Stanislaus River at Goodwin Dam under  
 23 Alternative 5 ((Appendix 6B, Figure B-17-1 and B-17-2)). Similar exceedances  
 24 would occur under the Second Basis of Comparison, although up to 10 percent  
 25 more frequently in November. Water temperatures for rearing from January to  
 26 May generally would be below 56°F, except in May when average monthly water  
 27 temperatures would reach about 60°F under both conditions (Appendix 6B,  
 28 Figure B-17-8).

29 Downstream at Orange Blossom Bridge, water temperatures suitable for fall-run  
 30 Chinook Salmon spawning would be exceeded frequently under both  
 31 Alternative 5 and Second Basis of Comparison during October and November.  
 32 Under Alternative 5, average monthly water temperatures would exceed 56°F  
 33 about 57 percent of the time in October (Appendix 6B, Figure B-18-1). This,  
 34 however, would be about 28 percent less frequently than under the Second Basis  
 35 of Comparison. In November, average monthly water temperatures would exceed  
 36 56°F about 33 percent of the time under Alternative 5, which would be about  
 37 5 percent more frequently than under the Second Basis of Comparison  
 38 (Appendix 6B, Figure B-18-2).

39 During January through May, rearing fall-run Chinook Salmon under  
 40 Alternative 5 would be subjected to average monthly water temperatures that  
 41 exceed 56° in March (less than 10 percent of the time) and May (about 30 percent  
 42 of the time) under Alternative 5 which is about 10 percent more frequently than  
 43 under the Second Basis of Comparison (Appendix 6B, Figure B-18-8).

1            *Changes in Egg Mortality (Stanislaus River)*

2 For fall-run Chinook Salmon in the Stanislaus River, the long-term average egg  
3 mortality rate is predicted to be around 8.5 percent, with higher mortality rates (in  
4 excess of 15 percent) occurring in critical dry years under Alternative 5. Overall,  
5 egg mortality would be similar under Alternative 5 and the Second Basis of  
6 Comparison (Appendix 9C, Table B-8).

7            *Changes in Delta Hydrodynamics*

8 San Joaquin River-origin fall run Chinook salmon smolts are most abundant in the  
9 Delta during the months of April, May and June. Near the confluence of the San  
10 Joaquin River and the Mokelumne River, the median proportion of positive  
11 velocities was slightly to moderately higher under Alternative 5 relative to Second  
12 Basis of Comparison in April and May, respectively whereas values in June were  
13 similar (Appendix 9K). On Old River downstream of the facilities, the median  
14 proportion of positive velocities was substantially higher in April and May and  
15 slightly higher in June under Alternative 5 relative to Second Basis of  
16 Comparison. In Old River upstream of the facilities, the median proportion of  
17 positive velocities was slightly higher under Alternative 5 April and May and  
18 slightly lower in June. On the San Joaquin River downstream of the Head of Old  
19 River, the median proportion of positive velocities was slightly to moderately  
20 lower under Alternative 5 relative to Second Basis of Comparison in April and  
21 May, respectively, and similar in June.

22           *Changes in Junction Entrainment*

23 Entrainment at the Head of Old River junction was substantially higher under  
24 Alternative 5 relative to Second Basis of Comparison during the months of April  
25 and May and slightly lower in June (Appendix 9L). For the Turner Cut junction,  
26 median entrainment under Alternative 5 was moderately lower in April and May  
27 relative to Second Basis of Comparison and slightly lower in June. At the  
28 Columbia Cut junction, median entrainment under Alternative 5 was slightly  
29 lower in June relative to the Second Basis of Comparison. Median entrainment  
30 was substantially lower under Alternative 5 relative to Second Basis of  
31 Comparison in April and May. A similar pattern of entrainment under  
32 Alternative 5 relative to Second Basis of Comparison was observed at the Middle  
33 River and Old River junctions.

34           *Summary of Effects on Fall-Run Chinook Salmon*

35 The multiple model and analysis outputs described above characterize the  
36 anticipated conditions for fall-run Chinook Salmon and their response to change  
37 under the No Action Alternative as compared to the Second Basis of Comparison.  
38 In the Stanislaus River, the analysis of the effects of the No Action  
39 Alternative and Second Basis of Comparison for fall-run Chinook Salmon relied  
40 on the water temperature model output for the rivers at various locations  
41 downstream of Goodwin Dam. The analysis of temperatures indicates lower  
42 temperatures and a slightly lower likelihood of exceedance of suitable  
43 temperatures for spawning and rearing of fall-run Chinook Salmon under  
44 Alternative 5 as compared to the Second Basis of Comparison in the Stanislaus

1 River below Goodwin Dam and in the San Joaquin River at Vernalis. The effect  
2 of lower temperatures is not reflected in the similar overall mortality of fall-run  
3 Chinook Salmon eggs predicted by Reclamation's salmon survival model for fall-  
4 run in the Stanislaus River. As described above, the instream flow patterns under  
5 Alternative 5 are anticipated to benefit fall-run Chinook Salmon in the Stanislaus  
6 River and downstream in the lower San Joaquin River below Vernalis.

7 Implementation of a fish passage project under Alternative 5, primarily intended  
8 to address the limited availability of suitable habitat for steelhead in the Stanislaus  
9 River reaches downstream of Goodwin Dam, is not likely to provide benefit to  
10 fall-run Chinook Salmon unless passage for fall-run Chinook Salmon was  
11 provided and additional habitat could be accessed. Any potential benefit to fall-  
12 run Chinook Salmon is uncertain. However, actions implemented under  
13 Alternative 5 intended to increase the efficiency of the Tracy and Skinner Fish  
14 Collection Facilities could improve the overall salvage survival of fall-run  
15 Chinook Salmon.

16 On balance, given the small differences in the modeling results and the potential  
17 benefits anticipated by actions not captured in the models, it is concluded that  
18 effects on fall-run Chinook Salmon under Alternative 5 and Second Basis of  
19 Comparison would be similar.

#### 20 *Steelhead*

21 Changes in operations that influence temperature and flow conditions in the  
22 Stanislaus River downstream of Goodwin Dam and the San Joaquin River below  
23 Vernalis could affect steelhead. The following describes those changes and their  
24 potential effects.

#### 25 *Changes in Water Temperature (Stanislaus River)*

26 Average monthly water temperatures in the Stanislaus River at Goodwin Dam  
27 under Alternative 5 and Second Basis of Comparison generally would be similar  
28 (differences less than 0.5°F), except in August through October when long-term  
29 average monthly temperatures could be up to 1.0°F warmer than under the Second  
30 Basis of Comparison. These differences would be of higher magnitude in drier  
31 years with average monthly water temperatures in September as much as 1.9°F  
32 warmer under Alternative 5 as compared to the Second Basis of Comparison.

33 Downstream at Orange Blossom Bridge, average monthly water temperatures in  
34 October and April under Alternative 5 would be lower in all water year types than  
35 the Second Basis of Comparison by as much as 1.4°F in October and 1.6°F in  
36 April. In most other months, long-term average monthly water temperatures  
37 under Alternative 5 generally would be similar to water temperatures under the  
38 Second Basis of Comparison. Water temperatures under Alternative 5 could be  
39 up to 1.3°F warmer in drier years from July to September than under the Second  
40 Basis of Comparison. (Appendix 6B, Table B-18-6).

41 Downstream at the confluence with the San Joaquin River, average monthly water  
42 temperatures in October, April and May would be lower by 2.0°F in October,  
43 1.9°F in April and 0.6°F in May. Differences in water temperatures between

1 Alternative 5 and the Second Basis of Comparison would be even greater in these  
2 months in some water year types. In most other months, long-term average  
3 monthly water temperatures under Alternative 5 generally would be similar, but  
4 could be somewhat higher (up to 1.1°F) in June, compared to the Second Basis of  
5 Comparison.

6 *Changes in Exceedance of Water Temperature Thresholds*  
7 *(Stanislaus River)*

8 Average monthly water temperatures in the Stanislaus River at Orange Blossom  
9 Bridge would frequently exceed the temperature threshold (56°F) established for  
10 adult steelhead migration under both Alternative 5 and Second Basis of  
11 Comparison during October and November. Under Alternative 5, average  
12 monthly water temperatures would exceed 56°F about 57 percent of the time in  
13 October which is about 28 percent less frequently than under the Second Basis of  
14 Comparison (Appendix 6B, Figure B-18-1). In November, average monthly  
15 water temperatures would exceed 56°F about 33 percent of the time under  
16 Alternative 5, which would be about 10 percent more frequently than under the  
17 Second Basis of Comparison.

18 In January through May, the temperature threshold at Orange Blossom Bridge is  
19 55°F, which is intended to support steelhead spawning. This threshold would not  
20 be exceeded under either Alternative 5 or Second Basis of Comparison during  
21 January or February. In March through May, however, exceedances would occur  
22 under both Alternative 5 and the Second Basis of Comparison in each month, with  
23 the threshold most frequently exceeded (40 percent) under Alternative 5 in May  
24 (Appendix 9N). Average monthly water temperatures under Alternative 5 would  
25 exceed the threshold 4 percent more frequently in March 26 percent less  
26 frequently in April and 5 percent less frequently in May than under the Second  
27 Basis of Comparison.

28 From June through November, the temperature threshold of 65°F established to  
29 support steelhead rearing would be exceeded by both Alternative 5 and Second  
30 Basis of Comparison in all months but November. The differences between  
31 Alternative 5 and Second Basis of Comparison, however, would be small, with  
32 average monthly water temperatures under Alternative 5 generally exceeding the  
33 threshold by 3 percent to 8 percent more frequently than under the Second Basis  
34 of Comparison.

35 Average monthly water temperatures also would exceed the threshold (52°F)  
36 established for smoltification at Knights Ferry. At Goodwin Dam, about 4 miles  
37 upstream of Knights Ferry, average monthly water temperatures under  
38 Alternative 5 would exceed 52°F in March, April, and May about 8 percent,  
39 37 percent, and 68 percent of the time, respectively. Alternative 5 would result in  
40 exceedances of the smoltification threshold occurring up to 6 percent more  
41 frequently during the January through May period. Farther downstream at Orange  
42 Blossom Bridge, the temperature threshold for smoltification is higher (57°F) and  
43 would be exceeded less frequently. The magnitude of the exceedance also would  
44 be less. Average monthly water temperatures under Alternative 5 and the Second

1 Basis of Comparison would not exceed the threshold during January through  
 2 April. In May, the threshold would be exceeded 8 percent of the time under  
 3 Alternative 5. Compared to the Second Basis of Comparison, the 57°F at Orange  
 4 Blossom Bridge would be exceeded about 8 percent less frequently in April and  
 5 6 percent less frequently in May under Alternative 5.

6 Overall, the temperature differences between Alternative 5 and Second Basis of  
 7 Comparison would be relatively small, with the exception of substantial  
 8 differences in the frequency of exceedances in October when the average monthly  
 9 water temperatures under Alternative 5 would exceed the threshold for adult  
 10 steelhead migration about 28 percent less frequently and in April during the  
 11 spawning period when the frequency would be about 26 percent less. Given the  
 12 frequency of exceedance under both Alternative 5 and Second Basis of  
 13 Comparison and the generally stressful temperature conditions in the river, the  
 14 substantial differences (improvements) in October and April under Alternative 5  
 15 suggest that there would be less potential to result in adverse effects on steelhead  
 16 under Alternative 5 than under the Second Basis of Comparison. Even during  
 17 months when the differences would be relatively small, the lower frequency of  
 18 exceedances under Alternative 5 suggest that there would be less potential to  
 19 result in adverse effects on steelhead under Alternative 5 than under the Second  
 20 Basis of Comparison.

#### 21 *Changes in Delta Hydrodynamics*

22 Stanislaus River-origin steelhead generally move through the Delta during spring  
 23 however there is less information on their timing relative to Chinook salmon.  
 24 Thus, hydrodynamics in the entire January through June period have the potential  
 25 to affect juvenile steelhead.

26 On the San Joaquin River near the Mokelumne River confluence, the median  
 27 proportion of positive velocities was slightly greater under Alternative 5 relative  
 28 to Second Basis of Comparison in January, February, April and May and similar  
 29 in March and June. In Old River downstream of the facilities, the median  
 30 proportion of positive velocities was substantially higher under Alternative 5  
 31 during January, April, and May and moderately higher in February. Values in  
 32 March and June were almost indistinguishable between scenarios. On Old River  
 33 upstream of the facilities, the median proportion of positive velocities was  
 34 moderately lower in January and February, slightly lower in March and June, and  
 35 slightly higher in April and May under Alternative 5 relative to Second Basis of  
 36 Comparison. On the San Joaquin River downstream of Head of Old River, the  
 37 median proportion of positive velocities was similar for both scenarios in January,  
 38 February, March, and June, but slightly to moderately lower in April and May.

#### 39 *Summary of Effects on Steelhead*

40 The analysis of the effects of the No Action Alternative and Second Basis of  
 41 Comparison for steelhead relied on the water temperature model output for the  
 42 rivers at various locations downstream of Goodwin Dam. Given the frequency of  
 43 exceedance under both Alternative 5 and Second Basis of Comparison and the  
 44 generally stressful temperature conditions in the river, the substantial differences

1 (improvements) in October and April under Alternative 5 suggest that there would  
2 be less potential to result in adverse effects on steelhead under Alternative 5 than  
3 under the Second Basis of Comparison.

4 Implementation of a fish passage program under Alternative 5 intended to address  
5 the limited availability of suitable habitat for steelhead in the Stanislaus River  
6 reaches downstream of Goodwin Dam could provide a benefit to steelhead,  
7 however, the extent of benefit is uncertain. In addition, the potential effects of  
8 Alternative 5 could be offset by actions intended to reduce predation risk on  
9 steelhead in the Stanislaus River and increase the efficiency of the Tracy and  
10 Skinner Fish Collection Facilities. The actions to augment spawning gravel in the  
11 Stanislaus River under Alternative 5 also could benefit steelhead.

12 The numerical model results for effects on steelhead under Alternative 5 and  
13 Second Basis of Comparison do not definitively show distinct differences.  
14 However, in consideration of the potentially beneficial effects resulting from the  
15 actions that would be implemented under Alternative 5 that are not included in the  
16 numerical models (see Appendix 5A, Section B), Alternative 5 has a much greater  
17 potential to address the long-term sustainability of steelhead than does the Second  
18 Basis of Comparison. Alternative 5 includes provisions for fish passage upstream  
19 of New Melones Dam to address long-term temperature increases associated with  
20 climate change. Even though the success of fish passage is uncertain, it is  
21 concluded that the potential for adverse effects on steelhead under Alternative 5  
22 would clearly be less than that under the Second Basis of Comparison, principally  
23 because the Second Basis of Comparison does not include a strategy to address  
24 water temperatures critical to steelhead sustainability over the long term with  
25 climate change by 2030.

#### 26 *White Sturgeon*

27 Evidence of White Sturgeon spawning has been recorded in the San Joaquin River  
28 upstream of the confluence with the Stanislaus River. While flows in the San  
29 Joaquin River upstream of the Stanislaus River are expected to be similar under all  
30 alternatives, flow contributions from the Stanislaus River could influence water  
31 temperatures in the San Joaquin River where White Sturgeon eggs or larvae may  
32 occur during the spring and early summer. The magnitude of influence on water  
33 temperature would depend on the proportional flow contribution of the Stanislaus  
34 River and the temperatures in both the Stanislaus and San Joaquin rivers. The  
35 potential for an effect on White Sturgeon eggs and larvae would be influenced by  
36 the proportion of the population occurring in the San Joaquin River. In  
37 consideration of this uncertainty, it is not possible to distinguish potential effects  
38 on White Sturgeon between alternatives.

#### 39 *Reservoir Fishes*

40 As described in Chapter 5, Surface Water Resources and Water Supplies, changes  
41 in CVP and SWP water supplies and operations under Alternative 5 as compared  
42 to the Second Basis of Comparison would result in lower Storage levels in New  
43 Melones Reservoir under Alternative 5 as compared to the Second Basis of

1 Comparison due to increased instream releases to support fish flows under the  
2 2009 NMFS BO.

3 Storage levels in New Melones Reservoir would be lower under Alternative 5 as  
4 compared to the Second Basis of Comparison (Appendix 5A), especially in  
5 critical years when the difference could be as much as 23 percent. Using storage  
6 volume as an indicator of available availability for fish species inhabiting these  
7 reservoirs, these results suggest that the amount of habitat for reservoir fishes  
8 could be decreased under Alternative 5 as compared to the Second Basis of  
9 Comparison. However, it is anticipated that aquatic habitat within the CVP and  
10 SWP water supply reservoirs is not limiting, such that this potential reduction in  
11 habitat may have little adverse effect on reservoir fishes.

12 Nest survival for black bass species in New Melones is higher than in the other  
13 reservoirs during May and June. For March, Largemouth Bass and Smallmouth  
14 Bass nest survival is predicted to be above 40 percent in all of the years simulated.  
15 For April, the likelihood that nest survival of Largemouth Bass and Smallmouth  
16 Bass is between 40 and 100 percent is substantially less (about 25 percent) under  
17 Alternative 5 as compared to the Second Basis of Comparison. For May, the  
18 likelihood of high nest survival is similar under Alternative 5 and the Second  
19 Basis of Comparison. For June, the likelihood of survival being greater than  
20 40 percent for Largemouth Bass and Smallmouth Bass in New Melones is  
21 somewhat (about 10 percent) higher under Alternative 5 as compared to the  
22 Second Basis of Comparison. For Spotted Bass, nest survival in March is  
23 anticipated to be near 100 percent in every year under both Alternative 5 and  
24 Second Basis of Comparison. The likelihood of survival being greater than  
25 40 percent is about 6 percent lower in April under Alternative 5 than under the  
26 Second Basis of Comparison, but is still reasonably high (about 90 percent). For  
27 May, the likelihood of high Spotted Bass nest survival is similar under  
28 Alternative 5 and the Second Basis of Comparison. For June, Spotted Bass nest  
29 survival would be greater than 40 percent in all of the simulation years under both  
30 Alternative 5 and the Second Basis of Comparison. Overall, the analysis suggests  
31 that conditions under Alternative 5 have the potential to influence black bass  
32 nesting success, especially in April and May in comparison to the Second Basis of  
33 Comparison. However, nesting success under Alternative 5 would still exceed  
34 40 percent most of the time under both alternatives. Therefore, it is concluded  
35 that there would be no definitive difference in effects on reservoir fish between  
36 Alternative 5 and the Second Basis of Comparison.

37 *Other species*

38 Changes in operations that influence temperature and flow conditions in the  
39 Stanislaus River downstream of Keswick Dam and the San Joaquin River at  
40 Vernalis could affect other species such as lampreys, Hardhead, and Striped Bass.

41 As described above, average monthly water temperatures in the Stanislaus River  
42 at Goodwin Dam under Alternative 5 and Second Basis of Comparison generally  
43 would be similar (differences less than 0.5°F), except in August through October  
44 when long-term average monthly temperatures could be up to 1.0°F warmer than



1 under the Second Basis of Comparison. These differences would be of higher  
2 magnitude in drier years with average monthly water temperatures in September  
3 as much as 1.9°F warmer under Alternative 5 as compared to the Second Basis of  
4 Comparison.

5 Downstream at Orange Blossom Bridge, average monthly water temperatures in  
6 October and April under Alternative 5 would be lower in all water year types than  
7 the Second Basis of Comparison by as much as 1.4°F in October and 1.6°F in  
8 April. In most other months, long-term average monthly water temperatures  
9 under Alternative 5 generally would be similar to water temperatures under the  
10 Second Basis of Comparison. Water temperatures under Alternative 5 could be  
11 up to 1.3°F warmer in drier years from July to September than under the Second  
12 Basis of Comparison (Appendix 6B, Table B-18-6).

13 Downstream at the confluence with the San Joaquin River, average monthly water  
14 temperatures in October, April and May would be lower by 2.0°F in October,  
15 1.9°F in April and 0.6°F in May. Differences in water temperatures between  
16 Alternative 5 and the Second Basis of Comparison would be even greater in these  
17 months in some water year types. In most other months, long-term average  
18 monthly water temperatures under Alternative 5 generally would be similar, but  
19 could be somewhat higher (up to 1.1°F) in June, compared to the Second Basis of  
20 Comparison.

21 In general, lamprey species can tolerate higher temperatures than salmonids, up to  
22 around 72°F during their entire life history. Because lamprey ammocoetes remain  
23 in the river for several years, any substantial flow reductions or temperature  
24 increases could adversely affect larval lamprey. Given the similar flows and  
25 temperatures during their spawning and incubation period, it is likely that the  
26 potential to affect lamprey species in the Stanislaus and San Joaquin rivers would  
27 be similar under Alternative 5 and the Second Basis of Comparison.

28 In general, Striped Bass and Hardhead also can tolerate higher temperatures than  
29 salmonids. Given the similar flows and temperatures during their spawning and  
30 incubation period, it is likely that the potential to affect Striped Bass and  
31 Hardhead in the Stanislaus and San Joaquin rivers would be similar under  
32 Alternative 5 and the Second Basis of Comparison.

### 33 *San Francisco Bay Area Region*

#### 34 *Killer Whale*

35 As described above for the comparison of Alternative 1 to the No Action  
36 Alternative, it is unlikely that the Chinook Salmon prey base of killer whales,  
37 supported heavily by hatchery production of fall-run Chinook Salmon, would be  
38 appreciably affected by any of the alternatives.

#### 39 **9.4.3.7 Summary of Environmental Consequences**

40 The results of the environmental consequences of implementation of  
41 Alternatives 1 through 5 as compared to the No Action Alternative and the  
42 Second Basis of Comparison are presented in Tables 9.4 and 9.5, respectively.

1 **Table 9.4 Comparison of Alternatives 1 through 5 to No Action Alternative**

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	<p><b>Trinity River Region</b></p> <p><u>Coho Salmon</u></p> <p>Overall, the temperature model outputs for each of the Coho Salmon life stages suggest that the temperature of water released at Lewiston Dam generally would be similar under both scenarios, although the exceedance of water temperature thresholds would be slightly less frequent (1 percent). Given the similarity of the results and the inherent uncertainty associated with the resolution of the temperature model (average monthly outputs), it is concluded that Alternative 1 and the No Action Alternative are likely to have similar effects on the Coho Salmon population in the Trinity River.</p> <p><u>Spring-run Chinook Salmon</u></p> <p>Although the water temperatures under Alternative 1 could result in adverse effects on spring-run Chinook Salmon in the Trinity River, these effects would not occur in every year and are not anticipated to be substantial based on the relatively small differences in water temperatures as compared to the No Action Alternative. However, implementation of the Hatchery Management Plan (RPA Action II.6.3) under the No Action Alternative could reduce the impacts of hatchery Chinook Salmon on natural spring-run Chinook Salmon in the Trinity River. Given the relatively minor changes in water temperature and water temperature threshold exceedance, the inherent uncertainty associated with the resolution of the temperature model (average monthly outputs), and the uncertainty of the hatchery benefits, Alternative 1 and the No Action Alternative are likely to have similar effects on spring-run Chinook Salmon in the Trinity River.</p> <p><u>Fall-run Chinook Salmon</u></p> <p>Although the combined analysis based on water temperature suggests that operations under Alternative 1 could be slightly less adverse than under the No Action Alternative, these effects would not occur in every year and are not anticipated to be substantial based on the relatively small differences in water temperatures (and similar egg mortality) between Alternative 1 and the No Action Alternative. In addition, the implementation of the Hatchery Management Plan (RPA Action II.6.3) under the No Action Alternative could reduce the impacts of hatchery Chinook Salmon on natural fall-run Chinook Salmon in the Trinity River. Overall, given the small differences in the numerical model results and the inherent uncertainty in the temperature model, as well as the potential for offsetting benefits associated with actions that were not modeled, it is concluded that Alternative 1 and the No Action Alternative are likely to have similar effects on the fall-run Chinook Salmon population in the Trinity River.</p> <p><u>Steelhead</u></p> <p>Although the analysis based on water temperature suggests that operations under Alternative 1 could be slightly less adverse than under the No Action Alternative, these effects would not occur in every year and are not anticipated to be substantial based on the relatively small differences in water temperatures between Alternative 1 and the No Action Alternative. Given these small differences in water temperatures and the inherent uncertainty in the temperature model,</p>	<p>Implement fish passage programs at Shasta, Folsom, and New Melones dams to reduce temperature impacts on Chinook Salmon and steelhead.</p> <p>Mitigation measures for other substantial impacts have not been identified at this time.</p>

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Alternative	Potential Change	Consideration for Mitigation Measures
	<p>Alternative 1 and the No Action Alternative are likely to have similar effects on steelhead in the Trinity River.</p> <p><u>Green Sturgeon</u></p> <p>Overall, given the similarities between average monthly water temperatures at Lewiston Dam, it is likely that water temperature conditions for Green Sturgeon in the Trinity River or lower Klamath River and estuary would be similar under Alternative 1 and the No Action Alternative.</p> <p><u>Reservoir Fishes</u></p> <p>Overall, the comparison of storage and the analysis of nesting suggest that effects on reservoir fishes would be similar under Alternative 1 and the No Action Alternative.</p> <p><u>Pacific Lamprey</u></p> <p>On average, the temperature of water released at Lewiston Dam generally would be similar under Alternative 1 and the No Action Alternative. Given the similarities in water temperatures, it is likely that the effects on Pacific Lamprey would be similar.</p> <p><u>Eulachon</u></p> <p>Given that the highest increases in flow under Alternative 1 would be less than 10 percent in the Trinity River, with a smaller relative change in the lower Klamath River and Klamath River estuary, and that water temperatures in the Klamath River are unlikely to be affected by changes upstream at Lewiston Dam, it is likely that Alternative 1 would have a similar potential to influence Eulachon in the Klamath River as the No Action Alternative.</p> <p><b>Sacramento River System</b></p> <p><u>Winter-run Chinook Salmon</u></p> <p>Overall, the quantitative results from the numerical models suggest that operation under the Alternative 1 would be more likely to result in adverse effects on winter-run Chinook Salmon than would the No Action Alternative. In addition, the potentially beneficial effects resulting from the RPA actions under the No Action Alternative that are not included in the numerical suggest that the No Action Alternative has a much greater potential to address the long-term sustainability of winter-run Chinook Salmon than does the Alternative 1. It is concluded that the potential for adverse effects on winter-run Chinook Salmon under Alternative 1 would be greater than those under the No Action Alternative, principally because Alternative 1 does not include fish passage to address water temperatures critical to winter-run Chinook Salmon sustainability over the long term with climate change by 2030.</p> <p><u>Spring-run Chinook Salmon</u></p> <p>Overall, the quantitative results from the numerical models suggest that operation under Alternative 1 would be less likely to result in adverse effects on spring-run Chinook Salmon. However, it is concluded that the potential for adverse effects on spring-run Chinook Salmon under Alternative 1 would be greater, principally because Alternative 1 does not include fish passage to address water temperatures critical to spring-run Chinook Salmon sustainability over the long term with climate change by 2030</p>	

Alternative	Potential Change	Consideration for Mitigation Measures
	<p><u>Fall-run Chinook Salmon</u></p> <p>Overall, the quantitative results from the numerical models suggest that operation under Alternative 1 would be less likely to result in adverse effects on fall-run Chinook Salmon. This potential distinction between the two scenarios, however, may be partially balanced by the potentially beneficial effects resulting from the RPA actions evaluated qualitatively for the No Action Alternative. Given the small differences in the numerical model results and the inherent uncertainty in the temperature model, as well as the potential for benefits associated with the RPA actions under the No Action Alternative, it is likely that the effects on fall-run Chinook Salmon would be similar.</p> <p><u>Late Fall-run Chinook Salmon</u></p> <p>The output from SALMOD indicated that late fall-run Chinook Salmon production would be similar. The analyses attempting to assess the effects on routing, entrainment, and salvage of juvenile salmonids in the Delta suggest that salvage (as an indicator of potential losses of juvenile salmon at the export facilities) of Sacramento River-origin Chinook Salmon is predicted to be higher under Alternative 1 in every month.</p> <p>Although survival in the Delta may be lower, given the similarity in the SALMOD outputs, it is likely that the effects on late fall-run Chinook Salmon would be similar.</p> <p><u>Steelhead</u></p> <p>The numerical model results suggest that overall, effects on steelhead could be slightly less adverse, particularly in the Feather River. However, Alternative 1 would not include fish passage and implementation of an HGMP for steelhead at the Nimbus Fish Hatchery that would occur under the No Action Alternative. Therefore, it is concluded that the adverse effects on steelhead under Alternative 1 would be greater than those under the No Action Alternative.</p> <p><u>Green Sturgeon</u></p> <p>Overall, the temperature model outputs suggest that thermal conditions and effects on Green Sturgeon generally would be slightly less adverse under Alternative 1. The analysis based on Delta outflows suggests that Alternative 1 provides lower mean (March to July) outflows which could result in weaker year classes of juvenile Green Sturgeon relative to the No Action Alternative. However, early life stage survival in the natal rivers is crucial in development of a strong year class. Therefore, based primarily on the analysis of water temperatures, Alternative 1 could be less likely to result in adverse effects on Green Sturgeon than the No Action Alternative.</p> <p><u>White Sturgeon</u></p> <p>Overall, the temperature model outputs suggest that thermal conditions and effects on White Sturgeon generally would be slightly less adverse under Alternative 1. The analysis based on Delta outflows suggests that Alternative 1 provides lower mean (March to July) outflows which could result in weaker year classes of juvenile White Sturgeon relative to the No Action Alternative. However, early life stage survival in the natal rivers is crucial in development of a strong year class. Therefore, based primarily on the analysis of water temperatures, Alternative 1 could be less likely to result in adverse effects on White Sturgeon than the No Action Alternative.</p>	

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Alternative	Potential Change	Consideration for Mitigation Measures
	<p><u>Delta Smelt</u></p> <p>Overall, Alternative 1 is likely to result in increased adverse effects on Delta Smelt primarily due to the potential for increased percentage entrainment during larval and juvenile life stages, and less favorable location of Fall X2 in wetter years, and on average. Given the current condition of the Delta Smelt population, even these small differences between Alternative 1 and the No Action Alternative may be important.</p> <p><u>Longfin Smelt</u></p> <p>Overall, based on the increase in frequency and magnitude of negative OMR flows and the lower Longfin Smelt abundance index values, especially in dry and critical dry years, potential adverse effects on the Longfin Smelt population likely would be greater.</p> <p><u>Sacramento Splittail</u></p> <p>Given the relatively minor changes in flows into the Yolo Bypass, and the inherent uncertainty associated with the resolution of the CalSim II model (average monthly outputs), it is concluded that there would be no definitive difference in effects on Sacramento Splittail between Alternative 1 and the No Action Alternative.</p> <p><u>Reservoir Fishes</u></p> <p>The analysis of black bass nest survival based on changes in water surface elevation during the spawning period indicated that the likelihood of high (&gt;40 percent) nest survival in most of the reservoirs would be similar in March, April, and May under Alternative 1 would be similar to or slightly lower than under and the No Action Alternative, but somewhat lower in June. Most black bass spawning likely occurs prior to June, such that drawdowns during June would likely affect only a small proportion of the spawning population. Thus, it is concluded that effects on black bass nesting success would be similar under Alternative 1 and the No Action Alternative.</p> <p><u>Pacific Lamprey</u></p> <p>Based on the similar water temperatures during their spawning and incubation period, it likely that conditions for and effects on Pacific Lamprey in the Sacramento, Feather, and American rivers would be similar. This conclusion likely applies to other species of lamprey that inhabit these rivers (e.g., River Lamprey).</p> <p><u>Striped Bass, American Shad, and Hardhead</u></p> <p>In general, Striped Bass, American Shad, and Hardhead can tolerate higher temperatures than salmonids. Based on the similar water temperatures during their spawning and incubation period, it is likely that thermal conditions for and effects on Striped Bass, American Shad, and Hardhead in the Sacramento, Feather, and American rivers would be similar. Overall, however, Alternative 1 likely would have slightly greater potential for adverse effects on Striped Bass and American Shad as compared to the No Action Alternative, primarily due to the potential for reduced survival during larval and juvenile life stages, and less favorable location of Spring X2 on average.</p> <p><b>Stanislaus River/Lower San Joaquin River</b></p> <p><u>Fall-run Chinook Salmon</u></p> <p>Overall, the quantitative results from the numerical models suggest that operation under Alternative 1 would be less likely to result in adverse effects on fall-</p>	

Alternative	Potential Change	Consideration for Mitigation Measures
	<p>run Chinook Salmon. This potential distinction between the two scenarios, however, may be partially balanced by the potentially beneficial effects resulting from the RPA actions evaluated qualitatively for the No Action Alternative. Given the small differences in the numerical model results and the inherent uncertainty in the temperature model, as well as the potential for benefits associated with the RPA actions under the No Action Alternative, there would be no definitive difference in effects on fall-run Chinook Salmon between Alternative 1 and the No Action Alternative.</p> <p><u>Steelhead</u></p> <p>The temperature model outputs suggest that the differences in the magnitude and frequency of exceedance of suitable temperatures for the various lifestages have the potential for adverse effects on the steelhead populations in the Stanislaus River under Alternative 1. However, the magnitude of this effect is uncertain. It is concluded that the potential for adverse effects on steelhead would be greater, principally because Alternative 1 does not include fish passage to address water temperatures critical to steelhead sustainability over the long term with climate change by 2030.</p> <p><u>White Sturgeon</u></p> <p>While flows in the San Joaquin River upstream of the Stanislaus River are expected to be similar, flow contributions from the Stanislaus River could influence water temperatures in the San Joaquin River where White Sturgeon eggs or larvae may occur during the spring and early summer. The magnitude of influence on water temperature would depend on the proportional flow contribution of the Stanislaus River and the temperatures in both the Stanislaus and San Joaquin rivers. The potential for an effect on White Sturgeon eggs and larvae would be influenced by the proportion of the population occurring in the San Joaquin River. In consideration of this uncertainty, it is not possible to distinguish potential effects on White Sturgeon between alternatives.</p> <p><u>Reservoir Fishes</u></p> <p>Overall, predicted nest survival is generally above 40 percent in all months evaluated, although survival would vary among months. In June, the likelihood of survival being greater than 40 percent is lower under Alternative 1. Most black bass spawning likely occurs prior to June, such that drawdowns during June would likely affect only a small proportion of the spawning population. Thus, effects on black bass nesting success would be similar.</p> <p><u>Other Species</u></p> <p>In general, lamprey species can tolerate higher temperatures than salmonids, up to around 72°F during their entire life history. Given the similar temperatures during their spawning and incubation period, it is likely that the potential to affect lamprey species in the Stanislaus and San Joaquin rivers would be similar.</p> <p>In general, Striped Bass and Hardhead also can tolerate higher temperatures than salmonids. Given the similar temperatures during their spawning and incubation period, it is likely that the potential to affect Striped Bass and Hardhead in the Stanislaus and San Joaquin rivers would be similar.</p>	

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Alternative	Potential Change	Consideration for Mitigation Measures
	<p><b>Pacific Ocean</b>  <u>Killer Whale</u>                      Given conclusions from NMFS (2009c), and the fact that at approximately 75 percent of fall-run Chinook Salmon available for Southern Residents are produced by Central Valley hatcheries, it is likely that Central Valley fall-run Chinook Salmon as a prey base for killer whales would not be appreciably affected.</p>	
Alternative 2	<p><b>Trinity River Region</b>  <u>Coho Salmon, spring-run and fall-run Chinook Salmon, steelhead, Green Sturgeon, Reservoir Fishes, Pacific Lamprey, River Lamprey, and Eulachon</u>                      Similar effects.</p> <p><b>Sacramento River System</b>  <u>Winter-run, spring-run, fall-run, and late fall-run Chinook Salmon, and steelhead</u>                      The effects under Alternative 2 may become more adverse due to the lack of fish passage and other actions, such as structural improvements for temperature control on the American River; gravel augmentation, floodplain restoration and pulse flows, in Clear Creek; and measures to increase the efficiency of the Tracy and Skinner Fish Collection Facilities. Thus, it is concluded that the potential for adverse effects on salmonids and sturgeon under Alternative 2 would be greater than under the No Action Alternative.</p> <p><u>Green Sturgeon, White Sturgeon, Delta Smelt, Longfin Smelt, Sacramento Splittail, Reservoir Fishes, Pacific Lamprey, River Lamprey, Striped Bass, American Shad, and Hardhead</u>                      Similar effects.</p> <p><b>Stanislaus River/Lower San Joaquin River</b>  <u>Fall-run Chinook Salmon and Steelhead</u>                      The effects under Alternative 2 may become more pronounced due to the lack of fish passage and other actions that would occur under the No Action Alternative such as gravel augmentation, floodplain restoration and inundation flows, and freshwater migratory habitat restoration in the Stanislaus River; and measures to increase the efficiency of the Tracy and Skinner Fish Collection Facilities.</p> <p><u>White Sturgeon, Reservoir Fishes, and Other Species</u>                      Similar effects.</p> <p><b>Pacific Ocean</b>  <u>Killer Whale</u>                      Similar effects.</p>	<p>Implement fish passage programs at Shasta, Folsom, and New Melones dams to reduce temperature impacts on Chinook Salmon and steelhead.</p>
Alternative 3	<p><b>Trinity River Region</b>  <u>Coho Salmon and Spring-run Chinook Salmon</u>                      Overall, the water temperature model outputs suggest that the temperature of water released at Lewiston Dam generally would be similar under both scenarios, although the exceedance of water temperature thresholds would be less frequent (by 1 to 2 percent) under Alternative 3. Given the similarity of the results and the inherent uncertainty associated with the resolution of the temperature model (average monthly outputs), it is concluded that Alternative 3 and the No Action Alternative are likely to have similar effects on the Coho Salmon population in the Trinity River. This conclusion also applies to spring-run Chinook Salmon,</p>	<p>Implement fish passage programs at Shasta, Folsom, and New Melones dams to reduce temperature impacts on Chinook Salmon and steelhead.</p> <p>Mitigation measures for other substantial impacts have not been identified at this time.</p>

Alternative	Potential Change	Consideration for Mitigation Measures
	<p>although the implementation of the Hatchery Management Plan (RPA Action II.6.3) under the No Action Alternative could reduce the impacts of hatchery Chinook Salmon on natural spring-run Chinook Salmon in the Trinity River, and increase the genetic diversity and diversity of run-timing for these stocks relative to Alternative 3.</p> <p><u>Fall-run Chinook Salmon</u></p> <p>Overall, the temperature model outputs suggest that the temperature of water released at Lewiston Dam generally would be similar under both scenarios, although the exceedance of water temperature thresholds would be less frequent (by up to 2 percent) under Alternative 3. Given the similarity of the results and the inherent uncertainty associated with the resolution of the temperature model (average monthly outputs), Alternative 3 is likely to have similar effects on the fall-run Chinook Salmon population in the Trinity River as compared to the No Action Alternative. However, the implementation of the Hatchery Management Plan (RPA Action II.6.3) under the No Action Alternative could reduce the impacts of hatchery Chinook Salmon on natural fall-run Chinook Salmon in the Trinity River, and increase the genetic diversity and diversity of run-timing for these stocks relative to Alternative 3.</p> <p><u>Steelhead</u></p> <p>Overall, the differences in the frequency of threshold exceedance between Alternative 3 and the No Action Alternative would be relatively minor and are unlikely to affect steelhead spawning in the Trinity River. This slight reduction in the frequency of threshold exceedance provided by Alternative 3 suggest that temperature conditions under Alternative 3 could be slightly less likely to affect steelhead than under the No Action Alternative. However, the relatively small differences in flows and water temperatures under Alternative 3 as compared to the No Action Alternative would likely have similar effects on steelhead in the Trinity River as compared to the No Action Alternative.</p> <p><u>Green Sturgeon</u></p> <p>Given the similarities between average monthly water temperatures at Lewiston Dam, it is likely that water temperature conditions for Green Sturgeon in the Trinity River or lower Klamath River and estuary would be similar.</p> <p><u>Reservoir Fishes</u></p> <p>Overall, while reservoir storage and nest survival would be slightly higher under Alternative 3, it is uncertain whether these differences would be biologically meaningful. Thus, it is concluded that effects on black bass likely would be similar for Alternative 3 and the No Action Alternative.</p> <p><u>Pacific Lamprey</u></p> <p>Overall, it is likely that effects on Pacific Lamprey would be similar. This conclusion likely also applies to other species of lamprey that inhabit the Trinity and lower Klamath rivers (e.g., River Lamprey).</p> <p><u>Eulachon</u></p> <p>Given that the highest increases in flow would be less than 10 percent in the Trinity River, with a smaller relative increase in the lower Klamath River and</p>	



Alternative	Potential Change	Consideration for Mitigation Measures
	<p>Klamath River estuary, and that water temperatures in the Klamath River would unlikely to be affected by changes upstream at Lewiston Dam, it is likely that effects would have a similar potential to influence Eulachon in the Klamath River.</p> <p><b>Sacramento River System</b></p> <p><u>Winter-run Chinook Salmon</u></p> <p>Overall, given the small differences between alternatives and the uncertainty regarding the non-operational components, distinguishing a clear difference between alternatives is difficult. The non-operational components associated with Alternative 3 could benefit winter-run Chinook Salmon over the short term if successful. However, these measures would not address the long-term temperature challenges in the river downstream of Shasta Dam that would be addressed under the No Action Alternative. It is concluded that the potential for adverse effects on winter-run Chinook Salmon under Alternative 3 would be greater, principally because Alternative 3 does not include a strategy to address water temperatures critical to winter-run Chinook Salmon sustainability over the long term.</p> <p><u>Spring-run Chinook Salmon</u></p> <p>The model results suggest that overall, effects on spring-run Chinook Salmon could be slightly more adverse. However, the ocean harvest restriction component and predator control measures could reduce spring-run Chinook Salmon mortality. These non-operational components could benefit spring-run Chinook Salmon over the short term if successful. However, these measures would not address the long-term temperature challenges in the river downstream of Shasta Dam that would be addressed through fish passage under the No Action Alternative. It is concluded that the potential for adverse effects on spring-run Chinook Salmon under Alternative 3 would be greater, principally because Alternative 3 does not include a strategy to address water temperatures critical to spring-run Chinook Salmon sustainability over the long term.</p> <p><u>Fall-run Chinook Salmon</u></p> <p>Overall, the results of the numerical models suggest the potential for less adverse effects on fall-run Chinook Salmon. However, discerning a meaningful difference between these two scenarios based on the quantitative results is not possible because of the similarity in results (generally differences less than 5 percent) and the inherent uncertainty of the models. Adverse effects of Alternative 3 could be offset by the potentially beneficial effects resulting from predator control and ocean harvest restrictions. However, Alternative 3 does not contain the RPA actions that could provide benefit under the No Action Alternative. Thus, effects on fall-run Chinook Salmon would be similar.</p> <p><u>Late Fall-run Chinook Salmon</u></p> <p>Overall, the results of the numerical models suggest that potential effects on late fall-run Chinook Salmon would be similar. Discerning a meaningful difference between these two scenarios based on the quantitative results is not possible because of the similarity in results (generally differences less than 5 percent) and the inherent uncertainty of the models. Because fish passage under the No Action Alternative is not expected</p>	

Alternative	Potential Change	Consideration for Mitigation Measures
	<p>to directly benefit late fall-run Chinook Salmon, the non-operational actions intended to benefit salmonids under both alternatives are expected to balance. Thus, it is concluded that the effects on late fall-run Chinook Salmon would be similar under Alternative 3 and the No Action Alternative.</p> <p><u>Steelhead</u></p> <p>The model results suggest that overall, effects on steelhead could be slightly less adverse, particularly in the Feather River. The ocean harvest restriction component and predator control measures could reduce steelhead mortality. This potential distinction may be partially offset and become more adverse by the lack of the benefits of implementation of fish passage. This is particularly important in light of anticipated increases in water temperature associated with climate change in 2030. Thus, on balance and over the long term, the adverse effects on steelhead under Alternative 3 would be greater than those under the No Action Alternative.</p> <p><u>Green Sturgeon</u></p> <p>The temperature model outputs suggest that thermal conditions and effects on Green Sturgeon in the Sacramento and Feather rivers generally would be slightly less adverse under Alternative 3. By contrast, the analysis based on Delta outflows suggests that Alternative 3 provides lower mean (March to July) outflows which could result in weaker year classes of juvenile sturgeon. However, early life stage survival in the natal rivers is crucial in development of a strong year class, and actions under the No Action Alternative intended to increase the efficiency of the Tracy and Skinner Fish Collection Facilities could improve the overall salvage survival of green sturgeon. Therefore, based primarily on the analysis of water temperatures, adverse effects on Green Sturgeon would be less likely.</p> <p><u>White Sturgeon</u></p> <p>Given the general similarity in results and the inherent uncertainty associated with the resolution of the temperature model, the effects likely would be similar. However, the analysis based on Delta outflows suggests that Alternative 3 provides lower mean (March to July) outflows which could result in weaker year classes of juvenile sturgeon. Overall, given the small differences in the numerical model results and the inherent uncertainty in the temperature model, as well as the potential for offsetting effects of increased Delta outflow and improved salvage survival under the No Action Alternative, there would be no definitive difference in effects on White Sturgeon.</p> <p><u>Delta Smelt</u></p> <p>Overall, likely would result in increased adverse effects, primarily due to increased percentage entrainment during larval and juvenile life stages, and less favorable location of Fall X2 in wetter years, and on average. Given the current condition of the Delta Smelt population, even these small differences between alternatives may be important.</p> <p><u>Longfin Smelt</u></p> <p>Overall, based on the increase in frequency and magnitude of negative OMR flows and the lower Longfin Smelt abundance index values, potential adverse effects likely would be greater.</p>	

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Alternative	Potential Change	Consideration for Mitigation Measures
	<p><u>Sacramento Splittail</u></p> <p>Flows entering the Yolo Bypass generally would be somewhat higher than under the No Action Alternative from December through March, especially during wetter years, providing similar value to Sacramento Splittail because of the similar area of potential habitat (inundation). Given the relatively minor changes in flows into the Yolo Bypass, and the inherent uncertainty associated with the resolution of the CalSim II model (average monthly outputs), it is concluded that there would be no definitive difference in effects on Sacramento Splittail between Alternative 3 and the No Action Alternative.</p> <p><u>Reservoir Fishes</u></p> <p>The analysis of black bass nest survival based on changes in water surface elevation during the spawning period indicated that the likelihood of high (greater than 40 percent) nest survival in most of the reservoirs would be similar in March, April, and May, but somewhat lower in June. Most black bass spawning likely occurs prior to June, such that drawdowns during June would likely affect only a small proportion of the spawning population. Overall, the results of the habitat and nest survival analysis suggest that conditions in the reservoirs likely to support self-sustaining populations of black bass would be similar under Alternative 3 and the No Action Alternative.</p> <p><u>Pacific Lamprey</u></p> <p>Pacific Lamprey would be subjected to the same temperature conditions described above for salmonids. Based on the somewhat increased water temperatures from January through the summer, it is likely that there would be little difference in potential effects on Pacific Lamprey in the Sacramento, Feather, and American rivers. This conclusion likely applies to other species of lamprey that inhabit these rivers (e.g., River Lamprey).</p> <p><u>Other Species</u></p> <p>Based on the similar water temperatures during their spawning and incubation period under Alternative 3, it is likely that thermal conditions for and effects on Striped Bass, American Shad, and Hardhead in the Sacramento, Feather, and American rivers would be similar under Alternative 1 and the No Action Alternative.</p> <p>Alternative 3 would result in a more eastward X2 position as compared to the No Action Alternative during April and May, with similar values in June (Appendix 5A, Section C Table C-16-2). Based on Kimmerer (2002) and Kimmerer et al. (2009), this change in X2 would likely reduce the survival index and the habitat index as measured by salinity for Striped Bass and abundance and habitat index for American Shad.</p> <p>In addition, the increased bag limits and ability of anglers to retain Striped Bass that are 12 inches in length versus 18 inches under Alternative 3 could reduce the ability to meet the doubling goals for Striped Bass populations under the requirements of Section 3406(b)(1) of CVPIA.</p> <p>Overall, Alternative 3 likely would have similar effects on Hardhead, but slightly greater potential for adverse effects on Striped Bass and American Shad as compared to the No Action Alternative, primarily due to the potential for reduced survival during larval and</p>	

Alternative	Potential Change	Consideration for Mitigation Measures
	<p>juvenile life stages, and less favorable location of Spring X2 on average.</p> <p><b>Stanislaus River/Lower San Joaquin River</b></p> <p><u>Fall-run Chinook Salmon</u></p> <p>Overall, likely would have similar effects on the fall-run Chinook Salmon population in the San Joaquin River watershed.</p> <p>Beneficial effects to juvenile fall-run Chinook Salmon could result from implementation of trap and haul passage through the Delta and ocean harvest restrictions. It remains uncertain, however, if predator management actions under Alternative 3 would benefit fall-run Chinook Salmon.</p> <p><u>Steelhead</u></p> <p>Given the frequency of exceedance under both Alternative 3 and the No Action Alternative, water temperature conditions for steelhead in the Stanislaus River would be generally stressful in the fall, late spring, and summer months. The differences in temperature exceedance between Alternative 3 and the No Action Alternative would be relatively small, with no clear benefit associated with either alternative. However, because Alternative 3 generally would exceed thresholds less frequently during the warmest months, it may have slightly less impact than under the No Action Alternative. Alternative 3 also could provide additional beneficial effects to juvenile steelhead as a result of trap and haul passage through the Delta. It remains uncertain, however, if predator management actions under Alternative 3 would benefit steelhead.</p> <p>This potential distinction between the two alternatives, however, may be partially offset by the benefits of implementation of fish passage under the No Action Alternative intended to address the limited availability of suitable habitat for in the Stanislaus River reaches downstream of New Melones Dam. In addition, RPA actions intended to increase the efficiency of the Tracy and Skinner Fish Collection Facilities could improve the overall salvage survival of steelhead under the No Action Alternative.</p> <p>Implementation of the fish passage program under the No Action could provide a benefit to Central Valley steelhead in the Stanislaus River. This is particularly important in light of anticipated increases in water temperature associated with climate change in 2030. In addition, RPA actions intended to increase the efficiency of the Tracy and Skinner Fish Collection Facilities could improve the overall salvage survival of steelhead under the No Action Alternative. Thus, it is concluded that the potential for adverse effects on steelhead would be greater, principally because Alternative 3 does not include a strategy to address water temperatures critical to steelhead sustainability over the long term with climate change by 2030.</p> <p><u>White Sturgeon</u></p> <p>While flows in the San Joaquin River upstream of the Stanislaus River are expected to be similar, flow contributions from the Stanislaus River could influence water temperatures in the San Joaquin River where White Sturgeon eggs or larvae may occur during the spring and early summer. The magnitude of influence on water temperature would depend on the proportional flow contribution of the Stanislaus River and the temperatures in both the Stanislaus and San Joaquin</p>	

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Alternative	Potential Change	Consideration for Mitigation Measures
	<p>rivers. The potential for an effect on White Sturgeon eggs and larvae would be influenced by the proportion of the population occurring in the San Joaquin River. In consideration of this uncertainty, it is not possible to distinguish potential effects on White Sturgeon.</p> <p><u>Reservoir Fishes</u></p> <p>While the analyses suggest that the effects could be more adverse, most black bass spawning likely occurs prior to June, such that drawdowns during June would likely affect only a small proportion of the spawning population. Thus, it is concluded that effects on black bass nesting success would be similar under Alternative 3 and the No Action Alternative.</p> <p><u>Other Species</u></p> <p>In general, lampreys, Striped Bass and Hardhead also can tolerate higher water temperatures than salmonids. Thus, temperature effects on these species are expected to be similar under both alternatives.</p> <p>Predator controls related to Striped Bass could result in adverse effects.</p> <p><b>Pacific Ocean</b></p> <p><u>Killer Whale</u></p> <p>It is unlikely that the Chinook Salmon prey base of killer whales, supported heavily by hatchery production of fall-run Chinook Salmon, would be appreciably affected.</p>	
Alternative 4	<p><b>Trinity River Region</b></p> <p><u>Coho Salmon, spring-run and fall-run Chinook Salmon, steelhead, Green Sturgeon, Reservoir Fishes, Pacific Lamprey, River Lamprey, and Eulachon</u></p> <p>The effects are identical as described under Alternative 1 as compared to the No Action Alternative.</p> <p><b>Sacramento River System</b></p> <p><u>Winter-run, spring-run, fall-run, and late fall-run Chinook Salmon, and steelhead</u></p> <p>CVP and SWP operations under Alternative 4 are identical to the CVP and SWP operations under the Second Basis of Comparison and Alternative 1. Therefore the effects in the Sacramento River system would be similar to those described under Alternative 1.</p> <p>Conditions related to salmonid survival could be improved under Alternative 4 by implementation of a trap and haul program, changes in Striped Bass bag limits, and changes in PMFC/NMFS harvest limits. However, these benefits would not likely exceed those described for the No Action Alternative, particularly in consideration of the provision of fish passage to address long-term temperature challenges on listed salmonids caused by climate change.</p> <p><u>Green Sturgeon, White Sturgeon, Delta Smelt, Longfin Smelt, Sacramento Splittail, Reservoir Fishes, Pacific Lamprey, River Lamprey, American Shad, and Hardhead</u></p> <p>The effects in the Sacramento River system would be similar to those described under Alternative 1.</p> <p><u>Striped Bass</u></p> <p>The effects in the Sacramento River system would be similar to those described under Alternative 1.</p> <p>Conditions for Striped Bass could be influenced by implementation of a predator control program that reduces the size restrictions and increases the catch</p>	<p>Implement fish passage programs at Shasta, Folsom, and New Melones dams to reduce temperature impacts on Chinook Salmon and steelhead.</p> <p>Mitigation measures for other substantial impacts have not been identified at this time.</p>

Alternative	Potential Change	Consideration for Mitigation Measures
	<p>limit for Striped Bass taken in the sport fishery. This also could reduce the ability to meet the doubling goals for Striped Bass populations under the requirements of Section 3406(b)(1) of CVPIA.</p> <p><b>Stanislaus River/Lower San Joaquin River</b>  <u>Fall-run Chinook Salmon and Steelhead</u>                      The effects in the Stanislaus River/Lower San Joaquin River system would be similar to those described under Alternative 1.                      Beneficial effects to Chinook Salmon as a result of trap and haul passage through the Delta and ocean harvest restrictions. It remains uncertain, however, if predator management actions would benefit the Chinook Salmon population.</p> <p><u>White Sturgeon, Reservoir Fishes, and Other Species</u>                      The effects in the Stanislaus River/Lower San Joaquin River system would be similar to those described under Alternative 1.</p> <p><u>Striped Bass</u>                      The effects in the Stanislaus River/Lower San Joaquin River system would be similar as described under Alternative 1 as compared to the No Action Alternative. Conditions for Striped Bass could be influenced by implementation of a predator control program that reduces the size restrictions and increases the catch limit for Striped Bass taken in the sport fishery. This also could reduce the ability to meet the doubling goals for Striped Bass populations under the requirements of Section 3406(b)(1) of CVPIA.</p> <p><b>Pacific Ocean</b>  <u>Killer Whale</u>                      It is unlikely that the Chinook Salmon prey base of killer whales, supported heavily by hatchery production of fall-run Chinook Salmon, would be appreciably affected.</p>	
Alternative 5	<p><b>Trinity River Region</b>  <u>Coho Salmon, Spring-run Chinook Salmon, Fall-run Chinook Salmon, Steelhead, and Green Sturgeon</u>                      Effects would be similar.</p> <p><u>Reservoir Fishes</u>                      Effects would be similar.</p> <p><u>Pacific Lamprey</u>                      Effects would be similar.</p> <p><u>Eulachon</u>                      Effects would be similar.</p> <p><b>Sacramento River System</b>  <u>Winter-run Chinook Salmon, Spring-run Chinook Salmon, Fall-run Chinook Salmon, Late Fall-run Chinook Salmon, Steelhead, Green Sturgeon, and White Sturgeon</u>                      Effects would be similar.</p> <p><u>Delta Smelt, Longfin Smelt, and Sacramento Splittail</u>                      Effects would be similar.</p> <p><u>Reservoir Fishes</u>                      Effects would be similar.</p> <p><u>Pacific Lamprey and Other Species</u>                      Effects would be similar.</p>	Mitigation measures for other substantial impacts have not been identified at this time.

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Alternative	Potential Change	Consideration for Mitigation Measures
	<p><b>Stanislaus River/Lower San Joaquin River</b></p> <p><u>Fall-run Chinook Salmon and Steelhead</u></p> <p>The analysis of temperatures indicates somewhat higher temperatures in some water year types and a higher likelihood of exceedance of suitable temperatures for spawning, and lower likelihood of exceeding suitable temperature for rearing of fall-run Chinook Salmon. The frequency of exceedance of temperature thresholds for steelhead smoltification and rearing could be more stressful. However, the higher flows in April and May and lower temperatures in April and May could benefit steelhead spawning. Given the variability in the results and the inherent uncertainty associated with the resolution of the models, it is concluded that Alternative 5 is likely to have similar effects on fall-run Chinook Salmon and steelhead in the Stanislaus and lower San Joaquin rivers.</p> <p><u>White Sturgeon</u></p> <p>While flows in the San Joaquin River upstream of the Stanislaus River are expected to be similar, flow contributions from the Stanislaus River could influence water temperatures in the San Joaquin River where White Sturgeon eggs or larvae may occur during the spring and early summer. The magnitude of influence on water temperature would depend on the proportional flow contribution of the Stanislaus River and the temperatures in both the Stanislaus and San Joaquin rivers. The potential for an effect on White Sturgeon eggs and larvae would be influenced by the proportion of the population occurring in the San Joaquin River. In consideration of this uncertainty, it is not possible to distinguish potential effects on White Sturgeon.</p> <p><u>Reservoir Fishes</u></p> <p>Overall, the analysis suggests that conditions under Alternative 5 have the potential to negatively influence black bass nesting success, especially in April and May. However, nesting success under Alternative 5 would still exceed 40 percent most of the time. Therefore, it is likely that the effects on black basses in New Melones Reservoir would be similar.</p> <p><u>Other Species</u></p> <p>Given the similar water temperatures, it is likely that the potential to affect lamprey species in the Stanislaus and San Joaquin rivers would be similar.</p> <p>Striped Bass and Hardhead also can tolerate higher temperatures than salmonids. Given the similar water temperatures, it is likely that the potential effects to affect Striped Bass and Hardhead in the Stanislaus and San Joaquin rivers would be similar.</p> <p><b>Pacific Ocean</b></p> <p><u>Killer Whale</u></p> <p>It is unlikely that the Chinook Salmon prey base of killer whales, supported heavily by hatchery production of fall-run Chinook Salmon, would be appreciably affected.</p>	

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Note: Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools, incremental differences of 5 percent or less between alternatives and the Second Basis of Comparison are considered to be "similar."

1 **Table 9.5 Comparison of No Action Alternative and Alternatives 1 through 5 to**  
 2 **Second Basis of Comparison**

Alternative	Potential Change	Consideration for Mitigation Measures
<p>No Action Alternative</p>	<p><b>Trinity River Region</b></p> <p><u>Coho Salmon</u></p> <p>Overall, the temperature model outputs for each of the Coho Salmon life stages suggest that the temperature of water released at Lewiston Dam generally would be similar, although the exceedance of water temperature thresholds would be slightly more frequent (1 percent). Given the similarity of the results and the inherent uncertainty associated with the resolution of the temperature model (average monthly outputs), it is concluded that the No Action Alternative and Second Basis of Comparison are likely to have similar effects on the Coho Salmon population in the Trinity River.</p> <p><u>Spring-run Chinook Salmon</u></p> <p>Overall, water temperature could have adverse effects on spring-run Chinook Salmon in the Trinity River; however, these effects would not occur in every year and are not anticipated to be substantial based on the relatively small differences in flows and water temperatures. However, the implementation of the Hatchery Management Plan could reduce the impacts of hatchery Chinook Salmon on natural spring-run Chinook Salmon in the Trinity River. Thus, given these relatively minor changes in temperature and temperature threshold exceedance, the inherent uncertainty associated with the resolution of the temperature model (average monthly outputs), and the uncertainty of the hatchery benefits, it is concluded that the No Action Alternative and Second Basis of Comparison are likely to have similar effects on the spring-run Chinook Salmon in the Trinity River.</p> <p><u>Fall-run Chinook Salmon</u></p> <p>Although the combined analysis based on water temperature suggests that operations could be slightly more adverse, these effects would not occur in every year and are not anticipated to be substantial based on the relatively small differences in water temperatures (as well as egg mortality). In addition, these potential adverse effects could be offset by implementation of the Hatchery Management Plan (RPA Action II.6.3), which could reduce the impacts of hatchery Chinook Salmon on natural fall-run Chinook Salmon in the Trinity River, and increase the genetic diversity and diversity of run-timing for these stocks. Overall, given the small differences in the numerical model results and the inherent uncertainty in the temperature model, as well as the potential for offsetting benefits associated with actions that were not modeled, it is concluded that the No Action Alternative is likely to have similar effects on the fall-run Chinook Salmon population in the Trinity River.</p> <p><u>Steelhead</u></p> <p>Although the combined analysis based on water temperature suggests that operations could be slightly more adverse, these effects would not occur in every year and are not anticipated to be substantial based on the relatively small differences in water temperature exceedances. Overall, given these small differences and the inherent uncertainty in the temperature model, these two scenarios are likely to have similar effects on the steelhead population in the Trinity River.</p>	<p>Not considered for this comparison.</p>



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Alternative	Potential Change	Consideration for Mitigation Measures
	<p><u>Green Sturgeon</u></p> <p>Overall, given the similarities between average monthly water temperatures at Lewiston Dam, it is likely that temperature conditions for Green Sturgeon in the Trinity River or lower Klamath River and estuary would be similar.</p> <p><u>Reservoir Fishes</u></p> <p>Overall, the comparison of storage and the analysis of black bass nesting suggest that effects would be similar.</p> <p><u>Pacific Lamprey</u></p> <p>Overall, given the similarities between average monthly water temperatures at Lewiston Dam, it is likely that the effects would be similar. This conclusion likely applies to other species of lamprey that inhabit the Trinity and lower Klamath rivers (e.g., River Lamprey).</p> <p><u>Eulachon</u></p> <p>Given that the highest reductions in flow would be less than 10 percent in the Trinity River, which would represent even a smaller proportion in the lower Klamath River and Klamath River estuary, and that water temperatures in the Klamath River are unlikely to be affected by changes upstream at Lewiston Dam, it is likely the conditions would be similar for Eulachon in the Klamath River.</p> <p><b>Sacramento River System</b></p> <p><u>Winter-run Chinook Salmon</u></p> <p>Overall, the quantitative results from the numerical models suggest that the No Action Alternative would be less likely to result in adverse effects on winter-run Chinook Salmon. In consideration of the potentially beneficial effects resulting from the RPA actions that are not included in the numerical models, the No Action Alternative has a much greater potential to address the long-term sustainability of winter-run Chinook Salmon than does the Second Basis of Comparison, principally because the Second Basis of Comparison does not include a strategy to address water temperatures critical to winter-run Chinook Salmon sustainability over the long term with climate change by 2030.</p> <p><u>Spring-run Chinook Salmon</u></p> <p>The model results suggest that overall, effects on spring-run Chinook Salmon could be slightly more adverse with a small likelihood that spring-run Chinook Salmon production would be lower under the No Action Alternative. However, it is concluded that the potential for adverse effects on spring-run Chinook Salmon suggested by the results of the numerical models would likely be offset by the potential benefits of the RPA actions that are not included in the numerical models, principally because the Second Basis of Comparison does not include a strategy to address water temperatures critical to spring-run Chinook Salmon sustainability over the long term with climate change by 2030. On balance and over the long term, the adverse effects on spring-run Chinook Salmon would be less than those under the Second Basis of Comparison.</p> <p><u>Fall-run Chinook Salmon</u></p> <p>Overall, the results of the numerical models suggest the potential for greater adverse effects on fall-run Chinook Salmon under the No Action Alternative as compared to the Second Basis of Comparison. However, discerning a meaningful difference between these two scenarios based on the quantitative results is not possible</p>	

Alternative	Potential Change	Consideration for Mitigation Measures
	<p>because of the similarity in results and the inherent uncertainty of the models. In addition, any adverse effect of the No Action Alternative could be offset by the potentially beneficial effects resulting from the RPA actions evaluated qualitatively for the No Action Alternative. Thus, it is concluded that the effects on fall-run Chinook Salmon would be less adverse under the No Action Alternative than under the Second Basis of Comparison.</p> <p><u>Late Fall-run Chinook Salmon</u></p> <p>The model results suggest that overall, effects on late fall-run Chinook Salmon could be slightly less adverse. Potential effects may be lessened further due to actions intended to increase the efficiency of the Tracy and Skinner Fish Collection Facilities to improve the overall salvage survival of salmonids, including late fall-run Chinook Salmon. Thus, it is concluded that the potential for adverse effects on late fall-run Chinook Salmon would be lower under the No Action Alternative compared to the Second Basis of Comparison.</p> <p><u>Steelhead</u></p> <p>The numerical model results suggest that overall, effects on steelhead could be slightly more adverse, particularly in the Feather and American rivers. However, implementation of a fish passage program under the No Action Alternative intended to address the limited availability of suitable habitat for steelhead in the Sacramento River reaches downstream of Keswick Dam and in the American River could provide a benefit to Central Valley steelhead in the Sacramento and American rivers. This is particularly important in light of anticipated increases in water temperature associated with climate change in 2030. In addition to fish passage, preparation and implementation of an HGMP for steelhead at the Nimbus Fish Hatchery and actions under the No Action Alternative intended to increase the efficiency of the Tracy and Skinner Fish Collection Facilities could benefit steelhead under the No Action Alternative in comparison to the Second Basis of Comparison. Thus, it is concluded that the effects on steelhead would be less adverse under the No Action Alternative than under the Second Basis of Comparison.</p> <p><u>Green Sturgeon</u></p> <p>The increased frequency of exceedance of temperature thresholds under the No Action Alternative could increase the potential for adverse effects on Green Sturgeon in the Sacramento and Feather rivers relative to the Second Basis of Comparison. However, the analysis based on Delta outflows suggests that the No Action Alternative provides higher mean (March to July) outflows which could result in stronger year classes of juvenile Green Sturgeon relative to the Second Basis of Comparison. In addition, actions under the No Action Alternative intended to increase the efficiency of the Tracy and Skinner Fish Collection Facilities could improve the overall salvage survival of Green Sturgeon. However, early life stage survival in the natal rivers is crucial in development of a strong year class. In addition, actions under the No Action Alternative intended to increase the efficiency of the Tracy and Skinner Fish Collection Facilities could improve the overall salvage survival of green sturgeon. Therefore, based primarily on the analysis of water temperatures, the No Action Alternative could be more</p>	

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Alternative	Potential Change	Consideration for Mitigation Measures
	<p>likely to result in adverse effects on Green Sturgeon than the Second Basis of Comparison.</p> <p><u>White Sturgeon</u></p> <p>Overall, the increased frequency of exceedance of temperature thresholds in June under the No Action Alternative could increase the potential for effects on White Sturgeon in the Sacramento River relative to the Second Basis of Comparison, however, these effects are uncertain and may include reduced spawning and/or increased growth. The analysis based on Delta outflows suggests that the No Action Alternative provides higher mean (March to July) outflows which could result in stronger year classes of juvenile White Sturgeon relative to the Second Basis of Comparison. However, early life stage survival in the natal rivers is crucial in development of a strong year class. Therefore, based primarily on the analysis of water temperatures, the No Action Alternative could be more likely to result in adverse effects on White Sturgeon than the Second Basis of Comparison.</p> <p><u>Delta Smelt</u></p> <p>Overall, likely to result in better conditions for Delta Smelt, primarily due to lower percentage entrainment for larval and juvenile life stages, and more favorable location of Fall X2 in wetter years, and on average. Given the current condition of the Delta Smelt population, even these small differences between alternatives may be important.</p> <p><u>Longfin Smelt</u></p> <p>Overall, based on the decrease in frequency and magnitude of negative OMR flows and the higher Longfin Smelt abundance index values, especially in dry and critical dry years, potential adverse effects on the Longfin Smelt population likely would be less.</p> <p><u>Sacramento Splittail</u></p> <p>Overall, the slight flow decreases under the No Action Alternative could result in less spawning habitat for Sacramento Splittail than under the Second Basis of Comparison because of the decreased area of potential habitat (inundation). Given the relatively minor changes in flows into the Yolo Bypass and the inherent uncertainty associated with the resolution of the CalSim II model (average monthly outputs), it is concluded that there would be no definitive difference in effects on Sacramento Splittail between the No Action Alternative and Second Basis of Comparison.</p> <p><u>Reservoir Fishes</u></p> <p>The analysis of black bass nest survival based on changes in water surface elevation during the spawning period indicated that the likelihood of high (greater than 40 percent) nest survival in most of the reservoirs would be similar from March through May and somewhat higher in June. Most black bass spawning likely occurs prior to June, such that drawdowns during June would likely affect only a small proportion of the spawning population. Thus, it is concluded that effects on black bass nesting success would be similar under the No Action Alternative and the Second Basis of Comparison.</p> <p><u>Pacific Lamprey</u></p> <p>Given the relatively minor changes in water temperature and water temperature threshold exceedance, and the inherent uncertainty associated with the resolution of the temperature model (average monthly outputs), it is</p>	

Alternative	Potential Change	Consideration for Mitigation Measures
	<p>likely that effects on Pacific Lamprey in the Sacramento, Feather, and American rivers would be similar. This conclusion likely applies to other species of lamprey that inhabit these rivers (e.g., River Lamprey).</p> <p><u>Striped Bass, American Shad, and Hardhead</u></p> <p>In general, Striped Bass, American Shad, and Hardhead can tolerate higher temperatures than salmonids. Given the relatively minor changes in temperature and temperature threshold exceedance, and the inherent uncertainty associated with the resolution of the temperature model (average monthly outputs), it is likely that conditions for and effects on Striped Bass, American Shad, and Hardhead in the Sacramento, Feather, and American rivers would be similar. Overall, the No Action Alternative likely would be similar for Hardhead and have a slightly lower potential for adverse effects on Striped Bass and American Shad as compared to the Second Basis of Comparison, primarily due to the potential for increased survival during larval and juvenile life stages, and more favorable location of Spring X2 on average.</p> <p><b>Stanislaus River/Lower San Joaquin River</b></p> <p><u>Fall-run Chinook Salmon</u></p> <p>The water temperature model outputs for each of the life stages suggest that thermal conditions and effects on fall-run Chinook Salmon in the Stanislaus River generally would be similar, although water temperatures under the No Action Alternative could be somewhat more suitable for fall-run Chinook Salmon spawning/egg incubation. Because the No Action Alternative has the potential for beneficial effects resulting from the RPA actions, it is concluded that the effects on fall-run Chinook Salmon would be less adverse relative to the Second Basis of Comparison.</p> <p><u>Steelhead</u></p> <p>The water temperature model outputs suggest that the differences in the magnitude and frequency of exceedance of suitable temperatures for the various lifestages could have the potential for adverse effects on steelhead in the Stanislaus River. However, the direction and magnitude of this effect is uncertain. It is concluded that the potential for adverse effects on steelhead would be lower, principally because the Second Basis of Comparison does not include a strategy to address water temperatures critical to steelhead sustainability over the long term with climate change by 2030.</p> <p><u>White Sturgeon</u></p> <p>Evidence of White Sturgeon spawning has been recorded in the San Joaquin River upstream of the confluence with the Stanislaus River. While flows in the San Joaquin River upstream of the Stanislaus River are expected to be similar under all alternatives, flow contributions from the Stanislaus River could influence water temperatures in the San Joaquin River where White Sturgeon eggs or larvae may occur during the spring and early summer. The magnitude of influence on water temperature would depend on the proportional flow contribution of the Stanislaus River and the temperatures in both the Stanislaus and San Joaquin rivers. The potential for an effect on White Sturgeon eggs and larvae would be influenced by the proportion of the population occurring in the San Joaquin River. In consideration of this uncertainty, it is not possible to</p>	

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Alternative	Potential Change	Consideration for Mitigation Measures
	<p>distinguish potential effects on White Sturgeon between alternatives.</p> <p><u>Reservoir Fishes</u></p> <p>Overall, predicted nest survival is generally above 40 percent in all months evaluated, although survival would vary among months. Given the relatively high survival in general and the uncertainty caused by the inconsistency in changes in survival, it is likely that effects would be similar.</p> <p><u>Other Species</u></p> <p>In general, Pacific Lamprey, Striped Bass, and Hardhead also can tolerate higher temperatures than salmonids. Given the relatively minor changes in temperature and temperature threshold exceedance, the inherent uncertainty associated with the resolution of the temperature model (average monthly outputs), it is likely that the potential to affect these species in the Stanislaus and San Joaquin rivers would be similar.</p> <p><b>Pacific Ocean</b></p> <p><u>Killer Whale</u></p> <p>Given conclusions from NMFS (2009c), and the fact that at least 75 percent of fall-run Chinook Salmon available for Southern Residents are produced by Central Valley hatcheries, it is likely that Central Valley fall-run Chinook Salmon as a prey base for killer whales would not be appreciably affected.</p>	
Alternative 1	No effects on aquatic resources.	Not considered for this comparison.
Alternative 2	<p><b>Trinity River Region</b></p> <p><u>The effects are identical as described under the No Action Alternative as compared to the Second Basis of Comparison.</u></p> <p><b>Sacramento River System</b></p> <p>The CVP and SWP operations under Alternative 2 are identical to the CVP and SWP operations under the No Action Alternative. Therefore, changes in physical conditions that affect aquatic resources in the Central Valley Region would be the same as the impacts described for the No Action Alternative Compared to the Second Basis of Comparison. However, actions to provide fish passage to portions of the Sacramento, American, and Stanislaus rivers upstream of their dams would not be undertaken under Alternative 2 or the Second Basis of Comparison.</p> <p><b>Stanislaus River/Lower San Joaquin River</b></p> <p>The effects are identical as described under the No Action Alternative as compared to the Second Basis of Comparison.</p> <p><b>Pacific Ocean</b></p> <p><u>Killer Whale</u></p> <p>The effects are identical as described under the No Action Alternative as compared to the Second Basis of Comparison.</p>	Not considered for this comparison.
Alternative 3	<p><b>Trinity River Region</b></p> <p><u>Coho Salmon and Chinook Salmon</u></p> <p>Given the similarity of the results and the inherent uncertainty associated with the resolution of the temperature model (average monthly outputs), it is concluded that Alternative 3 and the Second Basis of</p>	Not considered for this comparison.

Alternative	Potential Change	Consideration for Mitigation Measures
	<p>Comparison are likely to have similar effects on Coho Salmon and Chinook Salmon in the Trinity River.</p> <p><u>Steelhead</u></p> <p>Differences in water temperature conditions for steelhead in the Trinity River would be minor as described above for salmon. These results suggest that conditions for steelhead in the Trinity River generally would be similar.</p> <p><u>Green Sturgeon</u></p> <p>The results of the water temperature analysis suggests similar effects on Green Sturgeon in the Trinity River and lower Klamath River and estuary.</p> <p><u>Reservoir Fishes</u></p> <p>Overall, reservoir storage and nest survival suggest similar effects on black bass.</p> <p><u>Pacific Lamprey and Eulachon</u></p> <p>Overall, water temperature conditions for Pacific Lamprey and Eulachon in the Trinity River and Klamath River downstream of the confluence generally would be similar. This conclusion likely also applies to other species of lamprey that inhabit the Trinity and lower Klamath rivers (e.g., River Lamprey).</p> <p><b>Sacramento River System</b></p> <p><u>Winter-run Chinook Salmon</u></p> <p>The numerical model results suggest that effects on winter-run Chinook Salmon would be similar, with a small likelihood that winter-run Chinook Salmon escapement would be higher. The ocean harvest restrictions under Alternative 3 could provide a benefit, although the effects of the predator management program are uncertain. Overall, given the small differences, distinguishing a clear difference between alternatives is difficult. The non-operational components could benefit winter-run Chinook Salmon relative to the Second Basis of Comparison over the short term if successful. Thus, the potential for adverse effects on winter-run Chinook Salmon would be slightly less under Alternative 3 than under the Second Basis of Comparison.</p> <p><u>Spring-run Chinook Salmon</u></p> <p>The numerical model results suggest that overall, effects on spring-run Chinook Salmon could be slightly more adverse with a small likelihood that spring-run Chinook Salmon production would be lower. Although the operational components could have greater adverse effects on spring-run Chinook Salmon, the non-operational components could benefit spring-run Chinook Salmon over the short term if successful. The ocean harvest restrictions could increase spring-run Chinook Salmon numbers by reducing ocean harvest and the trap and haul program and predator control measures could reduce predation on juvenile spring-run Chinook Salmon and thereby increase survival. The effects of the trap and haul and predator management programs are uncertain. Thus, the potential for adverse effects on spring-run Chinook Salmon would be slightly less under Alternative 3 than under the Second Basis of Comparison.</p> <p><u>Fall-run Chinook Salmon</u></p> <p>Overall, the results of the numerical models suggest the potential for less adverse effects on fall-run Chinook Salmon. However, discerning a meaningful difference</p>	

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Alternative	Potential Change	Consideration for Mitigation Measures
	<p>based on the quantitative results is not possible because of the similarity in results (generally differences less than 5 percent) and the inherent uncertainty of the models. In addition, adverse effects could be offset by the potentially beneficial effects resulting from predator control and ocean harvest restrictions. Thus, the potential for adverse effects on fall-run Chinook Salmon would be slightly less under Alternative 3 than under the Second Basis of Comparison.</p> <p><u>Late Fall-run Chinook Salmon</u></p> <p>Overall, the results of the numerical models suggest the potential for less adverse effects on late fall-run Chinook Salmon. However, discerning meaningful differences based on the quantitative results is not possible because of the similarity in results (generally differences less than 5 percent) and the inherent uncertainty of the models. In addition, any adverse effects could be offset by the potentially beneficial effects resulting from predator control and ocean harvest restrictions. Thus, the effects on late fall-run Chinook Salmon would be similar under Alternative 3 and the Second Basis of Comparison.</p> <p><u>Steelhead</u></p> <p>Overall, the results of the numerical models suggest a slightly greater potential for adverse effects on steelhead. However, discerning a meaningful difference between based on the quantitative results is not possible because of the similarity in results (generally differences less than 5 percent) and the inherent uncertainty of the models. In addition, any adverse effects could be offset by the potentially beneficial effects resulting from predator control. Thus, the effects on steelhead would be similar under Alternative 3 and the Second Basis of Comparison.</p> <p><u>Green and White Sturgeon</u></p> <p>The slightly reduced frequency of exceedance of temperature thresholds could reduce the potential for adverse effects on sturgeon in the Sacramento and Feather rivers. The analysis based on Delta outflows suggests that there would be similar mean (March to July) outflows which would have similar effects on year class strength of juvenile sturgeon. Therefore, based primarily on the analysis of water temperatures, Alternative 3 could be less likely to result in adverse effects on White Sturgeon than the Second Basis of Comparison.</p> <p><u>Delta Smelt</u></p> <p>Overall, effects would be similar with regard to estimated entrainment and predicted location of Fall X2. However, given the current condition of the Delta Smelt population, even small differences between alternatives may be important.</p> <p><u>Longfin Smelt</u></p> <p>Overall, based on the decrease in frequency and magnitude of negative OMR flows and the higher Longfin Smelt abundance index values in drier years, the potential for adverse effects likely to be lower. Given the current condition of the Longfin Smelt population, even these small differences between alternatives may be important.</p> <p><u>Sacramento Splittail</u></p> <p>Flows entering the Yolo Bypass generally would be similar. Given the relatively minor changes in flows into</p>	

Alternative	Potential Change	Consideration for Mitigation Measures
	<p>the Yolo Bypass, and the inherent uncertainty associated with the resolution of the CalSim II model (average monthly outputs), there would be no definitive difference in effects on Sacramento Splittail between Alternative 3 and the Second Basis of Comparison.</p> <p><u>Reservoir Fishes</u></p> <p>The analysis of black bass nest survival based on changes in water surface elevation during the spawning period indicated that the likelihood of high (greater than 40 percent) nest survival in most of the reservoirs would be similar. Thus, it is likely that effects on black bass would be similar.</p> <p><u>Other Species</u></p> <p>Changes in average monthly water temperature would be small. In general, lampreys, Striped Bass, American Shad, and Hardhead can tolerate higher temperatures than salmonids. Given the similarity of the results and the inherent uncertainty associated with the resolution of the temperature model (average monthly outputs), likely to have similar effects on Striped Bass, American Shad, and Hardhead in the Sacramento, Feather, and American rivers.</p> <p>However, the increased bag limits and ability of anglers to retain Striped Bass that are 12 inches in length versus 18 inches could reduce the ability to meet the doubling goals for Striped Bass populations under the requirements of Section 3406(b)(1) of CVPIA.</p> <p><b>Stanislaus River/Lower San Joaquin River</b></p> <p><u>Fall-run Chinook Salmon</u></p> <p>Overall, likely would have similar effects on the fall-run Chinook Salmon population in the San Joaquin River watershed.</p> <p>Beneficial effects to juvenile fall-run Chinook Salmon as a result of trap and haul passage through the Delta and ocean harvest restrictions. It remains uncertain, however, if predator management actions under fall-run Chinook Salmon would benefit the fall-run Chinook Salmon population.</p> <p><u>Steelhead</u></p> <p>Given the frequency of exceedance under both Alternative 3 and the Second Basis of Comparison, water temperature conditions for steelhead in the Stanislaus River would be generally similar. Discerning a meaningful difference based on the quantitative results is not possible because of the similarity in results (generally differences less than 5 percent) and the inherent uncertainty of the models. Thus, the effects on steelhead would be similar under Alternative 3 and the Second Basis of Comparison.</p> <p><u>White Sturgeon</u></p> <p>While flows in the San Joaquin River upstream of the Stanislaus River are expected to be similar, flow contributions from the Stanislaus River could influence water temperatures in the San Joaquin River where White Sturgeon eggs or larvae may occur during the spring and early summer. The magnitude of influence on water temperature would depend on the proportional flow contribution of the Stanislaus River and the temperatures in both the Stanislaus and San Joaquin rivers. The potential for an effect on White Sturgeon eggs and larvae would be influenced by the proportion of the population occurring in the San Joaquin River. In</p>	



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Alternative	Potential Change	Consideration for Mitigation Measures
	<p>consideration of this uncertainty, it is not possible to distinguish potential effects on White Sturgeon.</p> <p><u>Reservoir Fishes</u></p> <p>The analysis of black bass nest survival based on changes in water surface elevation during the spawning period indicated that the likelihood of high (&gt;40 percent) nest survival in New Melones would be similar to or higher. This suggests that conditions in New Melones could be more likely to support self-sustaining populations of black bass.</p> <p><u>Other Species</u></p> <p>In general, Striped Bass and Hardhead also can tolerate higher temperatures than salmonids. Given the similarity of the results and the inherent uncertainty associated with the resolution of the temperature model (average monthly outputs), it is likely that the potential effects to affect Striped Bass and Hardhead in the Stanislaus and San Joaquin rivers would be similar.</p> <p>However, the increased bag limits and ability of anglers to retain Striped Bass that are 12 inches in length versus 18 inches could reduce the ability to meet the doubling goals for Striped Bass populations under the requirements of Section 3406(b)(1) of CVPIA.</p> <p><b>Pacific Ocean</b></p> <p><u>Killer Whale</u></p> <p>It is unlikely that the Chinook Salmon prey base of killer whales, supported heavily by hatchery production of fall-run Chinook Salmon, would be appreciably affected.</p>	
Alternative 4	<p><b>Trinity River Region</b></p> <p><u>Coho Salmon, spring-run and fall-run Chinook Salmon, steelhead, Green Sturgeon, Reservoir Fishes, Pacific Lamprey, River Lamprey, and Eulachon</u></p> <p>The effects would be identical.</p> <p><b>Sacramento River System</b></p> <p>The CVP and SWP operations under Alternative 4 are identical to the CVP and SWP operations under the Second Basis of Comparison. Therefore, changes in aquatic habitat conditions at CVP and SWP reservoirs, in the rivers downstream of the reservoirs, and in the Delta would be the same as under the Second Basis of Comparison.</p> <p><u>Winter-run, spring-run, fall-run, and late fall-run Chinook Salmon, and steelhead</u></p> <p>The effects in the Sacramento River system would be similar, although Alternative 4 could produce beneficial effects to Chinook Salmon as a result of trap and haul passage through the Delta and ocean harvest restrictions. However, the magnitude of these potential benefits remain uncertain.</p> <p><u>Green Sturgeon, White Sturgeon, Delta Smelt, Longfin Smelt, Sacramento Splittail, Reservoir Fishes, Pacific Lamprey, River Lamprey, American Shad, and Hardhead</u></p> <p>The effects in the Sacramento River system would be identical.</p> <p><u>Striped Bass</u></p> <p>The effects in the Sacramento River system would be similar, although predator control would result in adverse effects on Striped Bass.</p>	Not considered for this comparison.

Alternative	Potential Change	Consideration for Mitigation Measures
	<p><b>Stanislaus River/Lower San Joaquin River</b>  <u>Fall-run Chinook Salmon and Steelhead</u>                      The effects in the Stanislaus River/Lower San Joaquin River system would be similar. Beneficial effects to Chinook Salmon as a result of trap and haul passage through the Delta and ocean harvest restrictions. It remains uncertain, however, if predator management actions would benefit the Chinook Salmon population.</p> <p><u>White Sturgeon, Reservoir Fishes, and Other Species</u>                      The effects in the Stanislaus River/Lower San Joaquin River system would be identical.</p> <p><u>Striped Bass</u>                      The effects in the Stanislaus River/Lower San Joaquin River system would be similar. Predation controls related to Striped Bass would result in adverse effects.</p> <p><b>Pacific Ocean</b>  <u>Killer Whale</u>                      It is unlikely that the Chinook Salmon prey base of killer whales, supported heavily by hatchery production of fall-run Chinook Salmon, would be appreciably affected.</p> <p>Beneficial effects due to benefits to fall-run Chinook Salmon as a result of trap and haul passage through the Delta and ocean harvest restrictions. It remains uncertain, however, if predator management actions would benefit the fall-run Chinook Salmon population.</p>	
<p>Alternative 5</p>	<p><b>Trinity River Region</b>  <u>Coho Salmon, Spring-run Chinook Salmon, Fall-run Chinook Salmon, and Steelhead</u>                      Monthly water temperature generally would be similar (less than 0.5°F differences), with the exception of drier years when temperatures could be as much as 2.2°F cooler in November and 1.5°F warmer in December. Average monthly water temperatures could be slightly (up to 0.6°F) higher during July and August and lower (up to 0.7°F) in September. Lower September temperatures may result in slightly better conditions for spring-run Chinook Salmon spawning. Similarly, temperature conditions could be slightly better for fall-run Chinook Salmon spawning because of the reduced temperatures in November during critical dry years.</p> <p>Water temperature thresholds for Coho Salmon, fall-run Chinook Salmon, and steelhead would be exceeded slightly more frequently (less than 1 percent), whereas thresholds for spring-run Chinook Salmon would be exceeded less frequently (up to 4 percent) in August in September.</p> <p>Discerning a meaningful difference based on the quantitative results is not possible because of the similarity in results (generally differences less than 5 percent) and the inherent uncertainty of the models. In addition, implementation of a Hatchery Management Plan could reduce the impacts of hatchery Chinook Salmon on natural Chinook Salmon in the Trinity River and increase the genetic diversity and diversity of run-timing for these stocks, but the potential magnitude of these benefits is uncertain.</p> <p>Alternative 5 is likely to have similar effects on Chinook Salmon and steelhead in the Trinity River.</p> <p><u>Reservoir Fishes</u>                      Overall, the comparison of storage and the analysis of nesting suggest that effects would be similar.</p>	<p>Not considered for this comparison.</p>

Alternative	Potential Change	Consideration for Mitigation Measures
	<p><u>Other Species</u></p> <p>The minor differences in average monthly water temperatures described above for salmonids apply to Pacific Lamprey, Eulachon, and other aquatic species in the Trinity River. These minor differences suggest that conditions for aquatic species in the Trinity River and Klamath River downstream of the confluence generally would be similar under Alternative 5 and the Second Basis of Comparison.</p> <p><b>Sacramento River System</b></p> <p><u>Winter-run Chinook Salmon</u></p> <p>Overall, the quantitative results from the numerical models suggest that operations would be less likely to result in adverse effects on winter-run Chinook Salmon. In consideration of the potentially beneficial effects resulting from actions that are not included in the numerical models, the potential for adverse effects on winter-run Chinook Salmon under Alternative 5 would clearly be less than those under the Second Basis of Comparison, principally because the Second Basis of Comparison does not include a strategy to address water temperatures critical to winter-run Chinook Salmon sustainability over the long term with climate change by 2030.</p> <p><u>Spring-run Chinook Salmon</u></p> <p>The numerical model results suggest that, overall, Alternative 5 likely would have similar or slightly greater adverse effects on the spring-run Chinook Salmon population in the Sacramento River watershed as compared to the Second Basis of Comparison. The potential for adverse effects on spring-run Chinook Salmon suggested by the results of the numerical models would likely be offset by the potential benefits of the actions that are not included in the numerical models, principally because the Second Basis of Comparison does not include a strategy to address water temperatures critical to spring-run Chinook Salmon sustainability over the long term with climate change by 2030. On balance and over the long term, the adverse effects on spring-run Chinook Salmon under Alternative 5 would be less than those under the Second Basis of Comparison.</p> <p><u>Fall-run Chinook Salmon</u></p> <p>Overall, the results of the numerical models suggest the potential for greater adverse effects on fall-run Chinook Salmon. However, discerning a meaningful difference between these two scenarios based on the quantitative results is difficult because of the similarity in results (generally differences less than 5 percent), the inherent uncertainty of the models, and the potential for offsetting benefits. Thus, the effects on fall-run Chinook Salmon would be similar.</p> <p><u>Late Fall-run Chinook Salmon</u></p> <p>The numerical model results suggest that overall, Alternative 5 is likely to have less adverse effect on late fall-run Chinook Salmon in the Sacramento River. Benefits may be enhanced by actions intended to increase the efficiency of the Tracy and Skinner Fish Collection Facilities to improve the overall salvage survival of salmonids, including late fall-run Chinook Salmon. Thus, the potential for adverse effects on late fall-run Chinook Salmon would be less under Alternative 5 relative to the Second Basis of Comparison.</p>	

Alternative	Potential Change	Consideration for Mitigation Measures
	<p><u>Steelhead</u></p> <p>The numerical model results suggest that overall, effects on steelhead could be slightly more adverse, particularly in the Feather and American rivers. However, implementation of a fish passage program intended to address the limited availability of suitable habitat for steelhead in the Sacramento River reaches downstream of Keswick Dam and in the American River could provide a benefit to Central Valley steelhead in the Sacramento and American rivers. This is particularly important in light of anticipated increases in water temperature associated with climate change in 2030. In addition to fish passage, preparation and implementation of an HGMP for steelhead at the Nimbus Fish Hatchery and actions intended to increase the efficiency of the Tracy and Skinner Fish Collection Facilities could benefit steelhead. Thus, on balance and over the long term, the adverse effects on steelhead under Alternative 5 would be less than those under the Second Basis of Comparison.</p> <p><u>Green Sturgeon</u></p> <p>Overall, the increased frequency of exceedance of temperature thresholds could increase the potential for adverse effects on Green Sturgeon in the Sacramento and Feather rivers. However, analysis based on Delta outflows suggests that Alternative 5 provides higher mean (March to July) outflows which could result in stronger year classes of juvenile sturgeon relative to the Second Basis of Comparison. However, early life stage survival in the natal rivers is crucial in development of a strong year class; therefore, based primarily on the analysis of water temperatures, Alternative 5 could be more likely to result in adverse effects on Green Sturgeon than the Second Basis of Comparison.</p> <p><u>White Sturgeon</u></p> <p>The increased frequency of exceedance of temperature thresholds under Alternative 5 could increase the potential for adverse effects on White Sturgeon relative to the Second Basis of Comparison. However, the analysis based on Delta outflows suggests that the No Action Alternative provides higher mean (March to July) outflows which could result in stronger year classes of juvenile sturgeon relative to the Second Basis of Comparison. Early life stage survival in the natal rivers is crucial in development of a strong year class; therefore, based primarily on the analysis of water temperatures, Alternative 5 could be more likely to result in adverse effects on White Sturgeon than the Second Basis of Comparison.</p> <p><u>Delta Smelt</u></p> <p>Overall, likely would result in better conditions for Delta Smelt, primarily due to lower percentage entrainment for larval and juvenile life stages, and more favorable location of Fall X2 in wetter years, and on average. Given the current condition of the Delta Smelt population, even small differences between alternatives may be important.</p> <p><u>Longfin Smelt</u></p> <p>Overall, based on the decrease in frequency and magnitude of negative OMR flows and the higher Longfin Smelt abundance index values, especially in dry and critical dry years, potential adverse effects on the Longfin Smelt population likely would be less.</p>	

Alternative	Potential Change	Consideration for Mitigation Measures
	<p><u>Sacramento Splittail</u></p> <p>Overall, the slight adverse effects related to spawning habitat for Sacramento Splittail because of the decreased area of potential habitat (inundation) and the potential for a slight decrease in the frequency of inundation. Given the relatively minor changes in flows into the Yolo Bypass, and the inherent uncertainty associated with the resolution of the CalSim II model, no definitive difference in effects on Sacramento Splittail could be discerned.</p> <p><u>Reservoir Fishes</u></p> <p>The analysis of black bass nest survival based on changes in water surface elevation during the spawning period indicated that the likelihood of high (greater than 40 percent) nest survival in most of the reservoirs would be similar. Overall, the results of the nest survival analysis suggest that effects on reservoir fishes would be similar.</p> <p><u>Pacific Lamprey</u></p> <p>Given the similarity of the results and the inherent uncertainty associated with the resolution of the temperature model (average monthly outputs), it is likely that conditions for and effects on Pacific Lamprey in the Sacramento, Feather, and American rivers would be similar. This conclusion likely applies to other species of lamprey that inhabit these rivers (e.g., River Lamprey).</p> <p><u>Striped Bass, American Shad, and Hardhead</u></p> <p>In general, Striped Bass, American Shad, and Hardhead can tolerate higher temperatures than salmonids. Given the similarity of the results and the inherent uncertainty associated with the resolution of the temperature model, it is likely that thermal conditions for and effects on Striped Bass, American Shad, and Hardhead in the Sacramento, Feather, and American rivers would be similar. Overall, Alternative 5 likely would have similar effects on Hardhead and a slightly lower potential for adverse effects on Striped Bass, American Shad, and Hardhead as compared to the Second Basis of Comparison, primarily due to the potential for increased survival for these two species during larval and juvenile life stages, and more favorable location of Spring X2 on average.</p> <p><b>Stanislaus River/Lower San Joaquin River</b></p> <p><u>Fall-run Chinook Salmon</u></p> <p>The analysis of temperatures indicates lower temperatures and a lesser likelihood of exceedance of suitable temperatures for spawning and rearing of fall-run Chinook Salmon in the Stanislaus River below Goodwin Dam and in the San Joaquin River at Vernalis. As described above, the instream flow patterns are anticipated to benefit fall-run Chinook Salmon in the Stanislaus River and downstream in the lower San Joaquin River below Vernalis.</p> <p>Implementation of a fish passage project under Alternative 5, intended to address the limited availability of suitable habitat for steelhead in the Stanislaus River reaches downstream of Goodwin Dam, likely would not provide benefit to fall-run Chinook Salmon unless passage was provided and additional habitat could be accessed. Potential benefits to fall-run Chinook Salmon associated with fish passage is nevertheless uncertain. However, actions implemented under Alternative 5 intended to increase the efficiency of the Tracy and</p>	

Alternative	Potential Change	Consideration for Mitigation Measures
	<p>Skinner Fish Collection Facilities could improve the overall salvage survival of fall-run Chinook Salmon. Overall, given the small differences in the modeling results and the potential benefits anticipated by actions not captured in the models, effects on fall-run Chinook Salmon would be similar.</p> <p><u>Steelhead</u></p> <p>Given the frequency of exceedance and the generally stressful temperature conditions in the river, the substantial lower temperatures in October and April suggest that there would be less potential to result in adverse effects on steelhead.</p> <p>Implementation of a fish passage program under Alternative 5 intended to address the limited availability of suitable habitat for steelhead in the Stanislaus River reaches downstream of Goodwin Dam could provide a benefit to steelhead. In addition, the potential effects of Alternative 5 could be offset by actions intended to reduce predation risk on steelhead in the Stanislaus River and increase the efficiency of the Tracy and Skinner Fish Collection Facilities. The actions to augment spawning gravel in the Stanislaus River under Alternative 5 also could benefit steelhead.</p> <p>The numerical model results for effects on steelhead under Alternative 5 and Second Basis of Comparison do not definitively show distinct differences. However, in consideration of the potentially beneficial effects resulting from the actions that would be implemented under Alternative 5 that are not included in the numerical models, Alternative 5 has a much greater potential to address the long-term sustainability of steelhead than does the Second Basis of Comparison. Alternative 5 includes provisions for fish passage upstream of New Melones Dam to address long-term temperature increases associated with climate change. Even though the success of fish passage is uncertain, the potential for adverse effects on steelhead under Alternative 5 would clearly be less than that under the Second Basis of Comparison, principally because the Second Basis of Comparison does not include a strategy to address water temperatures critical to steelhead sustainability over the long term with climate change by 2030.</p> <p><u>White Sturgeon</u></p> <p>Evidence of White Sturgeon spawning has been recorded in the San Joaquin River upstream of the confluence with the Stanislaus River. While flows in the San Joaquin River upstream of the Stanislaus River are expected to be similar under all alternatives, flow contributions from the Stanislaus River could influence water temperatures in the San Joaquin River where White Sturgeon eggs or larvae may occur during the spring and early summer. The magnitude of influence on water temperature would depend on the proportional flow contribution of the Stanislaus River and the temperatures in both the Stanislaus and San Joaquin rivers. The potential for an effect on White Sturgeon eggs and larvae would be influenced by the proportion of the population occurring in the San Joaquin River. In consideration of this uncertainty, it is not possible to distinguish potential effects on White Sturgeon between alternatives.</p> <p><u>Reservoir Fishes</u></p> <p>Overall, the analysis suggests that conditions under Alternative 5 have the potential to influence black bass</p>	

Alternative	Potential Change	Consideration for Mitigation Measures
	<p>nesting success, especially in April and May in comparison to the Second Basis of Comparison. However, nesting success under Alternative 5 would still exceed 40 percent most of the time under both alternatives. Therefore, there would be no definitive difference in effects on reservoir fish between Alternative 5 and the Second Basis of Comparison.</p> <p><u>Other Species</u></p> <p>In general, Striped Bass and Hardhead can tolerate higher temperatures than salmonids. Given the similar flows and temperatures during their spawning and incubation period, it is likely that the potential to affect Striped Bass and Hardhead in the Stanislaus and San Joaquin rivers would be similar.</p> <p><b>Pacific Ocean</b></p> <p><u>Killer Whale</u></p> <p>Given conclusions from NMFS (2009c), and the fact that at least 75 percent of fall-run Chinook Salmon available for Southern Residents are produced by Central Valley hatcheries, it is likely that Central Valley fall-run Chinook Salmon as a prey base for killer whales would not be appreciably affected.</p>	

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Note: Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools, incremental differences of 5 percent or less between alternatives and the Second Basis of Comparison are considered to be "similar."

4 **9.4.3.8 Potential Mitigation Measures**

5 Mitigation measures are presented in this section to avoid, minimize, rectify,  
6 reduce, eliminate, or compensate for adverse environmental effects of  
7 Alternatives 1 through 5 as compared to the No Action Alternative. Mitigation  
8 measures were not included to address adverse impacts under the alternatives as  
9 compared to the Second Basis of Comparison because this analysis was included  
10 in this EIS for information purposes only.

11 Changes in CVP and SWP operations under Alternatives 1 through 5 as compared  
12 to the No Action Alternative would result in adverse impacts. Potential  
13 mitigation measures that could be considered to reduce the adverse water  
14 temperature impacts include implementation of fish passage programs. Mitigation  
15 measures for other substantial adverse impacts have not been identified at this  
16 time.

17 **9.4.3.8.1 Fish Passage Programs**

18 Implementation of Alternatives 1, 2, 3, and 4 would result in adverse impacts due  
19 to high water temperatures in the streams downstream of the dams. A potential  
20 mitigation measure to reduce these effects would be:

- 21 • Implement fish passage programs at Shasta and Keswick, Oroville and  
22 Thermalito, Folsom and Nimbus, and New Melones dams to reduce  
23 temperature impacts on Chinook Salmon and steelhead under Alternatives 1,  
24 2, 3, and 4.

1 These programs would be similar to programs implemented under the 2009  
 2 NMFS BO, as included in the No Action Alternative and Alternative 5. This  
 3 mitigation measure would be in response to the climate change effects anticipated  
 4 in 2030 in addition to the changes under Alternatives 1, 2, 3, and 4.

5 **9.4.3.9 Cumulative Effects Analysis**

6 As described in Chapter 3, the cumulative effects analysis considers projects,  
 7 programs, and policies that are not speculative; and are based upon known or  
 8 reasonably foreseeable long-range plans, regulations, operating agreements, or  
 9 other information that establishes them as reasonably foreseeable.

10 The cumulative effects analysis under Alternatives 1 through 5 for Fish and  
 11 Aquatic Resources are summarized in Table 9.6.

12 **Table 9.6 Summary of Cumulative Effects on Fish and Aquatic Resources of**  
 13 **Alternatives 1 through 5 as Compared to the No Action Alternative**

Scenarios	Actions	Cumulative Effects of Actions
Past & Present, and Future Actions Included in the No Action Alternative and in All Alternatives in Year 2030	Consistent with Affected Environment conditions plus: Actions in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives) Actions not included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives), including climate change and sea level rise: <ul style="list-style-type: none"> <li>• Implementation of Federal and state policies and programs, including Clean Water Act (e.g. Total Maximum Daily Loads); Safe Drinking Water Act; Clean Air Act; and flood management programs</li> <li>• General plans for 2030.</li> <li>• Trinity River Restoration Program.</li> <li>• Central Valley Project Improvement Act programs</li> <li>• Iron Mountain Mine Superfund Site</li> <li>• Nimbus Fish Hatchery Fish Passage Project</li> <li>• Folsom Dam Water Control Manual Update</li> </ul>	<u>These effects would be the same under all alternatives.</u> Climate change and sea level rise, development under the general plans, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce carryover storage in reservoirs, stream flows and Delta outflow, and the availability of CVP and SWP water supplies as compared to past conditions. These future actions could modify surface water conditions (e.g., flow) and affect habitat for fish and aquatic resources. However, many of these actions are intended to improve habitat conditions for aquatic resources or water quality, and thus the alternatives would not contribute to an adverse cumulative effect on aquatic resources. In addition, these actions were or would be subject to compliance with ESA, CESA, and other environmental laws and requirements, which serve to reduce the potential for impacts on aquatic resources.



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Scenarios	Actions	Cumulative Effects of Actions
	<ul style="list-style-type: none"> <li>• FERC Relicensing for the Middle Fork of the American River Project</li> <li>• Lower Mokelumne River Spawning Habitat Improvement Project</li> <li>• Dutch Slough Tidal Marsh Restoration</li> <li>• Suisun Marsh Habitat Management, Preservation, and Restoration Plan Implementation</li> <li>• Tidal Wetland Restoration: Yolo Ranch, Northern Liberty Island Fish Restoration Project, Prospect Island Restoration Project, and Calhoun Cut/Lindsey Slough Tidal Habitat Restoration Project</li> <li>• San Joaquin River Restoration Program</li> <li>• Stockton Deep Water Ship Channel Dissolved Oxygen Project</li> <li>• Grasslands Bypass Project</li> <li>• Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS)</li> </ul>	
<p>Future Actions Considered as Cumulative Effects Actions in All Alternatives in Year 2030</p>	<p>Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives):</p> <ul style="list-style-type: none"> <li>• Bay-Delta Water Quality Control Plan Update</li> <li>• FERC Relicensing Projects</li> <li>• Bay Delta Conservation Plan (including the California WaterFix alternative)</li> <li>• Shasta Lake Water Resources Investigation, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations</li> <li>• El Dorado Water and Power Authority Supplemental Water Rights Project</li> <li>• Sacramento River Water Reliability Project</li> <li>• Semitropic Water Storage District Delta Wetlands</li> </ul>	<p><u>These effects would be the same under all alternatives.</u></p> <p>Most of the future reasonably foreseeable actions are anticipated to reduce water supply impacts due to climate change, sea level rise, and increased water allocated to improve habitat conditions. It is unclear how these future reasonably foreseeable actions would influence aquatic resources because project details are not available. However, as described above, these actions would be subject to environmental regulations that avoid or limit the potential for cumulative effects on aquatic resources. Some of these actions (e.g., FERC relicensing projects) could cumulatively contribute to reducing adverse effects of climate change on aquatic resources if fish passage and improved water temperature control result from the FERC process.</p>

Scenarios	Actions	Cumulative Effects of Actions
	<ul style="list-style-type: none"> <li>• North Bay Aqueduct Alternative Intake</li> <li>• Irrigated Lands Regulatory Program</li> <li>• San Luis Reservoir Low Point Improvement Project</li> <li>• <i>Westlands Water District v. United States Settlement</i></li> <li>• Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects that did not have completed environmental documents during preparation of the EIS)</li> </ul>	
<p>No Action Alternative with Associated Cumulative Effects in Year 2030</p>	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO</p>	<p>Implementation of No Action Alternative would result in changes in stream flows, increased Delta outflow, and reduced CVP and SWP water supplies as compared to conditions prior to the BOs. These RPA actions are intended and anticipated to put fish and aquatic resources on a more favorable trajectory than would occur without these actions.</p>
<p>Alternative 1 with Associated Cumulative Effects in Year 2030</p>	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)</p>	<p>Implementation of Alternatives 1 and 4 with reasonably foreseeable actions would result in changes in stream flows, reduced Delta outflows, and increased CVP and SWP water exports as compared to the No Action Alternative with reasonably foreseeable actions. Favorable conditions for listed salmonids could be less available as compared to the No Action Alternative because access to habitat upstream of Shasta, Folsom, and New Melones dams would not be available. In addition, implementation of these alternatives could contribute cumulatively to impacts on listed Delta species by comparison to the No Action Alternative with reasonably foreseeable actions.</p>
<p>Alternative 2 with Associated Cumulative Effects in Year 2030</p>	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions.</p> <p>No implementation of structural improvements or other actions that require further study to develop a more detailed action description.</p>	<p>The effects of Alternative 2 on water temperature relative to the No Action Alternative could contribute incrementally to the cumulative effects on listed salmonids because the alternative provides no mechanism for addressing long-term temperature increases.</p>

Scenarios	Actions	Cumulative Effects of Actions
Alternative 3 with Associated Cumulative Effects in Year 2030	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)</p> <p>Slight increase in positive Old and Middle River flows in the winter and spring months</p> <p>Increased bag limits for Striped Bass and Pikeminnow</p> <p>Increased ocean salmon fishing harvest limitations</p>	<p>Implementation of Alternatives 1 and 4 with reasonably foreseeable actions would result in changes in stream flows, reduced Delta outflows, and increased CVP and SWP water exports as compared to the No Action Alternative with reasonably foreseeable actions. Favorable conditions for listed salmonids could be less available as compared to the No Action Alternative because access to habitat upstream of Shasta, Folsom, and New Melones dams would not be available. In addition, implementation of these alternatives could contribute cumulatively to impacts on listed Delta species by comparison to the No Action Alternative with reasonably foreseeable actions.</p>
Alternative 4 with Associated Cumulative Effects in Year 2030	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)</p> <p>Increased bag limits for Striped Bass and Pikeminnow</p> <p>Increased ocean salmon fishing harvest limitations</p> <p>No implementation of the USACE vegetation standards for levees</p>	<p>Implementation of Alternatives 1 and 4 with reasonably foreseeable actions would result in changes in stream flows, reduced Delta outflows, and increased CVP and SWP water exports as compared to the No Action Alternative with reasonably foreseeable actions. Favorable conditions for listed salmonids could be less available as compared to the No Action Alternative because access to habitat upstream of Shasta, Folsom, and New Melones dams would not be available. In addition, implementation of these alternatives could contribute cumulatively to impacts on listed Delta species by comparison to the No Action Alternative with reasonably foreseeable actions.</p>
Alternative 5 with Associated Cumulative Effects in Year 2030	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO</p> <p>Positive Old and Middle River flows and increased Delta outflow in spring months</p>	<p>Implementation of Alternative 5 with reasonably foreseeable actions would result in changes in stream flows, increased Delta outflows, and reduced CVP and SWP water exports as compared to the No Action Alternative with these added actions.</p>

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**Chapter 10****1 Terrestrial Biological Resources****2 10.1 Introduction**

3 This chapter describes terrestrial biological resources in the study area; and  
4 potential changes that could occur as a result of implementing the alternatives  
5 evaluated in this Environmental Impact Statement (EIS). Implementation of the  
6 alternatives could affect terrestrial biological resources through potential changes  
7 in operation of the Central Valley Project (CVP) and State Water Project (SWP)  
8 and ecosystem restoration.

**9 10.2 Regulatory Environment and Compliance  
10 Requirements**

11 Potential actions that could be implemented under the alternatives evaluated in  
12 this EIS could affect terrestrial biological resources in areas: along the shorelines  
13 and in the waters of reservoirs that store CVP and SWP water supplies, along  
14 rivers and waterways (including bypasses) impacted by changes in the operations  
15 of CVP or SWP reservoirs, within agricultural areas served by CVP and SWP  
16 water supplies, and modified to provide wetland habitat. Actions located on  
17 public agency lands; or implemented, funded, or approved by Federal and state  
18 agencies would need to be compliant with appropriate Federal and state agency  
19 policies and regulations, as summarized in Chapter 4, Approach to  
20 Environmental Analyses.

**21 10.3 Affected Environment**

22 This section describes terrestrial biological resources that could potentially be  
23 affected by implementing the alternatives considered in this EIS. Changes in  
24 terrestrial biological resources due to changes in CVP and SWP operations may  
25 occur in the Trinity River, Central Valley, San Francisco Bay Area, Central Coast,  
26 and Southern California regions.

27 Terrestrial biological resources occur throughout the study area. However, the  
28 analysis in this EIS is focused on terrestrial biological resources that could be  
29 directly or indirectly affected by the implementation of the alternatives analyzed  
30 in this EIS. The areas that could be affected are related to specific areas: 1) along  
31 the shorelines of reservoirs that store CVP and SWP water supplies, 2) along  
32 rivers downstream of CVP or SWP reservoirs, 3) areas with wetland habitat  
33 restoration in the Yolo Bypass and Suisun Marsh, 4) wildlife refuges that receive  
34 CVP water supplies, 5) riparian corridors within the Delta, and 6) within  
35 agricultural acreage that is irrigated with CVP and SWP water supplies.



1 Therefore, the following description of the affected environment is limited to  
2 these areas.

3 **10.3.1 Overview of Species with Special Status**

4 Species with special status are defined as species that are legally protected or  
5 otherwise considered sensitive by Federal, state, or local resource agencies,  
6 including:

- 7 • Species listed by the Federal government as threatened or endangered,
- 8 • Species listed by the State of California as threatened, endangered, or rare  
9 (rare status is for plants only),
- 10 • Species that are formally proposed for Federal listing or are candidates for  
11 Federal listing as threatened or endangered,
- 12 • Species that are candidates for State listing as threatened or endangered,
- 13 • Species that meet the definitions of rare, threatened, or endangered under  
14 California Environmental Quality Act,
- 15 • Species identified by the U.S. Fish and Wildlife Service (USFWS) as Birds of  
16 Conservation Concern,
- 17 • Species considered sensitive by the U.S. Bureau of Land Management (BLM)  
18 or U.S. Forest Service (USFS),
- 19 • Species identified by California Department of Fish and Wildlife (CDFW) as  
20 species of special concern, species designated by California statute as fully  
21 protected (e.g., California Fish and Game Code, sections 3511 [birds],  
22 4700 [mammals], and 5050 [reptiles and amphibians] and 5515 [fish]) or bird  
23 species on the CDFW Watch List, and
- 24 • Species, subspecies, and varieties of plants considered by CDFW and  
25 California Native Plant Society (CNPS) to be rare, threatened, or endangered  
26 in California. The CNPS Inventory of Rare and Endangered Plants of  
27 California assigns California Rare Plant Ranks (CRPR) categories for plant  
28 species of concern. Only plant species in CRPR categories 1 and 2 are  
29 considered special status plant species in this document:
  - 30 – CRPR 1A—Plants presumed to be extinct in California.
  - 31 – CRPR 1B—Plants that are rare, threatened, or endangered in California  
32 and elsewhere.
  - 33 – CRPR 2—Plants that are rare, threatened, or endangered in California but  
34 more common elsewhere.

35 A listing of wildlife and plant species with special status that occur or may occur  
36 in portions of the study area and are affected by the long-term coordinated  
37 operation of the CVP and SWP is provided in Appendix 10A. Relevant  
38 documents used to assemble these resource lists include the list of Federal  
39 endangered and threatened species that occur in or may be affected by projects in

1 the counties within the study area generated on-line from the USFWS Sacramento  
2 Fish and Wildlife Office.

3 To supplement the U.S. Fish and Wildlife lists, the California Natural Diversity  
4 Database (CNDDDB) was queried (DFG 2012) for regions where recent  
5 documentation was lacking. This included the Stanislaus River corridor between  
6 New Melones Dam and the San Joaquin River confluence, and the Trinity River  
7 Region, including Trinity Lake, Lewiston Reservoir, Whiskeytown Lake, and  
8 Clear Creek between Carr Powerhouse and the Sacramento River confluence.

### 9 **10.3.1.1 Critical Habitat**

10 Critical habitat refers to areas designated by the USFWS for the conservation of  
11 species listed as threatened or endangered under the Endangered Species Act of  
12 1973, as amended through the 108<sup>th</sup> Congress (ESA). When a species is proposed  
13 for listing under the ESA, the USFWS considers whether there are certain areas  
14 essential to the conservation of the species. Critical habitat is defined in  
15 Section 3, Provision 5 of the ESA as follows.

16 *(5)(A) The term “critical habitat” for a threatened or endangered species*  
17 *means -*

18 *(i) the specific areas within the geographical area occupied by*  
19 *a species at the time it is listed in accordance with the Act, on*  
20 *which are found those physical or biological features*  
21 *(I) essential to the conservation of the species, and (II) which*  
22 *may require special management considerations or protection;*  
23 *and*

24 *(ii) specific areas outside the geographical area occupied by a*  
25 *species at the time it is listed in accordance with the provisions*  
26 *of section 4 of this Act, upon a determination by the Secretary*  
27 *that such areas are essential for the conservation of the*  
28 *species.*

29 Any Federal action (permit, license, or funding) in critical habitat requires that  
30 Federal agency to consult with the USFWS where the action has potential to  
31 adversely modify the habitat for terrestrial species.

32 The federally listed wildlife and plant species considered in this EIS that have  
33 designated critical habitat areas that could be affected by modification of CVP  
34 and SWP operations are presented in Table 10.1 below. There are occurrences of  
35 critical habitat of other species not included in Table 10.1 or other locations of  
36 critical habitat of the species listed in Table 10.1 which are not included below  
37 because those occurrences are not located within the CVP or SWP service areas  
38 or in areas that could be affected by modification of CVP and SWP operations,  
39 such as lands located at high elevations within national forests where CVP and  
40 SWP water is not delivered.

1  
2**Table 10.1 Terrestrial Species with Designated Critical Habitat in Portions of the Study Area that Could Be Affected by Changes in CVP and SWP Operations**

<b>Species</b>	<b>Regions*</b>	<b>Counties</b>
Least Bell's Vireo	Central Coast and Southern California	Riverside, San Bernardino, San Diego, Santa Barbara, Ventura
Buena Vista Lake Shrew	Central Valley	Kern
Fresno Kangaroo Rat	Central Valley	Fresno
California Tiger Salamander	Central Valley	Alameda, Kern, Kings, Madera, Merced, San Benito, San Joaquin, Santa Barbara, Solano, Stanislaus, Tulare, Yolo
California Red-legged Frog	Central Valley, San Francisco Bay Area, Central Coast, Southern California	Alameda, Butte, Contra Costa, El Dorado, Kern, Kings, Los Angeles, Merced, Nevada, Placer, San Benito, San Joaquin, Santa Barbara, Santa Clara, Solano, Stanislaus, Ventura, Yuba
Alameda Whipsnake	Central Valley and San Francisco Bay Area	Alameda, San Joaquin, Santa Clara
Valley Elderberry Longhorn Beetle	Central Valley	Sacramento
Conservancy Fairy Shrimp	Central Valley	Butte, Merced, Solano, Stanislaus, Tehama, Ventura
Longhorn Fairy Shrimp	Central Valley	Alameda, Contra Costa, Merced
Vernal Pool Fairy Shrimp	Central Valley and San Francisco Bay Area	Alameda, Butte, Contra Costa, Fresno, Glenn, Madera, Merced, Placer, Sacramento, San Benito, San Joaquin, Santa Barbara, Shasta, Solano, Stanislaus, Tehama, Tulare, Ventura, Yuba
Vernal Pool Tadpole Shrimp	Central Valley	Alameda, Colusa, Kings, Madera, Merced, Sacramento, Shasta, Solano, Stanislaus, Tehama, Tulare, Yolo, Yuba
Butte County Meadowfoam	Central Valley	Butte, Tehama
Colusa Grass	Central Valley	Merced, Stanislaus, Yolo
Hairy Orcutt Grass	Central Valley	Butte, Fresno, Madera, Merced, Stanislaus, Tehama
San Joaquin Hairy Orcutt Grass	Central Valley	Fresno, Madera, Merced, Tulare
Slender Orcutt Grass	Central Valley	Plumas, Sacramento, Shasta, Tehama

Species	Regions*	Counties
Sacramento Orcutt Grass	Central Valley	Sacramento
Solano Grass	Central Valley	Yolo
Contra Costa Goldfields	Central Valley	Solano
Contra Costa Wallflower	Central Valley and San Francisco Bay Area	Contra Costa, Sacramento
Fleshy Owl's-Clover	Central Valley	Madera, Merced, Sacramento, San Joaquin, Stanislaus
Greene's Tuctoria	Central Valley	Madera, Merced, Shasta, Stanislaus, Tehama
Hoover's Spurge	Central Valley	Butte, Merced, Tehama, Tulare
Keck's Checker-Mallow	Central Valley	Fresno
Soft Bird's-Beak	Central Valley and San Francisco Bay Area	Contra Costa, Solano
Suisun Thistle	Central Valley	Solano

1 Source: USFWS 2014a - 2014aj

2 Note:

3 \* Only includes critical habitat within lands served by CVP or SWP water or in areas that  
 4 could be affected by modification of CVP and SWP operations. Therefore, does not  
 5 include lands where CVP and SWP water is not delivered or not affected by CVP and  
 6 SWP operations.

### 7 **10.3.2 Trinity River Region**

8 The Trinity River Region includes the area along the Trinity River from Trinity  
 9 Lake to the confluence with the Klamath River; and along the lower Klamath  
 10 River from the confluence with the Trinity River to the Pacific Ocean. The  
 11 Trinity River Region includes Trinity Lake, Lewiston Reservoir, the Trinity River  
 12 between Lewiston Reservoir and the confluence with the Klamath River, and  
 13 along the lower Klamath River.

14 The Trinity River includes the mainstem, North Fork Trinity River, South Fork  
 15 Trinity River, New River, and numerous smaller streams (NCRWQCB et al.  
 16 2009; USFWS et al. 1999). The mainstem of the Trinity River flows 170 miles to  
 17 the west from the headwaters to the confluence with the Klamath River. As  
 18 described in Chapter 5, Surface Water Resources and Water Supplies, the CVP  
 19 Trinity Lake and Lewiston Reservoir are located upstream of the confluences of  
 20 the Trinity River and the North Fork, South Fork, and New River. Flows on the  
 21 North Fork, South Fork, and New River are not affected by CVP facilities. The  
 22 Trinity River flows approximately 112 miles from Lewiston Reservoir to the  
 23 Klamath River through Trinity and Humboldt counties and the Hoopa Indian  
 24 Reservation within Trinity and Humboldt counties. The Trinity River is the  
 25 largest tributary to the Klamath River (DOI and DFG 2012).

1 The lower Klamath River flows 43.5 miles from the confluence with the Trinity  
2 River to the Pacific Ocean (USFWS et al. 1999). Downstream of the Trinity  
3 River confluence, the Klamath River flows through Humboldt and Del Norte  
4 counties and through the Hoopa Indian Reservation, Yurok Indian Reservation,  
5 and Resighini Indian Reservation within Humboldt and Del Norte counties (DOI  
6 and DFG 2012). There are no dams located in the Klamath River watershed  
7 downstream of the confluence with the Trinity River. The Klamath River estuary  
8 extends from approximately 5 miles upstream of the Pacific Ocean. This area is  
9 generally under tidal effects and salt water can occur up to 4 miles from the  
10 coastline during high tides in summer and fall when Klamath River flows are low.

11 As described in subsection 10.3.2, Overview of Species with Special Status, a  
12 listing of wildlife and plant species with special status that occur or may occur in  
13 portions of the study area affected by the long-term coordinated operation of the  
14 CVP and SWP is provided in Appendix 10A.

#### 15 **10.3.2.1 Trinity Lake and Lewiston Reservoir**

16 The dominant vegetation community in the Trinity River watershed upstream of  
17 Trinity Lake and Lewiston Reservoir includes mixed conifer, with ponderosa  
18 pine, sugar pine, and Douglas-fir as the dominant species. Some south-facing  
19 slopes are dominated by oak and brush. Mixed hardwood communities occur at  
20 lower elevations, and include species such as madrone, big-leaf maple, and a  
21 variety of oaks. The shrub community at lower elevations includes a number of  
22 chaparral species such as manzanita, bitterbrush, and deerbrush. South-facing  
23 slopes around Trinity Lake contain shrub fields that provide winter range for the  
24 Weaverville deer herd (USFS 2005; STNF 2014)

25 Along the margins of Trinity Lake and Lewiston Reservoir, vegetation is  
26 consistent with species associated with a reservoir environment and standing  
27 water, including floating species, rooted aquatic species, and emergent wetland  
28 species. Emergent wetland and riparian vegetation is constrained by fluctuating  
29 water levels and steep banks (NCRWQCB et al. 2009; USFWS et al. 1999).

30 The reservoirs attract resting and foraging waterfowl and other species that favor  
31 standing or slow moving water. Impounded water in the reservoirs also provides  
32 foraging habitat for eagles and other raptors that prey on fish (e.g., ospreys) and  
33 waterfowl.

34 Recently, ten pairs of mating bald eagles were observed at Trinity Lake and three  
35 pairs at Lewiston Lake (USFS 2012).

#### 36 **10.3.2.2 Trinity River from Lewiston Reservoir to Klamath River**

37 Current terrestrial habitat along the Trinity River is different than habitat prior to  
38 construction of Trinity and Lewiston dams. The ongoing Trinity River  
39 Restoration Program is restoring portions of the habitat. The following  
40 description reflects recent habitat changes along the mainstem of the Trinity River  
41 between Lewiston Reservoir and the confluence of the Klamath River.

#### 1 **10.3.2.2.1 Trinity River Restoration Program**

2 The hydrologic and geomorphic changes following construction of the Trinity and  
3 Lewiston dams changed the character of the river channel substantially and  
4 allowed riparian vegetation to encroach on areas that had previously been scoured  
5 by flood flows (USFWS et al. 1999). This resulted in the formation of a riparian  
6 berm that armored and anchored the river banks and prevented meandering of the  
7 river channel. The berm reduced the potential for encroachment and maturation  
8 of woody vegetation along the stabilized channel. In addition, the extent of  
9 wetlands probably declined following dam construction due, in part, to reduced  
10 flows and elimination of river meanders.

11 The ongoing Trinity River Restoration Program includes specific minimum  
12 instream flows, as described in Chapter 5, Surface Water Resources and Water  
13 Supplies; mechanical channel rehabilitation; fine and coarse sediment  
14 management; watershed restoration; infrastructure improvement; and adaptive  
15 management components (NCRWQCB et al. 2009; USFWS et al. 1999). The  
16 mechanical channel rehabilitation includes removal of fossilized riparian berms  
17 that had been anchored by extensive woody vegetation root systems and  
18 consolidated sand deposits, and thereby, had confined the river. Following  
19 removal of the berms, the areas had been re-vegetated to support native  
20 vegetation, re-establish alternate point bars, and re-establish complex fish habitat  
21 similar to conditions prior to construction of the dams. Sediment management  
22 activities include introduction of coarse sediment at locations to support spawning  
23 and other aquatic life stages; and relocation of sand outside of the floodway. In  
24 areas closer to Lewiston Dam with limited gravel supply, gravel/cobble point bars  
25 are being rebuilt to increase gravel storage and improve channel dynamics.  
26 Riparian vegetation planted on the restored floodplains and flows will be  
27 managed to encourage natural riparian growth on the floodplain and limit  
28 encroachment on the newly formed gravel bars. Improvement projects have been  
29 completed and others are under construction or in the planning phases. The  
30 restoration actions are occurring between Lewiston Dam and the North Fork.

#### 31 **10.3.2.2.2 Terrestrial Habitat**

32 Between the North Fork and the South Fork, the Trinity River channel is  
33 restricted by steep canyon walls that limit riparian vegetation to a narrow band  
34 (NCRWQCB et al. 2009; USFWS et al. 1999). Between the South Fork and the  
35 confluence with the Klamath River, there are confined reaches with little riparian  
36 vegetation, alternating with vegetation similar to the pre-dam conditions in the  
37 upper reach below Lewiston dam.

38 Many wildlife species that inhabited river and riparian habitats prior to dam  
39 construction still occur along the Trinity River. Species that prefer early-  
40 successional stages or require greater riverine structural diversity are likely to be  
41 less abundant under current conditions (NCRWQCB et al. 2009; USFWS et al.  
42 1999). For example, western pond turtle declined since completion of the dams in  
43 response to diminishing instream habitat. In contrast, species such as northern

1 goshawk and black salamander that favor mature, late-successional riparian  
2 habitats increased with more upland habitat along the riparian corridor.

3 Current habitats along the Trinity River include annual grassland, fresh emergent  
4 wetland, montane riparian, valley-foothill riparian, and riverine habitats  
5 (NCRWQCB et al. 2009, 2013). The annual grassland species include grasses  
6 (e.g., wild oat, soft brome, ripgut brome, cheatgrass, and barley); forbs  
7 (e.g., broadleaf filaree, California poppy, true clover, and bur clover); and native  
8 perennial species (e.g., Creeping Wildrye). The annual grassland habitat supports  
9 Mourning Dove, Savannah Sparrow, White-Crowned Sparrow, American Kestrel,  
10 Red-Tailed Hawk, coyote, California Ground Squirrel, Botta's Pocket Gopher,  
11 California Kangaroo Rat, Deer Mouse, Gopher Snake, Western Fence Lizard,  
12 Western Skink, Western Rattlesnake, and Yellow-Bellied Racer. The fresh  
13 emergent wetland species occur along the backwater areas, depressions, and along  
14 the river edges, including American Tule, Narrow-Leaved Cattail, Dense Sedge,  
15 Perennial Ryegrass, Himalayan Blackberry, and Narrow-Leaved Willow.  
16 Wildlife species along the fresh emergent wetland include Western Toad, Pacific  
17 Chorus Frog, Bullfrog, Green Heron, Mallard, and Red-Winged Blackbird. The  
18 montane riparian habitat adjacent to the river include trees, including bigleaf  
19 maple, white alder, oregon ash, black cottonwood, and Goodding's black willow;  
20 and understory species, including mugwort, virgin's bower, American dogwood,  
21 oregon golden-aster, dalmatian toadflax, white sweet clover, musk monkeyflower,  
22 straggly gooseberry, California grape, and California blackberry. The valley-  
23 foothill riparian habitat occur along alluvial fans, slightly dissected terraces, and  
24 floodplains; and include cottonwood, California sycamore, valley oak, white  
25 alder, boxelder, Oregon ash, wild grape, wild rose, California blackberry, blue  
26 elderberry, poison oak, buttonbush, willow, sedge, rushes, grasses, and miner's  
27 lettuce. Riparian woodlands along the montane riparian habitat support breeding,  
28 foraging, and roosting habitat for tree swallow, bushtit, White-Breasted Nuthatch,  
29 Nuttall's Woodpecker, Downy Woodpecker, Spotted Towhee, and Song Sparrow;  
30 cover for amphibians, including Western Toad and Pacific Chorus Frog; and  
31 habitat for deer mouse, raccoon, and Virginia Opossum. The riverine habitat  
32 supports amphibians and reptiles, including Western Toad, Pacific Chorus Frog,  
33 bullfrog, and Western Pond Turtle; birds, including mallard, Great Blue Heron,  
34 Osprey, and Belted Kingfisher; and mammals, including river otter, beaver, Big  
35 Brown Bat, and Yuma Myotis (bat).

36 The lands upslope of the Trinity River are characterized by mixed chaparral,  
37 montane hardwood-conifer, blue oak-foothill pine, foothill pine, and Klamath  
38 mixed conifer (NCRWQCB et al. 2009, 2013). The trees include Pacific  
39 madrone, bigleaf maple, canyon live oak, black oak, blue oak, ponderosa pine,  
40 Douglas fir, and incense cedar. Shrubs include greenleaf manzanita, buckbrush,  
41 cascara, snowberry, and poison oak. Underlying herbaceous vegetation includes  
42 ripgut brome, blue wild rye, silver bush lupine, purple sanicle, false hedge-  
43 parsley, The habitats support numerous birds, including Northern Flicker,  
44 Stellar's Jay, Hairy Woodpecker, Acorn Woodpecker, Wrentit, Bewick's Wren,  
45 California Quail, Mountain Quail, Blue Grouse, Sharp-Shinned Hawk, Red-Tailed  
46 Hawk, and Great Horned Owl; mammals including Black-Tailed Deer, Gray Fox,

1 coyote, Black-Tailed Jackrabbit, Raccoon, Virginia Opossum, Spotted Skunk,  
 2 Gray Squirrel, Allen's Chipmunk, Deer Mouse, and Pallid Bat; and reptiles and  
 3 amphibians, including California Kingsnake, Western Rattlesnake, Sharp-Tailed  
 4 Snake, Western Fence Lizard, Southern Alligator Lizard, and Ensatina.

5 Inundation of lands by Trinity Lake, Lewiston Reservoir, and Whiskeytown Lake  
 6 inundated approximately 20,500 acres of habitat for an estimated 8,500 black-  
 7 tailed deer (USFWS 1975). The CDFW established a deer herd management plan  
 8 for the Critical Winter Range for the Weaverville deer herd. A portion of the  
 9 winter range is located along the Trinity River (NCRWQCB et al. 2009).

### 10 **10.3.2.3 Lower Klamath River Watershed from Trinity River to the** 11 **Pacific Ocean**

12 The Klamath River from the confluence with the Trinity River to the Pacific  
 13 Ocean is characterized by a forested river canyon with riparian vegetation  
 14 occurring along the channel. There is a greater diversity of riparian vegetation  
 15 along the lower Klamath River below the mouth of the Trinity River, partly as a  
 16 result of a more natural hydrograph on the Klamath River than exists on the  
 17 Trinity River. Plant species composition changes as the Klamath River nears the  
 18 Pacific Ocean; because the river slows, temperatures increase, and the tides  
 19 affect salinity.

20 Grazing, timber harvest, and roads have degraded riparian conditions along the  
 21 lower Klamath River (Yurok Tribe 2000). Riparian areas are dominated by  
 22 deciduous trees including red alder. Red alder is a typical hardwood in riparian  
 23 zones, tanoak is a typical hardwood on mid to upper slopes, and Pacific madrone  
 24 occurs in small stands on drier sites (Green Diamond Resource Company 2006).

25 The broad lower Klamath River meanders within the floodplain and supports  
 26 wetland habitats similar to those that existed pre-dam along the Trinity River.  
 27 Wetland habitats along the lower Klamath River are dominated by cattails, tules,  
 28 and a variety of rushes and sedges. As the river nears the ocean, salt-tolerant  
 29 plants such as cord grass and pickleweed increase in abundance as the salinity  
 30 increases (USFWS et al. 1999). Wildlife species in the lower Klamath River  
 31 watershed are similar to those found in the Trinity River watershed.

### 32 **10.3.3 Central Valley Region**

33 The Central Valley Region extends from above Shasta Lake to the Tehachapi  
 34 Mountains, and includes the Sacramento Valley, San Joaquin Valley, Delta, and  
 35 Suisun Marsh.

36 The Central Valley Region includes portions of the Sacramento Valley and San  
 37 Joaquin Valley; including the Delta, Suisun Marsh, and the Yolo Bypass. The  
 38 areas where terrestrial biological resources could potentially be affected include  
 39 the fluctuation zones associated with reservoirs; river margins influenced by the  
 40 magnitude, duration, and frequency of flows; and agricultural lands and refuges  
 41 served by CVP and SWP water supplies.



1 The Central Valley Region is predominantly made up of lowlands and plains  
2 surrounded by foothills and tall mountains of the Coast Ranges to the west, the  
3 Cascade Range to the north, the Sierra Nevada Mountains to the east, and the  
4 Tehachapi Mountains to the south. Communities of various sizes and an  
5 extensive network of roadways are located throughout the valley.

6 Land use within the Sacramento Valley and San Joaquin Valley is dominated by  
7 agriculture and urban development. Grassland and oak woodland habitats occur  
8 in the foothills, particularly in the mid-elevation eastern margin of the Sacramento  
9 and San Joaquin valleys. Coniferous forests, mixed hardwood/coniferous forests,  
10 and oak woodlands generally represent the dominant vegetation surrounding CVP  
11 and SWP reservoirs. Riparian vegetation is generally constrained to narrow  
12 ribbons immediately adjacent to creeks and rivers. Many of the wetlands and  
13 riparian areas that once occurred in the Central Valley have been eliminated as a  
14 consequence of land use conversion to agriculture and urbanization.

### 15 **10.3.3.1 Overview of Terrestrial Communities**

16 This section describes the terrestrial communities in the Central Valley Region  
17 that could be affected directly or indirectly by operations of the CVP and SWP.  
18 These communities are broadly described for lakes/reservoirs (including open  
19 water and drawdown areas); rivers (including open water and riparian and  
20 floodplain areas); wetlands; and agricultural lands that could be affected by  
21 changes in water deliveries and ecosystem restoration activities. Other  
22 communities are described for areas that could be affected by restoration activities  
23 related to the proposed action and alternatives.

#### 24 **10.3.3.1.1 Lake/Reservoir Communities**

25 Reservoirs that store CVP and SWP water supplies provide habitat used by some  
26 terrestrial species, either within the open water area of the reservoirs or along the  
27 margins and in the drawdown areas.

##### 28 *Open Water Areas*

29 As described in Chapter 5, Surface Water Resources and Water Supplies, water  
30 surface elevations in reservoirs that store CVP and SWP water supplies change  
31 seasonally and annually due to hydrologic and operational variables. The open  
32 water areas of these reservoirs are used as foraging and resting sites by waterfowl  
33 and other birds, and by semi-aquatic mammals such as river otter and beaver.  
34 Bald Eagles and Ospreys nest in forests at the margins of these reservoirs, and  
35 frequently use the reservoirs to forage for fish.

##### 36 *Margin and Drawdown Areas*

37 The CVP and SWP reservoirs in the Central Valley are generally located in  
38 canyons where the surrounding slopes are dominated by upland vegetation such  
39 as woodland, forest, and chaparral. The water surface elevations in these  
40 reservoirs fluctuate within the inundation area, as described in Chapter 5, Surface  
41 Water Resources and Water Supplies, between maximum allowed storage  
42 elevations and minimum elevations defined by the lowest elevation on the intake  
43 structure. Along the water surface edge of the inundation area, the soils are

1 usually shallow. Soil is frequently lost to wave action and periodic inundation,  
 2 followed by severe desiccation when the water elevation declines, which  
 3 generally results in a barren drawdown zone around the perimeter of the  
 4 reservoirs. Natural regeneration of vegetation within the drawdown zone is  
 5 generally prevented by the timing of seed release when reservoir levels are high in  
 6 the spring, lack of sediment replenishment necessary for seedling establishment in  
 7 the spring, and high temperatures combined with low soil moisture levels of  
 8 exposed soils in the summer.

9 Lack of vegetative cover within the drawdown zone can limit wildlife use of this  
 10 area. Rapidly rising reservoir levels can potentially result in direct mortality of  
 11 some sedentary wildlife species or life stages within the drawdown zone of  
 12 reservoirs. As reservoir levels drop, energy expenditures can increase for  
 13 piscivorous (fish-eating) birds foraging in the reservoirs as these species must  
 14 travel greater distances to forage (DWR 2004a).

### 15 **10.3.3.1.2 Riverine Communities**

16 The rivers and streams influenced by the long-term coordinated operation of the  
 17 CVP and SWP support habitats for plants and wildlife. The primary components  
 18 of the riverine environment that support plants and wildlife, including open water  
 19 areas and adjacent riparian and floodplain communities (including bypasses that  
 20 are inundated at high flows), are described below.

#### 21 *Open Water Areas*

22 The riverine environment downstream of reservoirs is managed generally for  
 23 water supply and flood control purposes. As such, the extent of open water in the  
 24 rivers varies somewhat predictably, although not substantially, within and among  
 25 years. In the wetter years when bypasses and floodplains are inundated, vast  
 26 areas of open water become available during the flood season, generally in the  
 27 late winter and early spring. Open water portions of riverine systems provide  
 28 foraging habitat for fish eating birds and waterfowl. Gull, Tern, Osprey, and Bald  
 29 Eagle forage over open water. Near shore and shoreline areas provide foraging  
 30 habitat for birds such as waterfowl, heron, egret, shorebirds, and belted kingfisher.  
 31 Many species of insectivorous birds such as swallows, swifts, and flycatchers  
 32 forage over open water areas of lakes and streams. Mammals known to associate  
 33 with open water and shoreline habitats include river otter, American mink,  
 34 muskrat, and beaver.

#### 35 *Riparian and Floodplain Areas*

36 The riparian and floodplain communities that could be affected by CVP and SWP  
 37 operations refers primarily to the vegetation and associated wildlife community  
 38 supported and influenced by proximity to the waterway, including areas  
 39 frequently flooded by rising water levels in the rivers (floodplains). The extent of  
 40 riparian vegetation within the Central Valley has been reduced over time due to a  
 41 variety of actions, including local, state, and Federal construction and operation of  
 42 flood control facilities isolated historic floodplains; agricultural and land use  
 43 development that occurred following development of flood control projects;  
 44 regulation of flows from dams that has reduced the magnitude and frequency of

1 larger flow events, increased recession rates, and increased summertime flows;  
2 and construction and maintenance of active ship channels by the U.S. Army Corps  
3 of Engineers (USACE) (DWR 2012). Currently, levee and bank protection  
4 structures associated with the flood protection system are present along more than  
5 2,600 miles of rivers in the Central Valley, including the Delta (DWR 2009a).

6 Characteristic riparian tree species in the Central Valley include willows,  
7 cottonwoods, California sycamore, and valley oaks. Typical understory plants  
8 include elderberry, blackberries, and poison oak. On the valley floor in the deep  
9 alluvial soils, the structure and species composition of the plant communities  
10 change with distance from the river, with the denser stands of willow and  
11 cottonwood at the water's edge transitioning into stands of valley oaks on the less  
12 frequently inundated terraces. In other areas, the riparian zone does not support a  
13 canopy of large trees and instead is dominated by shrub species (sometime  
14 referred to as riparian scrub).

15 Riparian and floodplain vegetation supports wildlife habitats because of its high  
16 floristic and structural diversity, high biomass and high food abundance, and  
17 proximity to water. In addition to providing breeding, foraging, and roosting  
18 habitat for an array of animals, riparian and floodplain vegetation also provides  
19 movement corridors for some species, connecting a variety of habitats throughout  
20 the region. The Sacramento and San Joaquin valleys lack substantial areas of  
21 natural habitat that support native biodiversity or corridors between the areas of  
22 natural habitat; therefore, riparian and floodplain corridors play a critical role in  
23 connecting wildlife among the few remaining natural areas (CalTrans and  
24 DFG 2010).

25 Typical wildlife species associated with the riparian and floodplain communities  
26 include mammals such as striped skunk, raccoon, and gray fox. Riparian bird  
27 species include Red-Shouldered Hawk, Wood Duck, Great Blue Heron, Black-  
28 Crowned Night Heron, and many neotropical migratory birds, including Yellow  
29 Warbler and Western Yellow-Billed Cuckoo. Amphibians and reptiles include  
30 Pacific Tree Frog, Pacific Gopher Snake, Garter Snake, and Western Pond Turtle.  
31 Special status species that associate with riparian and floodplain habitats include  
32 Bank Swallow (state listed), Western Yellow-Billed Cuckoo (Federally and state  
33 listed), and the Valley Elderberry Longhorn Beetle (Federally listed).

34 River flows and associated hydrologic and geomorphic processes are important  
35 for maintaining riparian and floodplain ecosystems. Most aspects of a flow  
36 regime (e.g., the magnitude, frequency, timing, duration, and sediment load)  
37 affect a variety of riparian and floodplain habitat processes. Two processes that  
38 create riparian and floodplain ecosystems are disturbance and plant recruitment.  
39 The interaction of these processes across the landscape is primarily responsible  
40 for the pattern and distribution of riparian and floodplain habitat structure and  
41 condition, and for the composition and abundance of riparian-associated species.

42 High flow events and associated scour, deposition, and prolonged inundation can  
43 create exposed substrate for plant establishment or openings in existing riparian  
44 and floodplain communities. Early successional species, like cottonwoods and

1 willows that recruit into these openings, become more abundant in the landscape  
2 as vegetation grows within disturbed areas. As a result, structural and species  
3 diversity within riparian and floodplain vegetation could increase, as could overall  
4 wildlife habitat values. Without disturbance, larger trees and species less tolerant  
5 of frequent disturbance begin to dominate riparian woodlands.

6 The recruitment of cottonwoods and willows especially depends on geomorphic  
7 processes that create bare mineral soil through erosion and deposition of sediment  
8 along river channels and on floodplains, and on flow events that result in  
9 floodplain inundation. Receding flood flows that expose moist mineral soil create  
10 ideal conditions for germination of cottonwood and willow seedlings. After  
11 germination occurs, the water surface must decline gradually to enable seedling  
12 establishment. Riparian and floodplain communities also undergo natural  
13 disturbance cycles when flood flows remove streamside vegetation and  
14 redistribute sediments and seeds, thereby maintaining habitat diversity for  
15 terrestrial species that associate with riparian and floodplain corridors.

16 Both prolonged drought and prolonged inundation, however, can lead to plant  
17 death and loss of riparian plants (Kozlowski and Pallardy 2002). Riparian plants  
18 have high moisture requirements during the active growing season (spring  
19 through fall), and dry soil conditions can reduce growth and injure or kill plants.  
20 On the other hand, prolonged inundation creates anaerobic conditions that, during  
21 the active growing season, also can reduce growth, injure, or kill plants.

22 The continuation of riparian and floodplain communities is anticipated to change  
23 along levees within the federally authorized levee systems that have maintenance  
24 agreements with the USACE (including Delta levees along the Sacramento and  
25 San Joaquin rivers) and other levees that are eligible for the federal Rehabilitation  
26 and Inspection Program (Public Law 84-99). As described in Section 3.3.2.2 of  
27 Chapter 3, Description of Alternatives, the vegetation management policies of the  
28 USACE were changed in 2009 and 2010. Historically, the USACE allowed brush  
29 and small trees to be located on the waterside of federal flood management  
30 project levees if the vegetation would preserve, protect, and/or enhance natural  
31 resources, and/or protect rights of Native Americans, while maintaining the  
32 safety, structural integrity, and functionality of the levee (DWR 2011). After  
33 Hurricane Katrina in 2005, the USACE issued a policy and draft policy guidance  
34 to remove substantial vegetation from these levees throughout the nation (USACE  
35 2009). In 2010, the USACE issued a draft policy guidance letter, *Draft Process  
36 for Requesting a Variance from Vegetation Standards for Levees and  
37 Floodwalls—75 Federal Register 6364-68* (USACE 2010) that included  
38 procedures for State and local agencies to request variances on a site-specific  
39 basis. DWR has been in negotiations with USACE to remove vegetation on the  
40 upper third of the waterside slope, top, and landside of the levees, and continue to  
41 allow vegetation on the lower two-thirds of the waterside slope of the levee and  
42 along benches above the water surface (DSC 2011). The effects of these changes  
43 have not become widespread at this time. Future conditions under these  
44 requirements are further described under the description of the No Action

1 Alternative in this chapter (see Section 10.4.2.1.3, Changes in River and Delta  
2 Floodplains).

### 3 **10.3.3.1.3 Wetlands, Marshes, and Wet Meadows**

4 Wetlands in the Central Valley can be characterized as perennial or seasonal with  
5 perennial wetlands further classified as tidal or non-tidal. Natural, non-tidal  
6 perennial wetlands are scattered along the Sacramento and San Joaquin rivers,  
7 typically in areas with slow moving backwaters. Management of wetlands,  
8 marshes, and wet meadows can include irrigation of open areas to support native  
9 herbaceous plants or cultivated species; periodic or continuous flooding to  
10 provide feeding and roosting sites for many wetland-associated birds; and either  
11 limited or no tilling or disturbance of the managed areas.

12 Managed seasonal wetlands on the west side of the Sacramento River generally  
13 occur between Willows and Dunnigan along the Colusa Basin Drain. Substantial  
14 portions of these managed wetland habitats occur at the flood bypasses, including  
15 the Yolo Bypass Wildlife Area and Fremont Weir, as a part of the Sacramento  
16 National Wildlife Refuge Complex, and around the Thermalito Afterbay  
17 (Reclamation 2010a). Both tidal and nontidal, perennial wetlands are found in the  
18 Delta and Suisun Marsh.

#### 19 *Perennial Non-tidal (Freshwater) Wetlands and Marshes*

20 In the Sacramento and San Joaquin valleys and foothills, perennial non-tidal  
21 wetland habitats include freshwater emergent wetlands and wet meadows.  
22 Freshwater emergent wetlands, or marshes, are dominated by large, perennial  
23 herbaceous plants, particularly tules and cattails, which are generally restricted to  
24 shallow water. In marshes, vegetation structure and the number of species are  
25 strongly influenced by disturbance, changes in water levels, and the range of  
26 elevations present at a site. Wet meadows are similar to perennial freshwater  
27 wetlands in many regards; however, they are dominated by a greater variety of  
28 perennial plants such as rushes, sedges, and grasses than are found in freshwater  
29 wetlands. Perennial freshwater wetlands also provide ecological functions related  
30 to water quality and hydrology. These areas generally qualify as jurisdictional  
31 wetlands subject to U.S. Army Corps of Engineers jurisdiction under Sections 401  
32 and 404 of the federal Clean Water Act.

33 Perennial freshwater wetlands are among the most productive wildlife habitat in  
34 California (CDFW 1988a). In the Sacramento and San Joaquin valleys and  
35 foothills, these wetlands support several sensitive amphibians, reptiles, birds, and  
36 mammals. Perennial freshwater wetlands also provide food, cover, and water for  
37 numerous species of wildlife. Wetlands in the Sacramento and San Joaquin  
38 valleys and foothills are especially important to migratory birds and wintering  
39 waterfowl.

#### 40 *Seasonal Wetlands*

41 Natural seasonal wetlands occur in topographic depressions and swales that are  
42 seasonally saturated and exhibit hydric soils that support hydrophytic plant  
43 species. Natural seasonal wetlands are generally dominated by hydrophytic plants

1 during the winter and spring months. Characteristic plant species in seasonal  
 2 wetlands consist of both native and nonnative species. Native species include  
 3 coyote thistle, toad rush, hyssop loosestrife, and foothill meadowfoam. Natural  
 4 seasonal wetlands provide food, cover, and water for numerous common and  
 5 special status species of wildlife that rely on wetlands for all or part of their life  
 6 cycle. Like perennial wetlands, seasonal wetlands have been substantially  
 7 reduced from their historical extent.

8 Numerous managed seasonal wetlands occur within the Sacramento Colusa,  
 9 Sutter, Tisdale, and Yolo Bypasses and around the Thermalito Afterbay  
 10 (Reclamation 2010a).

11 Managed marsh areas are intentionally flooded and managed during specific  
 12 seasonal periods to enhance habitat values for specific wildlife species (CALFED  
 13 2000). Managed marsh areas are distributed largely in the northern, central, and  
 14 western portions of the Delta, as well as in Suisun Marsh and the Yolo Bypass,  
 15 Stone Lakes National Wildlife Refuge, Cosumnes River Preserve, and  
 16 Suisun Marsh.

#### 17 *Perennial Tidal Wetlands and Open Water*

18 In the Central Valley, tidal wetlands and open water are primarily found in the  
 19 Delta and Suisun Marsh. Tidal wetlands are influenced by tidal movement of salt  
 20 water from San Francisco Bay and inflow of freshwater from the Delta and  
 21 smaller local watersheds. Tidal open water in the Delta is mainly freshwater  
 22 habitat, with brackish and saline conditions occurring in the western Delta at  
 23 times of high tides and low flows into the western Delta. It is freshwater in the  
 24 Yolo Bypass and mainly brackish and saline in Suisun Marsh. Tidal mudflats  
 25 occur as mostly unvegetated sediment deposits in the intertidal zone between the  
 26 tidal wetland communities at its upper edge and the tidal perennial aquatic  
 27 community at its lower edge. Tidal brackish wetlands exist from near Collinsville  
 28 westward to the Carquinez Strait. Suisun Marsh is the largest contiguous brackish  
 29 water marsh remaining on the North America west coast (Reclamation et al.  
 30 2011). Tidal freshwater marshes occur at the shallow, slow-moving or stagnant  
 31 edges of freshwater waterways in the intertidal zone and are subject to frequent  
 32 long duration flooding.

33 Salinity levels vary throughout the year and are influenced largely by inflow from  
 34 the Delta (Reclamation et al. 2011). Tidal water in the Delta is mainly freshwater,  
 35 with brackish and saline conditions occurring in the western Delta at times of high  
 36 tides and low flows into the western Delta. Tidal marshes associated with the  
 37 lower Yolo Bypass are freshwater, whereas they are mainly brackish and saline in  
 38 Suisun Marsh where tidal brackish marshes exist from near Collinsville westward  
 39 to the Carquinez Strait.

#### 40 **10.3.3.1.4 Agricultural Lands**

41 Agricultural land uses and farming practices in the Central Valley provide  
 42 habitats and resources for a variety of terrestrial species, including several Federal  
 43 and state special status species. Agricultural lands are primarily found within the

1 Sacramento and San Joaquin valleys on the rich alluvial soils of the riverine  
2 floodplains. The distribution of seasonal crops varies annually and seasonally,  
3 depending on market forces and crop-rotation patterns. Some of the principal  
4 crop types and their value to wildlife are described below.

5 Crops in the Sacramento and San Joaquin valleys include grain and seed crops  
6 (e.g., barley and wheat), forage crops (e.g., hay and alfalfa), row crops  
7 (e.g., tomatoes, lettuce, sugar beets), cotton, orchards (e.g., almonds, walnuts,  
8 peaches, plums), and vineyards. There are also areas of irrigated pastureland  
9 throughout the Sacramento and San Joaquin valleys.

10 Grain and seed crops include wheat, barley, corn, and other annual grasses that  
11 are grown in dense stands. Most of the value for wildlife occurs during the early  
12 growing period because the later dense growth makes it difficult for wildlife to  
13 move through these fields. Following harvesting, waste grain is available to  
14 waterfowl and other birds, such as sandhill crane. Row crop and silage fields  
15 generally provide lesser value to wildlife than native cover types, but can support  
16 abundant populations of small mammals, such as California vole and western  
17 harvest mouse. These species attract predators such as snakes and raptors. Other  
18 reptile and bird species prey on the abundant insect populations found in row crop  
19 and silage fields.

20 Species generally associated with field and row crops include the Red-Winged  
21 Blackbird, Western Meadowlark, California Vole, Black-Tailed Jackrabbit,  
22 Western Harvest Mouse, Botta's Pocket Gopher, Raccoon, Striped Skunk, and  
23 Virginia Opossum. Croplands also provide foraging habitat for many raptors  
24 including Swainson's Hawk, Northern Harrier, Red-Tailed Hawk, and  
25 White-Tailed Kite.

26 Alfalfa is irrigated and intensively mowed such that vegetation structure varies  
27 with the growing, harvesting, and fallowing cycle. As a result, alfalfa supports  
28 some of the highest biodiversity amongst crops in California, second only to rice  
29 in agricultural habitat biodiversity (Hartman and Kyle 2010), with many species  
30 using alfalfa to forage, nest, rest, and hide. A wide range of species, including  
31 songbirds, swallows, bats, and many types of waterfowl and migratory birds feed  
32 on insects in alfalfa fields. Mammals such as gophers, mice, and rabbits feed  
33 directly on alfalfa. Larger herbivorous mammals, such as deer, antelope, and elk,  
34 frequent alfalfa fields, especially during dry or cold seasons. Hawks, eagles,  
35 migratory birds, coyotes, and mountain lions feed on the birds and rodents that  
36 feed on the alfalfa. Scavengers such as coyotes and vultures feed on carrion  
37 (Putnam et al. 2001).

38 Rice cultivation is also widespread in the Sacramento Valley. Rice fields provide  
39 surrogate wetland habitats and many wetland wildlife species use rice fields,  
40 especially waterfowl and shorebirds, and wading birds that forage on aquatic  
41 invertebrates and vertebrates such as crayfish and small fish. Foraging  
42 opportunities are provided by fish that become entrained in the irrigation canals  
43 that supply water to the rice fields and the crayfish that are found along canal  
44 banks and berms of the rice fields. Other wildlife species that use flooded rice

1 fields include Giant Garter Snake and bullfrog. Ring-necked pheasant and  
2 Sandhill Cranes among others forage on post-harvest waste grain. The practice of  
3 flooding rice fields in winter to allow for decomposition of rice stubble, as  
4 opposed to burning, enhances the wildlife value of rice fields. Winter flooding  
5 provides loafing and foraging opportunities for a variety of birds, including  
6 waterfowl, cranes, herons, and egrets.

7 Orchards and vineyards, typically dominated by a single tree species, are grown in  
8 fertile areas that once supported diverse and productive habitats for wildlife.

9 Orchards and vineyards generally provide relatively low wildlife value; however,  
10 some species of birds and mammals have adapted to orchard and vineyard  
11 habitats. Many have become "agricultural pests" which result in crop losses.

12 Deer and rabbits browse on the trees while other wildlife such as squirrels and  
13 numerous birds feed on fruit or nuts. Cover crops grown under the trees provide a  
14 food source for wildlife that feed on seeds or herbaceous vegetation. Wildlife

15 species reported to feed on nuts (almonds and walnuts) include Northern Flicker,  
16 Western Scrub-Jay, American Crow, Plain Titmouse, Brewer's Blackbird, House  
17 Finch, Gray Squirrel and California Ground Squirrel (DFG 1999a, 1999b, 1999c).

18 Other fruit crops such as apples, cherries, figs, pears and prunes are also eaten by  
19 these same species and others such as Band-Tailed Pigeon, Yellow-Billed

20 Magpie, Western Bluebird, American Robin, Varied Thrush, Northern

21 Mockingbird, Cedar Waxwing, Yellow-Rumped Warbler, Black-Headed

22 Grosbeak, Bullock's Oriole, Desert Cottontail, Gray Squirrel, coyote, black bear,

23 raccoon, and Mule Deer. Evergreen orchards (citrus, olives, avocado) do not

24 provide the food for wildlife that many of the deciduous fruit and nut trees

25 provide. Mourning Dove and California Quail use orchard habitats for cover and

26 nesting sites. Carnivores such as fox, bobcat, and coyote frequently use avocado

27 orchards (Nogeire et al. 2013). Irrigated pastures are managed grasslands with a

28 low structure of native herbaceous plants, cultivated species, or a mixture of both.

29 Pastures are not typically tilled or disturbed frequently and provide breeding

30 opportunities for ground-nesting birds, including waterfowl, Ring-Necked

31 Pheasant, and Sandhill Crane if adequate residual vegetation is present. Flood

32 irrigation of pastures provides feeding and roosting sites for many wetland-

33 associated birds, including shorebirds, wading birds, gulls, waterfowl, and raptors.

34 Large mammals such as deer, and elk graze in pastures when there is adequate

35 escape cover adjacent to the open pasture. Burrowing species using irrigated

36 pastures include California Ground Squirrel, Pocket Gophers, and Burrowing

37 Owls. Pastures provide foraging habitat for grassland-foraging wildlife, such as

38 coyote and fox, and raptors like the Northern Harrier, American Kestrel, and

39 Red-Tailed Hawk.

40 In addition to the crop lands, the network of irrigation canals, drains, and

41 reservoirs that convey water in the agricultural areas provide habitat for many

42 species of wildlife, including species with special status. These conveyance

43 features, particularly those that contain water throughout the growing season,

44 typically support some of the plants and animals characteristic of riverine systems

45 and riparian areas. While water flows through many of these facilities

46 intermittently, these features can provide habitat for species, such as Giant Garter



1 Snake. Giant Garter Snake is frequently associated with the water conveyance  
2 systems that support rice cultivation.

### 3 **10.3.3.1.5 Invasive Species**

4 Invasive plants and wildlife are species that are not native to the region, persist  
5 without human assistance, and have serious impacts on the environment. They  
6 are termed “invasive” because they displace native species and alter habitat  
7 functions and values. Many invasive plant species are considered “noxious  
8 weeds” by governmental agencies such as the U.S. Department of Agriculture and  
9 California Department of Food and Agriculture. Numerous invasive plants have  
10 been introduced into the study area, and many have become established. The  
11 California Invasive Plant Council maintains a list of species that have been  
12 designated as invasive in California (CalIPC 2006).

13 According to the California Department of Fish and Wildlife’s aquatic invasive  
14 species management plan (DFG 2008), invasive species threaten the diversity or  
15 abundance of native species through competition for resources, predation,  
16 parasitism, hybridization with native populations, introduction of pathogens, or  
17 physical or chemical alteration of the invaded habitat. Unlike the native riparian  
18 flora, many invasive riparian species do not provide the food, shelter, and other  
19 habitat components on which many native fish and wildlife species depend. In  
20 addition to the ability to degrade wildlife habitat, many of these invasive trees and  
21 shrubs have the potential to harm human health and the economy by adversely  
22 affecting the ecosystem, flood protection systems, water delivery, recreation, and  
23 agriculture.

24 Changes in CVP and SWP operations would affect the wetted edges at CVP and  
25 SWP reservoirs, reservoirs that store CVP and SWP water supplies, and along the  
26 rivers downstream of the CVP and SWP reservoirs. Therefore, only those  
27 invasive plant species that are associated with the margins at these waterways  
28 would be likely to cause adverse effects on terrestrial biological resources.  
29 Examples of these species include tree-of-heaven, giant reed, purple loosestrife,  
30 perennial pepperweed, tamarisk, and red sesbania. In addition to the potential  
31 effects caused by changed water operations, invasive species have the potential to  
32 be introduced as part of construction of habitat restoration, or to colonize areas  
33 disturbed by restoration construction activities (e.g., yellow star thistle, perennial  
34 pepperweed, Spanish broom, Himalaya blackberry).

### 35 **10.3.3.2 Sacramento Valley**

36 The Sacramento Valley portion of the Central Valley Region considered in this  
37 EIS includes Shasta Lake, Keswick Reservoir, and the Sacramento River from  
38 Keswick Reservoir to the Delta. The Sacramento Valley also includes the lower  
39 Yuba River and the middle and lower portions of the Feather River and American  
40 River watersheds that are influenced by CVP and SWP operations, respectively.

41 Historically, the Sacramento Valley contained a mosaic of riverine, wetland, and  
42 riparian communities with terrestrial habitats consisting of perennial grassland  
43 and oak woodlands. With development of the Sacramento Valley, native habitats

1 were converted to cultivated fields, pastures, residences, water impoundments,  
2 and flood-control structures. As a result, native habitats generally are restricted in  
3 their distribution and size and are highly fragmented.

4 A listing of wildlife and plant species with special status that occur or may occur  
5 in portions of the study area affected by the long-term coordinated operation of  
6 the CVP and SWP is provided in Appendix 10A.

7 The USFWS has approved a habitat conservation plan for the Natomas  
8 Basin/Metropolitan Air Park near Sacramento. Six other habitat conservation  
9 plans are being prepared in the Sacramento Valley, including programs for Butte  
10 County, Yuba-Sutter counties, Placer County, Yolo County, South Sacramento  
11 County, and Solano County.

#### 12 **10.3.3.2.1 Shasta Lake and Keswick Reservoir**

13 The area in which Shasta Lake is situated is characterized by a variety of  
14 vegetation and wildlife habitats typical of transitional mixed woodland and low-  
15 elevation forest habitats (Reclamation 2013a). The majority of vegetation  
16 communities and wildlife habitats around Shasta Lake are tree-dominated, and  
17 include upland forests with associated mixed chaparral, riparian forests, and  
18 woodlands. Other wildlife habitats around the lake include annual grasslands and  
19 barren areas. Montane riparian, the dominant riparian vegetation type at and near  
20 Shasta Lake, also occurs as thin stringers and patches along most stream corridors  
21 tributary to Shasta Lake.

22 Wildlife species around Shasta Lake are those typically associated with  
23 tree-dominated habitats and chaparral (Reclamation 2013a). Mammals in these  
24 habitats include deer, rabbits, chipmunks, and squirrels. Mature trees provide  
25 nesting habitat for raptors such as the bald eagle and osprey. Hollow trees and  
26 logs provide denning sites for mammals such as the coyote and skunks, and  
27 cavities in mature trees are used by cavity-dwelling species such as the Acorn  
28 Woodpecker and California Myotis. Many amphibians and reptiles, including  
29 *Ensatina*, Western Skink, and Western Fence Lizard, inhabit the detrital layer of  
30 moist areas. Snakes, including the Western Rattlesnake and Sharp-Tailed Snake,  
31 also are found in these habitats.

32 Recently, 38 pairs of mating Bald Eagles were observed at Shasta Lake  
33 (USFS 2012).

34 Terrestrial resources around Keswick Reservoir are similar to those found at  
35 lower elevations around Shasta Lake. Otters, Gray Fox, coyote, bobcat, Osprey,  
36 and turtles occur along the Keswick Reservoir reach of the Sacramento River  
37 (BLM 2006). Historically, vegetation in this area of the watershed was harvested  
38 to provide fuel for mining smelters. Chaparral habitat, dominated by manzanita  
39 with intermittent oak, pine, and fir trees occur on the foothills above the reservoir.  
40 As described in Chapter 5, Surface Water Resources and Water Supplies, water  
41 elevations in Keswick Reservoir are relatively stable throughout the year.

1 **10.3.3.2.2 Whiskeytown Lake and Clear Creek**

2 Riparian communities within the Whiskeytown Unit of the Whiskeytown-Shasta-  
3 Trinity National Recreation Area, which includes Whiskeytown Reservoir,  
4 include the following species: grey pine, willow, white alder, dogwoods, Oregon  
5 ash, bigleaf maple, and Fremont and black cottonwood. Wild grape is also very  
6 common; other riparian shrubs include snowberry, California blackberry, toyon,  
7 buckeye, and button willow. Flowering herbaceous plants, cattails, sedges,  
8 rushes, and ferns make up the riparian understory. The riparian habitats are  
9 generally vigorous and well-vegetated, especially in the most favorable locations,  
10 such as canyons and stream bottoms (NPS 1999).

11 Riparian vegetation is limited to a narrow band along the channel margins in the  
12 confined canyon reaches of Clear Creek between Whiskeytown Dam and Clear  
13 Creek Bridge, where the alluvial section of the creek begins. Downstream of  
14 Clear Creek Bridge, where the valley widens, the channel becomes predominately  
15 alluvial, and floodplains and terraces allow riparian vegetation to be more  
16 extensive (CBDA 2004).

17 Fresh emergent wetlands occur throughout the entire reach of lower Clear Creek  
18 from Whiskeytown Dam to the Sacramento River. These wetlands are more  
19 prominent in the reach below Clear Creek Road Bridge where soils are deeper and  
20 the valley becomes wider and is subject to periodic flooding. Valley-foothill  
21 riparian is found primarily in the lower reaches of lower Clear Creek from Clear  
22 Creek Road Bridge to the Sacramento River. In addition, smaller linear patches  
23 occur scattered throughout the system up to Whiskeytown Dam (BLM and  
24 NPS 2008).

25 Due to the diversity of habitats present within the watershed, the areas adjacent to  
26 Whiskeytown Lake and lower Clear Creek support a diverse assemblage of  
27 wildlife species. More than 200 vertebrate species are known to occur within the  
28 Whiskeytown Unit of the Whiskeytown-Shasta-Trinity National Recreation Area,  
29 including at least 35 mammal species, 150 bird species, and 25 reptile and  
30 amphibian species (NPS 2014).

31 **10.3.3.2.3 Sacramento River: Keswick Reservoir to the Delta**

32 Release of flows from Shasta Dam changed the pre-dam flow patterns from high  
33 flows in the mid-spring during snow melt to high flows in the summer months, as  
34 described in Chapter 5, Surface Water Resources and Water Supplies.  
35 Consequently, in most years, the current flow regime precludes or substantially  
36 reduces opportunities for establishment of cottonwoods and willows; and the  
37 structure and composition of riparian vegetation has undergone change  
38 (Roberts et al. 2002). The extent of early-successional riparian communities  
39 (e.g., cottonwood forest) has been decreasing, while the extent of mid-  
40 successional communities (e.g., mixed riparian forest) has been increasing.  
41 Generally, these effects diminish with distance downstream because of the  
42 influence of inflows from tributaries, diversions, and flood bypasses  
43 (Reclamation 2013a).

1 Much of the Sacramento River from Shasta Dam to Redding is deeply entrenched  
 2 in bedrock, which precludes development of extensive areas of riparian vegetation  
 3 (Reclamation 2013a). The upper banks along these steep-sided, bedrock-  
 4 constrained segments of the upper Sacramento River are characterized primarily  
 5 by upland communities, including woodlands and chaparral. Outside the river  
 6 corridor, other vegetation communities along the upper Sacramento River include  
 7 riparian scrub, annual grassland, and agricultural lands.

8 The river corridor between Redding and Red Bluff once supported extensive areas  
 9 of riparian vegetation (Reclamation 2013a). Agricultural and residential  
 10 development has permanently removed much of the native and natural habitat.  
 11 Riparian vegetation now occupies only a small portion of floodplains. Willow  
 12 and blackberry scrub and cottonwood- and willow-dominated riparian  
 13 communities are still present along active channels and on the lower flood  
 14 terraces, whereas valley oak–dominated communities occur on higher flood  
 15 terraces. Although riparian woodlands along the upper Sacramento River  
 16 typically occur in narrow or discontinuous patches, they provide value for wildlife  
 17 and support both common and special status species of birds, mammals, reptiles,  
 18 amphibians, and invertebrates.

19 Portions of the adjacent land along the Sacramento River from Red Bluff to  
 20 Hamilton City include substantial remnants of the pre-European Sacramento  
 21 Valley historical riparian forest (Reclamation 2013a). Along the Sacramento  
 22 River below Red Bluff, riparian vegetation is characterized by narrow linear  
 23 stands of trees and shrubs, in single- to multiple-story canopies. These patches of  
 24 riparian vegetation may be on or at the toe of levees. Riparian communities in  
 25 this region include woodlands and riparian scrub.

26 From Red Bluff to Colusa, the Sacramento River contains point bars, islands, high  
 27 and low terraces, instream woody cover, and early-successional riparian plant  
 28 growth, reflecting river meander and erosional processes (Reclamation 2013a).  
 29 Major physiographic features include floodplains, basins, terraces, active and  
 30 remnant channels, and oxbow sloughs. These features sustain a diverse riparian  
 31 community and support a wide range of wildlife species including raptors,  
 32 waterfowl, and migratory and resident avian species, plus a variety of mammals,  
 33 amphibians, and reptiles that inhabit both aquatic and upland habitats.

34 Downstream of Colusa, the Sacramento River channel changes from a dynamic  
 35 and active meandering one to a confined, narrow channel (Reclamation 2013a).  
 36 Surrounding agricultural lands encroach directly adjacent to the levees, which  
 37 have cut the river off from most of its riparian corridor, especially on the eastern  
 38 side of the river. Most of the levees in this reach are lined with riprap, allowing  
 39 the river no erodible substrate and limiting the extent of riparian vegetation and  
 40 riparian wildlife habitat.

#### 41 **10.3.3.2.4 Feather River**

42 Antelope Lake, Lake Davis, and Frenchman Lake located in the Upper Feather  
 43 River; Lake Oroville and Thermalito Forebay and Afterbay; and the lower Feather  
 44 River are located within areas in the Feather River watershed that could be

1 affected by changes in CVP and/or SWP operations. Downstream of Lake  
2 Oroville, the basin extends south and includes the drainage of the Yuba and  
3 Bear Rivers.

4 *Upper Feather River Lakes*

5 The Upper Feather River Lakes, including Antelope Lake, Lake Davis, and  
6 Frenchman Lake, are SWP facilities on the upper Feather River upstream of Lake  
7 Oroville. These lakes are part of the Plumas National Forest and provide habitat  
8 for raptor nesting and wintering areas, waterfowl nesting area, and deer  
9 movement area (DWR 2013a; Plumas County 2012). Deer movement and  
10 fawning areas also occur around Lake Davis.

11 *Lake Oroville and Thermalito Complex*

12 Lake Oroville is situated in the foothills on the western slope of the Sierra Nevada  
13 Mountains, about a mile downstream of the confluence of its major tributaries.  
14 Below the dam, a portion of the river flow is diverted at the Thermalito Diversion  
15 Dam and routed to the Thermalito Forebay, which is an offstream reservoir with a  
16 surface area up to 630 acres (DWR 2007a, 2007b). Downstream of the forebay,  
17 water is stored in Thermalito Afterbay (up to 4,300 surface acres), which among  
18 other purposes serves as a warming basin for agricultural water.

19 The majority of vegetation around Lake Oroville consists of a variety of native  
20 vegetation associations, including mixed oak woodlands, foothill pine/mixed oak  
21 woodlands, and oak/pine woodlands with a mosaic of chaparral (DWR 2004a,  
22 2007a). Open areas within the woodlands consist of annual grassland species.  
23 Native riparian habitats are restricted to narrow strips along tributaries, consisting  
24 mostly of alder, willow, and occasional cottonwood and sycamore. There is  
25 minimum wetland vegetation around Lake Oroville, and most is associated with  
26 seeps and springs that are a natural part of the landscape above the high water  
27 line. Emergent wetlands are generally absent within the drawdown zone of Lake  
28 Oroville.

29 Lack of vegetative cover within the drawdown zone severely limits wildlife use of  
30 this area. Thirty-six wildlife species were detected using habitats within the  
31 drawdown zone on at least one occasion during field surveys (DWR 2004a).  
32 Several of these species may use habitats within the drawdown zone for  
33 reproduction including Belted Kingfisher, Canada Goose, Canyon Wren,  
34 American Dipper, killdeer, mallard, Common Merganser, and Northern  
35 Rough-Winged Swallow.

36 Riparian vegetation occurs around the north shore of Thermalito Forebay as a thin  
37 strip of mixed riparian species (mostly willows), with an understory of emergent  
38 wetland vegetation. Cottonwoods and willows occur in scattered areas around the  
39 high water surface elevation of Thermalito Afterbay shoreline (FERC 2007).  
40 Emergent wetlands ranging from thin strips to more extensive areas are found  
41 around Thermalito Forebay and Thermalito Afterbay. Waterfowl brood ponds  
42 constructed in inlets of Thermalito Afterbay support emergent vegetation along  
43 much of their shores.

1 Species observed within the wetland margin of Thermalito Afterbay include Barn  
 2 Swallow, Black Phoebe, White-Tailed Kite, Black-Tailed Jackrabbit,  
 3 Brown-Headed Cowbird, bullfrog, Common Garter Snake, Common  
 4 Yellowthroat, Gopher Snake, Northern Harrier, Pacific tree Frog, raccoon,  
 5 red-Winged Blackbird, Ring-Necked Pheasant, Short-Eared Owl, Striped Skunk,  
 6 Tree Swallow, Virginia Opossum, and Violet-Green Swallow (DWR 2004a).

7 In contrast to the drawdown area around the margin of Lake Oroville, the  
 8 drawdown zone of Thermalito Afterbay supports a richer wildlife community and  
 9 greater habitat diversity. Survey data collected as part of the relicensing process  
 10 indicate that exposed mudflats seasonally provide habitat for a variety of  
 11 migratory waterbirds including Black-Necked Stilt, Black Tern, California Gull,  
 12 Caspian Tern, Forster's Tern, Greater Yellowlegs, Least Sandpiper, Long-Billed  
 13 Dowitcher, Ring-Billed Gull, Semipalmated Sandpiper, Spotted Sandpiper, and  
 14 White-Faced Ibis. Wading birds and other waterfowl have been observed on the  
 15 mudflats as well as shallow flooded areas (DWR 2004a). Potentially suitable  
 16 Giant Garter Snake habitat is present along portions of the afterbay and forebay  
 17 margins. The existing waterfowl brood ponds provide a refuge for Giant Garter  
 18 Snakes during periods of afterbay drawdown.

19 Several invasive plant species are found around Lake Oroville and downstream in  
 20 and around the Thermalito Complex. Invasive species associated with riparian  
 21 and wetland areas include purple loosestrife, giant reed, tree-of-heaven, and red  
 22 sesbania. About 85 of the roughly 900 acres of wetlands and riparian areas along  
 23 the margin of Thermalito Afterbay contain varying densities of purple loosestrife  
 24 (DWR 2007a). Purple loosestrife adversely affects native vegetation.

#### 25 *Feather River from Oroville Complex to the Sacramento River*

26 The Feather River from Oroville Dam to the confluence with the Sacramento  
 27 River supports stands of riparian vegetation, which have been restricted over time  
 28 by flood control levees and land clearing for agriculture and urbanization. As a  
 29 consequence, the vegetation generally occurs in a narrow zone along much of the  
 30 river in this reach. However, remnant riparian forest exist in areas where wide  
 31 meander bends persist, such as at Abbott Lake and O'Connor Lake near the Lake  
 32 of the Woods State Recreation Area (DWR 2004b). This area contains mixed  
 33 riparian forests, including Fremont cottonwood, willow, boxelder, alder, and  
 34 Oregon ash. The riparian strip along the river is bordered mostly by agricultural  
 35 fields. Downstream of Yuba City near the confluence with the Sacramento River,  
 36 valley oak and cottonwood riparian stands becomes more common.

37 As described above for the Sacramento River, riparian areas provide value for  
 38 wildlife and support a wide range of species of birds, mammals, reptiles,  
 39 amphibians, and invertebrates.

#### 40 **10.3.3.2.5 Yuba River**

41 Portions of the Yuba River watershed along the North Yuba River between New  
 42 Bullards Bar Reservoir and Englebright Lake and along the Lower Yuba River

1 between Englebright Lake and the Feather River could be affected by operation of  
2 the Lower Yuba River Water Accord (DWR et al. 2007b).

3 New Bullards Bar Dam and Reservoir are owned and operated by the Yuba  
4 County Water Agency to provide flood control, water storage, and hydroelectric  
5 generation. The Harry L. Englebright Dam and Reservoir were constructed by  
6 the California Debris Commission downstream of New Bullards Bar Reservoir to  
7 trap and store sediment from historical hydraulic mining sites in the upper  
8 watershed, and to provide recreation and hydroelectric generation opportunities  
9 (USACE 2013). Following decommissioning of the California Debris  
10 Commission in 1986, administration of Englebright Dam and Reservoir (Lake)  
11 was assumed by the USACE. Portions of the watershed along the Middle Yuba  
12 River between New Bullards Bar Reservoir and Englebright Reservoir are within  
13 the Plumas and Tahoe national forests.

14 Vegetation communities adjacent to New Bullards Bar Reservoir include oak  
15 woodlands, mixed conifer, and montane hardwood habitats which include live  
16 oak, blue oak, foothill pine, California wild rose, and lupine (DWR et al. 2007).  
17 The shoreline is generally barren. Bald Eagles have been observed near New  
18 Bullards Bar Reservoir; and California Red-legged Frogs have been reported in a  
19 tributary to the reservoir, Oregon Creek.

20 Vegetation communities at Englebright Reservoir are generally blue oak  
21 woodland and montane chaparral with small areas of mixed chaparral and live oak  
22 woodland (Yuba County 2011).

23 Vegetation along the lower Yuba River downstream of Englebright Dam is  
24 characterized by a number of vegetation types including grasslands, woodlands,  
25 and chaparral (USACE 2014). Within the Narrows, a steep gorge in the  
26 Yuba River immediately below Englebright Dam, there is little vegetation; small,  
27 isolated clumps of willow, mulefat, and other riparian species are widely scattered  
28 along the mostly barren, rocky banks. Downstream of the Narrows, there are  
29 extensive piles of cobble and gravel left from past gold and gravel mining  
30 operations. Here there are narrow strips of riparian vegetation consisting of  
31 Fremont cottonwood, willow, boxelder, and elderberry shrub. As described above  
32 for the Sacramento River, these communities support a wide range of similar  
33 wildlife species including raptors, waterfowl, and migratory and resident avian  
34 species, plus a variety of mammals, amphibians, and reptiles that inhabit both  
35 aquatic and upland habitats.

#### 36 **10.3.3.2.6 Bear River**

37 The Bear River flows into the Feather River downstream of the confluence with  
38 the Yuba River. As described in Chapter 5, Surface Water Resources and Water  
39 Supplies, the Bear River includes Nevada Irrigation District's Rollins and Combie  
40 reservoirs along the upper and middle reaches of the Bear River, and South Sutter  
41 Water District's Camp Far West Reservoir along the lower reach of the Bear  
42 River (FERC 2013; NID 2005).

1 Vegetation communities near the reservoirs and along the Bear River from  
 2 Rollins Reservoir to the confluence with the Feather River occur in bands based  
 3 on elevations (FERC 2013; NID 2005). Gray pine, ponderosa pine, hardwoods,  
 4 and chaparral shrubs occur at the higher elevations with black cottonwood, white  
 5 alder, and valley oak in the riparian zones. Incense cedar, Douglas fir, white fir,  
 6 madrone, sugar pine, Brewer's oak, whiteleaf manzanita, greenleaf manzanita,  
 7 wedgeleaf ceanothus, deerbrush, and poison oak at mid-elevations with white  
 8 alders, maple, and willow along the riparian areas.

#### 9 **10.3.3.2.7 American River**

10 The American River watershed encompasses approximately 2,100 square miles  
 11 (Reclamation et al. 2006). The North, Middle, and South forks of the American  
 12 River converge upstream of Folsom Lake. Lake Natoma is located downstream  
 13 of Folsom Lake. Water continues to flow between Nimbus Dam and the  
 14 confluence with the Sacramento River, as described in Chapter 5, Surface Water  
 15 Resources and Water Supplies.

#### 16 *Folsom Lake and Lake Natoma*

17 Folsom Lake, formed by Folsom Dam, has a surface area of about 11,500 acres,  
 18 and 75 miles of shoreline (Reclamation 2005a). Lake Natoma, which serves as an  
 19 afterbay downstream of Folsom Dam, has about 540 acres of surface area.

20 Vegetation communities associated with Folsom Lake include oak woodland and  
 21 annual grassland. The oak woodland habitat is located on the upland banks and  
 22 slopes of the reservoir, and is dominated by live oak, blue oak, and foothill pine  
 23 with several species of understory shrubs and forbs. Annual grasslands occur  
 24 around the reservoir, primarily at the southern end.

25 The oak woodlands and annual grasslands around the reservoir support a variety  
 26 of birds. A number of raptors, including red-tailed hawk, Cooper's hawk, great  
 27 horned owl, and long-eared owl use oak woodlands for nesting, foraging, and  
 28 roosting. Mammal species likely to occur in woodland habitats include deer,  
 29 coyote, bobcat, fox, Virginia Opossum, raccoon, rabbits, squirrels, and a variety  
 30 of rodents. Amphibians and reptiles that may be found in oak woodlands include  
 31 California Newt, Pacific Tree Frog, Western Fence Lizard, Gopher Snake,  
 32 Common Kingsnake, and Western Rattlesnake. The adjacent grasslands are used  
 33 by various bird species for foraging, including White-Crowned Sparrow, Lesser  
 34 Goldfinch, Western Meadowlark, and several raptor species. Migratory  
 35 waterfowl also are known to feed and rest in the grasslands associated with the  
 36 north fork of Folsom Reservoir.

37 Seasonal wetland communities occur both inside and outside of the area  
 38 influenced by the reservoir. These communities are exposed to wetland  
 39 hydrology for a limited period of time and may not meet all criteria for wetlands.  
 40 Within the reservoir drawdown zone, this seasonal vegetation is frequently  
 41 inundated and may receive overland flow from upland areas. Outside of the  
 42 drawdown zone, seasonally wet areas receive water from seeps, drainages, and  
 43 precipitation (Reclamation et al. 2006). Small areas of permanent freshwater



1 marsh are found at the toe of the Mormon Island Auxiliary Dam. Water birds and  
2 other wildlife depend on the freshwater marshes in these areas for foraging and/or  
3 rearing habitat. These species include Pacific Tree Frog, Western Toad, Common  
4 Garter Snake, beaver, raccoon, and muskrat.

5 Folsom Lake is surrounded by a relatively barren drawdown zone due to annual  
6 fluctuations in water elevations. The majority of this zone is devoid of  
7 vegetation, although scattered stands of woody vegetation occur in some areas of  
8 the drawdown zone (Reclamation et al. 2006). The only contiguous riparian  
9 vegetation occurs along Sweetwater Creek at the southern end of the reservoir.

10 Between Folsom Dam and Lake Natoma, the river channel is narrower and  
11 flanked by steep, rocky cliffs (Reclamation 2005a). The land along the river  
12 includes wooded canyon areas, sheer bluffs, and dredge tailings from the gold  
13 mining era. Within Lake Natoma, the open water is bordered by narrow bands of  
14 riparian woodland. Patches of permanent freshwater marsh exist in shallow coves  
15 that are inundated when water rises in Lake Natoma (Reclamation 2005a).

16 *Lower American River between Lake Natoma and Confluence with the*  
17 *Sacramento River*

18 Downstream of Lake Natoma, the lower American River flows to the confluence  
19 with the Sacramento River. In the upper reaches of the lower American River, the  
20 river channel is controlled by natural bluffs and terraces. Levees have been  
21 constructed along the northern and southern banks for approximately 13 miles  
22 upstream of the confluence with the Sacramento River (Reclamation et al. 2006).

23 Most of the lower American River is encompassed by the American River  
24 Parkway, which preserves what remains of the historic riparian zone  
25 (Reclamation et al. 2006). Vegetation communities along the lower  
26 American River downstream of Nimbus Dam include freshwater emergent  
27 wetland, riparian forest and scrub. Oak woodland and annual grassland are  
28 present in the upper, drier areas farther away from the river. The current  
29 distribution and structure of riparian communities along the river reflects the  
30 human-induced changes caused by activities such as gravel extraction, dam  
31 construction and operations, and levee construction and maintenance, as well as  
32 by both historical and ongoing streamflow and sediment regimes, and  
33 channel dynamics.

34 In general, willow and alder tend to occupy areas within the active channel of the  
35 river that are repeatedly disturbed by river flows, with cottonwood-willow  
36 thickets occupying the narrow belts along the active river channel (Reclamation et  
37 al. 2006). Typical species in these thickets include Fremont cottonwood, willow,  
38 poison oak, wild grape, blackberry, northern California black walnut, and  
39 white alder.

40 Cottonwood forest is found on the steep, moist banks along much of the river  
41 corridor (Reclamation et al. 2006). Valley oak woodlands occur on upper terraces  
42 where fine sediment and adequate soil moisture provide a long growing season.  
43 Live oak woodland occurs on the more arid and gravelly terraces that are isolated  
44 from the fluvial dynamics and moisture of the river. Annual grassland occurs in

1 areas that have been disturbed by human activity and can be found in many areas  
2 within the river corridor.

3 The cottonwood-dominated riparian forest and areas associated with backwater  
4 and off-river ponds are highest in wildlife diversity and species richness relative  
5 to other river corridor habitats (Reclamation et al. 2006). More than 220 species  
6 of birds have been recorded along the lower American River and more than  
7 60 species are known to nest in the riparian habitats. Typical species that can be  
8 found along the river include Great Blue Heron, Mallard, Red-Tailed Hawk,  
9 American Kestrel, California Quail, Killdeer, Belted Kingfisher, Western  
10 Scrub-Jay, Swallows, and American Robin. Additionally, more than 30 species  
11 of mammals reside along the river, including skunk, rabbit, raccoon, squirrel,  
12 vole, muskrat, deer, fox, and coyote. Reptiles and amphibians that occupy  
13 riparian habitats along the river include Western Toad, Pacific Tree Frog,  
14 bullfrog, Western Pond Turtle, Western Fence Lizard, Common Garter Snake,  
15 and Gopher Snake (Reclamation 2005a).

16 Backwater areas and off-river ponds are located throughout the length of the river,  
17 but occur predominantly at the Sacramento Bar, Arden Bar, Rossmoor Bar, and  
18 between Watt Avenue and Howe Avenue (Reclamation 2005a; Reclamation et al.  
19 2006). Plant species that dominate these backwater areas include various species  
20 of willow, sedge, cattail, bulrush, and rush. Riparian vegetation around these  
21 ponded areas is composed of mixed-age willow, alder, and cottonwood. These  
22 backwater ponds may be connected to the river by surface water during high  
23 winter flood flows and by groundwater during other times of the year. Wildlife  
24 species typical of these areas include: Pied-Billed Grebe, American Bittern, Green  
25 Heron, Common Merganser, White-Tailed Kite, Wood Duck, Yellow Warbler,  
26 Warbling Vireo, Dusky-Footed Woodrat, Western Gray Squirrel, Pacific Tree  
27 Frog, and Western Toad.

28 Several non-native weed populations are rapidly expanding in the riparian  
29 vegetation of the lower American River (County of Sacramento 2008). In  
30 particular, red sesbania is expanding along shorelines of streams and ponds, along  
31 with other invasive species such as Chinese tallowtree, giant reed, pampasgrass,  
32 Spanish broom, Himalayan blackberry, and tamarisk, which can rapidly colonize  
33 exposed bar surfaces and stream banks.

#### 34 **10.3.3.2.8 Agricultural Lands in the Sacramento Valley**

35 The study area in the Sacramento Valley includes Shasta, Plumas, Tehama,  
36 Glenn, Colusa, Butte, Sutter, Yuba, Nevada, Placer, El Dorado, Sacramento,  
37 Yolo, and Solano counties. As described in Chapter 12, Agricultural Resources,  
38 field and forage crops dominate the irrigated acreage in Sacramento Valley with  
39 over 1.4 million acres irrigated. Rice, irrigated pasture, and hay are the largest  
40 acreages. Second to field and forage crops are orchard and vine crops, making up  
41 roughly 21 percent of the total acreage. Almonds and walnuts are the largest  
42 acreages in this category. In total, the Sacramento Valley contains nearly two  
43 million agricultural acres. Typical terrestrial resources of these crops are  
44 described in subsection 10.3.4.1.4, Agricultural Lands.

1 **10.3.3.2.9 Wildlife Refuges in the Sacramento Valley**

2 The Sacramento Valley supported three major landscape types: wetlands,  
3 grassland-prairies, and riparian woodlands (Reclamation et al 2001a). These  
4 habitats were hydrologically and biologically linked to the river systems. Prior to  
5 their containment by the construction of dams and levees, the major rivers  
6 meandered, forming oxbows and riparian habitat. Winter floods would inundate  
7 and scour areas along these rivers, creating marshes and early-succession riparian  
8 scrub. Expanses of seasonal wetlands were also created by winter flooding.  
9 These seasonal wetlands formed habitat for overwintering and migrating  
10 waterfowl. Habitat areas such as wetlands are now intensively managed to  
11 support a wide range of birds and other wildlife within small and fragmented  
12 areas. Remnant wetlands and agricultural lands in the Central Valley support  
13 approximately 60 percent of the waterfowl wintering in the Pacific Flyway region  
14 (includes Alaska, Arizona, California, Idaho, Nevada, Oregon, Utah, Washington,  
15 and portions of Colorado, Montana, New Mexico, and Wyoming west of the  
16 Continental Divide [PFC 2014]). In addition, another 20 percent of the Pacific  
17 Flyway population passes through the Central Valley, using the wetlands for  
18 foraging and resting on their migratory passage through the region. The  
19 Sacramento Valley provides winter habitat for 44 percent of the Pacific Flyway  
20 waterfowl. The wetland and associated habitat are also important to several  
21 federally listed and proposed species, and other special status species such as the  
22 American Peregrine Falcon, Bald Eagle, Aleutian Canada Goose, Giant Garter  
23 Snake, and California Tiger Salamander.

24 The Sacramento National Wildlife Refuge (NWR) Complex is composed of five  
25 national wildlife refuges (Sacramento, Delevan, Colusa, Sutter and Sacramento  
26 River NWRs) and three state wildlife management areas (Willow Creek-Lurline,  
27 Butte Sink and North Central Valley Wildlife Management Areas) (USFWS  
28 2013a). The refuges of the Sacramento NWR Complex contain permanent ponds,  
29 seasonal wetlands, irrigated moist soil impoundments, and uplands (Reclamation  
30 et al 2001). Gray Lodge Wildlife Area is located adjacent to the Butte Sink, an  
31 overflow area of Butte Creek and the Sacramento River. It consists of seasonal  
32 wetlands and upland areas with permanent wetland and riparian habitats (DFG  
33 2011a). The Gray Lodge Wildlife Area supports permanent and seasonal  
34 wetlands, crops, and pasture (Reclamation et al. 2001).

35 Seasonally flooded marsh is the most prevalent and diverse of the wetland habitat  
36 types (Reclamation et al 2001). Wetland units managed as seasonally flooded  
37 marsh are typically flooded from early September through mid-April. Their  
38 diversity is the product of a variety of water depths that result in an array of  
39 vegetative species that, in combination, provide habitat for the greatest number of  
40 wildlife species throughout the course of a year. Through the fall and winter,  
41 seasonally flooded marshes are used by a wide range of waterfowl and smaller  
42 numbers of egret, heron, ibis, and grebe, to name a few. In addition, raptors take  
43 advantage of the water bird prey base. Water is removed in the spring; therefore,  
44 shorebirds use the shallow depth and exposed mudflats on their northern  
45 migration.

1 Moist soil impoundments, or seasonally flooded impoundments, are similar to  
2 seasonally flooded marshes (Reclamation et al 2001). Moist soil impoundments  
3 are typically irrigated during the summer to bolster plant growth and to enhance  
4 seed production. Irrigation is usually performed in mid-summer to increase plant  
5 biomass and seed production of watergrass, sprangletop, and smartweed plants.  
6 During these irrigation periods, these units are often used by locally nesting  
7 colonial water birds (egrets, herons).

8 Permanent ponds and summer water provide wetland habitat for year-round and  
9 summer resident species (Reclamation et al 2001). Permanent ponds remain  
10 flooded throughout the year, while units managed for summer water are flooded  
11 through June or July. Characterized by both emergent and submergent aquatic  
12 plants, permanent ponds and summer water units provide brood and molting areas  
13 for waterfowl, secure roosting and nesting sites for wading birds and other over-  
14 water nesters, and feeding areas for species like cormorants and pelicans.  
15 Permanent wetland habitats are also important to a number of special status  
16 species, such as the Giant Garter Snake, White-Faced Ibis, and Tricolored  
17 Blackbird.

18 Valley-foothill riparian habitats are found along low- to mid-elevation streams  
19 and waterways (Reclamation et al. 2001). Riparian habitats provide nesting,  
20 roosting, and feeding areas for passerines, raptors, herons, egrets, waterfowl, and  
21 small mammals. These areas also provide corridors for resident and migratory  
22 wildlife. Riparian woodland habitats are characterized by even-aged, broad-  
23 leafed, deciduous trees with open canopies that reflect flood-mediated episodic  
24 events. Cottonwood, willow, alder, and oak are typical trees found in riparian  
25 woodlands. Riparian scrub habitats are described as streamside thickets  
26 dominated by one or more willow species, as well as other fast-growing shrubs  
27 and vines.

### 28 **10.3.3.3 San Joaquin Valley**

29 The San Joaquin Valley portion of the Central Valley Region considered in this  
30 EIS includes the San Joaquin River from Millerton Lake to the Delta; lower  
31 Stanislaus River from New Melones Reservoir to the confluence with the San  
32 Joaquin River; San Luis Reservoir; and agricultural areas and wildlife refuges that  
33 use CVP and SWP water supplies.

34 Historically, the San Joaquin Valley was a large floodplain that supported vast  
35 expanses of permanent and seasonal marshes, lakes, and riparian areas. Almost  
36 70 percent of the valley has been converted to irrigated agriculture (Reclamation  
37 2005b). Relict stands of alkali desert scrub are widely scattered throughout the  
38 San Joaquin Valley, but are generally found in the Tulare Basin in the southern  
39 San Joaquin Valley. Annual and perennial grasslands occur throughout the San  
40 Joaquin Valley, mostly on level plains and the gently rolling foothills at  
41 elevations immediately higher than the patches of alkali desert scrub. Ruderal  
42 vegetation is typically associated with road and utility rights-of-way, borders of  
43 fields, ditches, and abandoned fields.

1 As described in subsection 10.3.2, Overview of Species with Special Status, A  
2 listing of wildlife and plant species with special status that occur or may occur in  
3 portions of the study area affected by the long-term coordinated operation of the  
4 CVP and SWP is provided in Appendix 10A.

5 The USFWS has approved a habitat conservation plan for San Joaquin County  
6 Multi-species Habitat Conservation and Open Space Plan, Kern Water Bank, and  
7 the Metropolitan Bakersfield.

#### 8 **10.3.3.3.1 San Joaquin River**

9 Potential changes in CVP and SWP operations could affect terrestrial resources  
10 associated with the San Joaquin River from Millerton Lake to the Delta.

##### 11 *Millerton Lake*

12 Millerton Lake on the San Joaquin River is located in the western foothills of the  
13 Sierra Nevada Mountains in an area that ranges from grasslands and rolling hills  
14 near Friant Dam, to steep, craggy slopes in the upper reaches of the lake.

15 Vegetation around Millerton Lake consists of a number of terrestrial  
16 communities, including annual grassland, oak woodland, foothill pine oak  
17 woodland, and chaparral (Reclamation 2011; Reclamation and State Parks 2010).

18 The most dominant vegetation community near the water edge is the nonnative  
19 grassland with blue oak woodland on the slopes above the lake and mixed riparian  
20 woodlands along drainages to the lake (Reclamation 2011; Reclamation and State  
21 Parks 2010). The dominant grassland species include broad-leaf filaree,  
22 fiddleneck, Heermann tarweed, vinegar weed, and ripgut brome, soft chess,  
23 zorro grass. The blue oak woodland also includes gray pine, buck brush, bush  
24 lupine, holly-leaf redberry, and hoary coffeeberry. The mixed riparian woodland  
25 species include interior live oak and gray pine with red willow, Fremont  
26 cottonwood, California buckeye, edible fig, and Oregon ash with an understory of  
27 California grape, button bush, Himalayan blackberry, sedges, and nonnative  
28 spearmint. Aquatic plants occur along the drainages where the water is relatively  
29 stagnant including mosquito fern, common duckweed, dotted duckmeat,  
30 punctuate smartweed, tall flat sedge, and broad-leaf cattail. Much of the shoreline  
31 is barren or characterized by nonnative grasslands with weedy species, such as  
32 Bermuda grass and cocklebur, and sporadic Goodding's black willow.

33 Mule Deer, California Quail, wild turkey, and feral pig, all of which are game  
34 species, occur in the area around Millerton Lake (Reclamation 2011; Reclamation  
35 and State Parks 2010). The region provides winter range and migratory routes for  
36 the San Joaquin deer herd. A number of special status bat species have potential  
37 to occur in the area, and suitable roost sites may be found throughout the area.  
38 Other special status species that may occur in the area include the ringtail,  
39 American badger, and San Joaquin pocket mouse.

40 A relatively diverse community of reptile and amphibian species exists in and  
41 around Millerton Lake (Reclamation 2011; Reclamation and State Parks 2010).  
42 The presence of the nonnative bullfrog has changed, and continues to dramatically  
43 alter, the extant reptile and amphibian community through predation and because

1 of its ability to out-compete native species. The Western Pond Turtle is known to  
2 occur around the lake. The California Tiger Salamander has also been reported.  
3 Limited areas of potential breeding habitat for California tiger salamander,  
4 primarily stock ponds dominated by nonnative species, have been identified in the  
5 San Joaquin River gorge upstream of the lake.

6 Bald eagles use roost trees near open water for foraging and are known to winter  
7 around Millerton Lake (Reclamation 2011; Reclamation and State Parks 2010).  
8 Several species associated with riparian habitats, including the least Bell's vireo  
9 and willow flycatcher, occurred historically around the lake, but have not been  
10 recently documented. A number of nonnative birds, including European Starling  
11 and Brown-Headed Cowbird, influence the native bird community through  
12 competition and nest parasitism.

13 A number of rare and listed plant species are known to occur around Millerton  
14 Lake and the upper San Joaquin River (Reclamation 2011; Reclamation and State  
15 Parks 2010). These include Ewan's larkspur, Michael's piperia, tree anemone,  
16 and Madera leptosiphon. Two plant species which serve as hosts for special  
17 status invertebrates, the elderberry and California pipevine, are also known to  
18 occur in the area. California pipevine is the obligate host plant for the pipevine  
19 swallowtail, a butterfly species and the elderberry shrub is the host plant of the  
20 Valley Elderberry Longhorn Beetle.

#### 21 *San Joaquin River from Friant Dam to the Confluence with the Merced River*

22 A multilayered riparian forest dominated by cottonwoods occurs on the active low  
23 floodplain of the San Joaquin River along with older stands of cottonwood-  
24 dominated riparian forest in areas that were formerly active floodplains prior to  
25 the completion of Friant Dam and associated diversion channels, and the resulting  
26 reduction in river flow (DWR and Reclamation 2002; Reclamation and DWR  
27 2011). Other areas on the low floodplain are dominated by willow, with  
28 occasional scattered cottonwood, ash, or white alder. California buttonbush is  
29 often present and may even dominate the riverbank for stretches.

30 The intermediate terrace of the floodplain of the San Joaquin River is primarily a  
31 mixed-species riparian forest (DWR and Reclamation 2002; Reclamation and  
32 DWR 2011). Species dominance in this mixed riparian forest depends on site  
33 conditions, such as availability of groundwater and frequency of flooding.  
34 Typical dominant trees in the overstory and midstory include Fremont  
35 cottonwood, boxelder, Goodding's black willow, Oregon ash, and California  
36 sycamore. Immediately along the water's edge, white alder occurs in the upper  
37 reaches of the San Joaquin River. Typical shrubs include red willow, arroyo  
38 willow, and California buttonbush.

39 Tree-dominated habitats with an open-to-closed canopy are typically found on the  
40 higher portions of the floodplain (DWR and Reclamation 2002; Reclamation and  
41 DWR 2011). These areas are exposed to less flood-related disturbance than areas  
42 lower on the floodplain. Valley oak is the dominant tree species while California  
43 sycamore, Oregon ash, and Fremont cottonwood are present in small numbers.

1 Typical understory species include creeping wild rye, California wild rose,  
2 Himalayan blackberry, California wild grape, and California blackberry.

3 Dense stands of willow shrubs frequently occur within the active floodplain of the  
4 river in areas subject to more frequent scouring flows and often occupy stable  
5 sand and gravel point bars immediately above the active channel (DWR and  
6 Reclamation 2002; Reclamation and DWR 2011). Dominant species include  
7 sandbar willow, arroyo willow, and red willow. Occasional emergent Fremont  
8 cottonwood may also be present.

9 Other areas have vegetation consisting of woody shrubs and herbaceous species  
10 dominated by different species depending on river reach. Some areas are  
11 dominated by mugwort, together with stinging nettle and various tall weedy  
12 herbs. Other areas are dominated either by blackberry (usually the introduced  
13 Himalayan blackberry) or wild rose in dense thickets, with or without scattered  
14 small emergent willows.

15 Areas with fine-textured, rich alluvium located outside the active channels but in  
16 areas that are subject to periodic flooding contain a shrub-dominated community  
17 characterized by widely spaced blue elderberry shrubs (DWR and Reclamation  
18 2002; Reclamation and DWR 2011). The herbaceous understory is typically  
19 dominated by nonnative grasses and forbs that are characteristic of annual  
20 grassland communities, including ripgut brome, foxtail fescue, foxtail barley,  
21 red-stemmed filaree, and horseweed.

22 Emergent wetlands typically occur in the river bottom immediately adjacent to the  
23 low-flow channel (DWR and Reclamation 2002; Reclamation and DWR 2011).  
24 Backwaters and sloughs where water is present through much of the year support  
25 emergent marsh vegetation, such as tule and cattails. More ephemeral wetlands,  
26 especially along the margins of the river and in swales adjacent to the river,  
27 support native and nonnative herbaceous species.

28 Prevalent invasive species found in this portion of the San Joaquin River corridor  
29 include red sesbania, tamarisk, giant reed, Chinese tallow, Tree-of-heaven, and  
30 perennial pepperweed (Reclamation and DWR 2011). Water hyacinth, water  
31 milfoil, Parrot's feather, curly-leaf pondweed, and sponge plant occur within the  
32 streams, especially in areas with slow or ponded water.

33 The riparian forest trees and understory provide habitat for raptors, cavity-nesting  
34 birds, and songbirds, including Red-Tailed Hawk, Red-Shouldered Hawk,  
35 Swainson's Hawk, White-Tailed Hawk, Downy Woodpecker, Wood Duck,  
36 Northern Flicker, Ash-Throated Flycatcher, Pacific-Slope Flycatcher, Olive Sided  
37 Flycatcher, Tree Swallow, Oak Titmouse, White-Breasted Nuthatch, Western  
38 Wood-Pewee, Warbling Vireo, Orange-Crowned Warbler, Yellow Warbler,  
39 Bullock's Oriole, and Spotted Towhee (DWR and Reclamation 2002;  
40 Reclamation and DWR 2011). Western Wood-Pewee, Bushtit, Bewick's Wren,  
41 Lazuli Bunting, Blue Grosbeak, and American Goldfinch inhabit the riparian  
42 scrub vegetation. Song Sparrow, Common Yellowthroat, Marsh Wren, and  
43 Red-Winged Blackbird inhabit the emergent wetlands. Coyote, River Otter,  
44 raccoon, Desert Cottontail, and Striped Skunk occur in the riparian forest and

1 shrub communities. Shorebirds, such as Killdeer; Mallard Duck; California Vole;  
 2 Common Muskrat; Norway Rat; Pacific Chorus Frog; Western Pond Turtle; and  
 3 Western Terrestrial Garter Snake occur near the river.

#### 4 *San Joaquin River from Merced River to the Delta*

5 Downstream of the Merced River confluence, vegetation and wildlife resources  
 6 along the San Joaquin River are similar to the upstream reaches described above  
 7 (DWR and Reclamation 2002; Reclamation and DWR 2011). The reach of the  
 8 San Joaquin River immediately downstream of the Merced River is more incised  
 9 than areas further downstream and has a less developed riparian area with less  
 10 understory vegetation. Between the Merced River and the Delta, agricultural land  
 11 use has encroached on the riparian areas, leaving only a narrow band of riparian  
 12 habitat. Near the confluence with tributary rivers, in cutoff oxbows, and in the  
 13 San Joaquin River NWR, there are more extensive riparian habitat areas.  
 14 Remnant cattail-dominated marshes and tules occur in these areas.

15 Wildlife species are similar to those found in the reaches upstream of the Merced  
 16 River described above (DWR and Reclamation 2002; Reclamation and  
 17 DWR 2011).

#### 18 **10.3.3.3.2 Stanislaus River**

19 The upper Stanislaus River watershed has a drainage area of approximately  
 20 980 square miles (Reclamation 2010b). The North, Middle, and South forks of  
 21 the Stanislaus River converge upstream of the CVP New Melones Reservoir.  
 22 Water from New Melones Reservoir flows into Tulloch Reservoir. Downstream  
 23 of Tulloch Reservoir, the Stanislaus River flows to Goodwin Dam and then  
 24 approximately 40 miles to the confluence with the San Joaquin River.

#### 25 *New Melones Reservoir*

26 Several broad categories of vegetation have been described in other studies  
 27 around the New Melones Reservoir, including blue oak woodland and blue  
 28 oak-foothill pine woodland, grasslands, chaparral, wetlands, and serpentine-based  
 29 communities (Reclamation 2010b). The montane hardwood and montane  
 30 hardwood-conifer woodlands occur at higher elevations substantially above the  
 31 reservoir open water, especially along the eastern portion of the New Melones  
 32 Reservoir; and are not anticipated to be affected by changes in CVP and  
 33 SWP operations.

34 Blue oak woodland vegetation occurs in the western and southwestern portion of  
 35 New Melones Reservoir, especially on rocky slopes and along riparian corridors  
 36 (Reclamation 2010b). Oak trees that are established along the shoreline during  
 37 drier periods are frequently killed when the reservoir fills to the maximum  
 38 elevation. The blue oak woodland community also includes ponderosa pine,  
 39 California buckeye, manzanita, ceanothus, yerba santa, foothill pine, scrub oak,  
 40 black oak, valley oak, interior live oak, coffeeberry, redberry, holly-leaved cherry,  
 41 and needlegrass. The blue oak-foothill pine woodland occurs at higher elevations  
 42 along the western and southern areas of the New Melones Reservoir, and includes  
 43 understory species, including poison oak, woodland star, sugar cup, shooting star,



1 Chinese house, and gooseberry. The oak woodland supports woodpecker,  
2 mourning doves, wild turkey, California quail, mule deer, black-tailed deer,  
3 western grey squirrel, gray fox, raccoon, feral pig, striped skunk, mountain lion,  
4 and bobcat. The transition chaparral zones between the oak woodlands and  
5 grasslands support California Thrasher, quail, wrentit, bobcat, Deer Mouse, feral  
6 pig, and Fence Lizard.

7 Annual grasslands occur along adjacent plains and foothills on the western and  
8 southern portions of New Melones Reservoir (Reclamation 2010b). The annual  
9 plant species, including wild oats, soft chess, ripgut, fiddleneck, longbeak stork's  
10 bill, and redstem stork's bill. Perennial grass species include triple-awned grass,  
11 wheat grass, bent grass, wild-rye, melic grass, needle-grass, and muhly. The area  
12 also includes foothill pine, blue oak, California poppy, and lupines. Grasslands  
13 support Meadowlark, Horned Lark, sparrow, quail, mouse, and vole. Raptors that  
14 forage in the grasslands include White-Tailed Kite, Northern Harrier, Great  
15 Horned Owl, Red-Tailed Hawk, and Swainson's Hawk.

16 Little riparian vegetation exists along the shoreline of New Melones Reservoir  
17 because fluctuating water levels limit the establishment of riparian vegetation  
18 (Reclamation 2010b). Riparian vegetation is generally found in the upstream  
19 reaches of some of the perennial drainages that flow into the reservoir. Wetland  
20 vegetation is found in some locations along the edges of the lake and in moist  
21 canyons. There are many riparian communities, seeps, and wet meadows in the  
22 upper reaches of streams that are tributaries of the lake. Species in the valley and  
23 foothill riparian woodlands include boxelder, Fremont cottonwood, willows,  
24 white alder, and big-leaf maple. The wet meadow species include short-hair  
25 sedge, gentian-aster, few-flowered spikerush, carpet clover, bentgrass, pull-up  
26 muhly, beaked sedge, Nebraska sedge, Kentucky bluegrass, longstalk clover, and  
27 tufted hairgrass.

28 The open water of New Melones Lake, along with associated shoreline  
29 vegetation, provides foraging and resting habitat for a variety of waterfowl and  
30 shorebirds (Reclamation 2010b). Several fish-eating bird species, such as grebe,  
31 forage in the open water; other species, such as ducks, herons, and egrets, dabble  
32 along the shoreline foraging on seeds and small fish in shallow areas. Trees along  
33 the shoreline provide nesting areas for osprey. Riparian areas along larger  
34 tributaries to New Melones Reservoir provide food, cover, water, and nesting  
35 habitat for a variety of wildlife species and serve as travel corridors for species  
36 such as black-tailed deer.

37 Limestone caves are located in portions of the upper reaches of New Melones  
38 Reservoir, especially along the Stanislaus River (Reclamation 2010b). Bats use  
39 the caves for roosting and breeding. A type of rare spider, New Melones  
40 harvestman, was transplanted from caves that were to be inundated through the  
41 filling of New Melones Reservoir into neighboring caves.

#### 42 *Tulloch Reservoir*

43 Many vegetation community types characteristic of the New Melones Reservoir  
44 and other portions of the Sierra foothills are found around Tulloch Reservoir,

1 including blue oak woodland, chaparral, grassland, various tree-shrub  
 2 communities dominated by pines, and grasslands (Tri-Dam Project 2008). The  
 3 elderberry shrub (*Sambucus* species) occurs at multiple locations around the  
 4 reservoir and may provide habitat for the Valley Elderberry Longhorn Beetle. A  
 5 number of nonnative weedy species have been documented around the reservoir  
 6 including Himalayan blackberry, red brome, tree-of-heaven, slenderflower thistle,  
 7 yellow star thistle, pampas grass, Bermuda grass, and the aquatic parrot's feather.  
 8 The vegetation along the water edge is affected by daily and seasonal water  
 9 elevation variability. Wildlife supported by the vegetative community are similar  
 10 to wildlife communities near New Melones Reservoir as well as Western Pond  
 11 Turtle, bat, river otter, and mink (Goodwin Power 2013).

#### 12 *Goodwin Dam*

13 Downstream of Tulloch Dam, the Stanislaus River flows to Goodwin Dam, and  
 14 then continues approximately 40 miles to the confluence with the San Joaquin  
 15 River. Goodwin Dam serves as a diversion dam for Oakdale Irrigation District,  
 16 South San Joaquin Irrigation District, and Stockton East Water District, as  
 17 described in Chapter 5, Surface Water Resources and Water Supplies (Tri-Dam  
 18 Project 2003, 2007). The Goodwin Dam impounds 502 acre-feet of water along  
 19 the Stanislaus River approximately 1.6 miles downstream of Tulloch Dam and  
 20 8.3 miles downstream of New Melones Dam. Water surface elevations are  
 21 relatively constant upstream of Goodwin Dam.

22 The vegetation communities in this area of the Stanislaus River are similar to the  
 23 vegetation near Tulloch Dam, including hardwood and oak woodlands with blue  
 24 oak, interior live oak, gray pine, California buckeye, toyon, tree of heaven, and  
 25 California black walnut (Tri-Dam 2003). Near the Stanislaus River, the  
 26 vegetation is characterized by riparian woodland with cottonwood, willows, white  
 27 alder, blue elderberry, and Himalayan berry. Some low-gradient areas along the  
 28 shoreline of Goodwin Lake, especially in coves, support small patches of  
 29 emergent aquatic vegetation such as bulrush and cattail (Goodwin Power 2013).  
 30 Wildlife occurrences are similar to conditions near Tulloch Reservoir.

#### 31 *Stanislaus River from Goodwin Dam to the Confluence with the San Joaquin* 32 *River*

33 From Goodwin Dam to Knight's Ferry, the Stanislaus River flows through a  
 34 bedrock canyon with nearly vertical walls and rock outcrops (DFG 1995). The  
 35 riparian edge includes valley foothill riparian vegetation in a very narrow band for  
 36 the entire length of this reach. This habitat is characterized by a canopy layer of  
 37 cottonwood, California sycamore, and valley oak. Subcanopy cover trees are  
 38 white alder, boxelder, and Oregon ash. Typical understory shrub layer plants  
 39 include wild grape, wild rose, California blackberry, elderberry, button brush, and  
 40 willow. The herbaceous layer consists of sedges, rushes, grasses, miner's lettuce,  
 41 poison-hemlock, and stinging nettle.

42 From Knights Ferry to the Orange Blossom Bridge, located to the east of the City  
 43 of Oakdale, the valley foothill riparian habitat continues along the river (DFG  
 44 1995). Further away from the river, vegetation is dominated by blue oak-digger

1 pine woodland and shrub, including California redbud, California buckeye,  
2 ceanothus, manzanita, poison oak, and grasslands. Vernal pools and vernal pool  
3 complexes are found within adjacent grasslands.

4 Downstream of the Orange Blossom Bridge, the riparian corridor is virtually  
5 nonexistent in some areas with agricultural land uses extending into the riparian  
6 corridor (DFG 1995). In a few areas the riparian corridor is wide, such as within  
7 Caswell Memorial State Park. The major habitats include valley foothill riparian  
8 along the Stanislaus River with annual grasslands and fresh emergent wetlands  
9 amount the agricultural and urban developments.

#### 10 **10.3.3.3.3 San Luis Reservoir Complex**

11 The San Luis Reservoir complex, consisting of San Luis Reservoir, O'Neill  
12 Forebay, and Los Banos Creek Reservoir, is located in northwestern San Joaquin  
13 Valley and is part of the water storage and delivery system for the CVP and SWP.  
14 The area is located within several vegetative communities (Reclamation and State  
15 Parks 2013). The northern and western portion of the San Luis Reservoir is  
16 located within the coastal foothills with blue oak-foothill pine woodlands. The  
17 O'Neill Forebay and parts of Los Banos Creek Reservoir are located within the  
18 San Joaquin Valley with valley oak habitat.

19 The vegetation around the San Luis Reservoir complex and wildlife management  
20 areas consists of riparian woodlands, blue oak woodlands and savanna, coast live  
21 oak woodland, ornamental trees, California sagebrush scrub, grasslands, wetlands,  
22 alkali sink scrub, and nonnative and weedy plant communities (Reclamation and  
23 State Parks 2013). The riparian woodland and wetland communities occur at the  
24 edge of the reservoirs and along watercourses. The San Luis Wildlife Area also  
25 contains blue oak woodland, blue oak savanna, coast live oak woodland, and  
26 California sycamore riparian woodland. California sagebrush scrub occurs on  
27 hillsides above and to the west of Los Banos Creek Reservoir. Iodine bush scrub  
28 occurs at Salt Spring, a tributary to Los Banos Creek Reservoir. Native purple  
29 needlegrass occurs throughout the complex.

30 Along the shorelines, riparian vegetation remains in an early successional stage  
31 because either the extreme fluctuation of the water level inundates the vegetation  
32 or the vegetation does not receive enough water during the dry season  
33 (Reclamation and State Parks 2013). Areas at the edges of O'Neill Forebay and  
34 Los Banos Creek Reservoir appear to be slowly changing to riparian vegetation.

35 A herd of more than 200 tule elk occurs towards the western shoreline of San Luis  
36 Reservoir within and near Pacheco State Park (Reclamation and State Park 2013).  
37 The herd moves down towards the water edge within the reservoir inundation area  
38 when the water elevation is low. Another herd of approximately 60 individuals  
39 occur around B.F. Sisk Dam which forms San Luis Reservoir; and approximately  
40 70 tule elk occur throughout other areas in the complex.

#### 41 **10.3.3.3.4 Agricultural Lands in the San Joaquin Valley**

42 The study area in the San Joaquin Valley includes the counties of Stanislaus,  
43 Merced, Madera, San Joaquin, Fresno, Kings, Tulare, and Kern counties. As

1 described in Chapter 12, Agricultural Resources, field and forage crops dominate  
2 the irrigated acreage in the San Joaquin Valley with over 5.5 million agricultural  
3 acres. Hay, cotton, and silage are the largest acreages. Second to field and forage  
4 crops are orchards and vineyards, making up roughly 35 percent of total acreage.  
5 Almonds and grapes are the largest acreages in this category.

6 Typical terrestrial resources of these crops are described in subsection 10.3.4.1.4,  
7 Agricultural Lands. In the grassland and pasture areas, areas not dominated by  
8 crops include nonnative grasses, foxtail barley, and forbs (Reclamation and DWR  
9 2011). The grassland and pasture support Northern Harrier, Ring-Necked  
10 Pheasant, Mourning Dove, Burrowing Owl, Loggerhead Shrike, Deer Mouse,  
11 California Vole, California Ground Squirrel, Botta's Pocket Gopher, American  
12 Badger, coyote, Western Toad, Western Fence Lizard, Western Racer, and  
13 Gopher Snake. The cropland provides foraging areas for raptors and supports  
14 Ground Squirrel, American Crow, Brewer's Blackbird, and European Starling.

### 15 **10.3.3.3.5 Wildlife Refuges in the San Joaquin Valley**

16 The San Joaquin Valley historically supported three major landscape types:  
17 wetlands, grassland-prairies, and riparian woodlands (Reclamation et al 2001b).  
18 These habitats were hydrologically and biologically linked to the river systems.  
19 Prior to their containment by the construction of dams and levees, the major rivers  
20 meandered, forming oxbows and riparian habitat. Winter floods would inundate  
21 and scour areas along these rivers, creating marshes and early-succession riparian  
22 scrub. Expanses of seasonal wetlands were also created by winter flooding.  
23 These seasonal wetlands formed habitat for overwintering and migrating  
24 waterfowl. Habitat areas such as wetlands are now intensively managed to  
25 support a wide range of birds and other wildlife within small and fragmented  
26 areas. Remnant wetlands and agricultural lands in the Central Valley support  
27 approximately 60 percent of the waterfowl wintering in the Pacific Flyway region.  
28 In addition, another 20 percent of the Pacific Flyway population passes through  
29 the Central Valley, using the wetlands for foraging and resting on their migratory  
30 passage through the region. The Sacramento Valley provides winter habitat for  
31 44 percent of the Pacific Flyway waterfowl. The wetland and associated habitat  
32 are also important to several federally listed and proposed species, and other  
33 special status species such as the American Peregrine Falcon, Bald Eagle,  
34 Aleutian Canada Goose, Giant Garter Snake, and California Tiger Salamander.

35 CVP water supplies are provided to the San Luis NWR Complex which includes  
36 the Merced NWR, San Luis NWR (including the San Luis Unit, West Bear Creek  
37 Unit, East Bear Creek Unit, Freitas Unit, Blue Goose Unit, and Kesterson Unit),  
38 and Grasslands Wildlife Management Area (Reclamation 2012; USFWS 2012b,  
39 2013b). The San Luis NWR Complex also includes the San Joaquin River NWR  
40 which is influenced by CVP operations; however, this refuge does not specifically  
41 receive CVP water under a contract. CVP water supplies are also provided to the  
42 Los Banos Wildlife Area; Volta Wildlife Area; Mendota Wildlife Area; and North  
43 Grasslands Wildlife Area (including China Island Unit and Salt Slough Unit)  
44 (Reclamation 2012b). In the southern San Joaquin Valley, the Kern and Pixley  
45 NWRs provide wildlife viewing opportunities.

1 *San Luis National Wildlife Refuge Complex*

2 The San Luis NWR Complex includes wetlands, riparian forests, native  
3 grasslands, and vernal pools (USFWS 2012a, 2012b). The refuge is a major  
4 wintering ground and migratory stopover point for a wide range of waterfowl,  
5 shorebirds, and other waterbirds. The refuge is host to significant assemblages of  
6 birds, mammals, reptiles, amphibians, insects, and plants, some of which, such as  
7 the California Tiger Salamander and San Joaquin Kit Fox, are endangered  
8 species. Riparian woodlands occur along rivers and sloughs with willow,  
9 cottonwood, and oak to support egrets, herons, cormorants, raptors, and songbirds  
10 (USFWS 2012b). Wetlands occur on over 25 percent of the San Luis NWR  
11 Complex lands and provide nesting habitat for coots, grebes, blackbirds, bitterns,  
12 ibis, and marsh wrens; and seasonal wetlands for ducks, geese, shorebirds, and  
13 other waterbirds. Grasslands occur on over 70 percent of the lands, including the  
14 native creeping wild Rye and alkali sacaton, to support elk, Black-Tailed Deer,  
15 Desert Cottontail Rabbit, Black-Tailed Jackrabbit, voles, and songbirds. Vernal  
16 pools occur in some areas during the spring, especially in the Kesterson NWR and  
17 West Bear Creek Unit. Artificial dens and other habitat structures have been  
18 constructed on the refuge, including nest boxes for songbirds, owls, and wood  
19 ducks; and dens for kit foxes (USFWS 2012a).

20 *San Luis National Wildlife Refuge*

21 The San Luis NWR contains approximately 26,800 acres of wetlands, riparian  
22 forests, native grasslands, and vernal pools (USFWS 2012c). Saline and alkaline  
23 conditions on portions of the upland habitat support a rich botanical community of  
24 native bunchgrasses, native and nonnative annual grasses, forbs, and native  
25 shrubs. Wintering habitat is provided for numerous waterbirds, including green-  
26 winged teal, northern shoveler, mallard, gadwall, wigeon, cinnamon teal, northern  
27 pintail, ring-necked, canvasback, and ruddy ducks; snow, Ross', and white-  
28 fronted geese. Shorebirds include sandpipers and plovers. Tule elk occur in the  
29 upland habitats.

30 *Merced National Wildlife Refuge*

31 The Merced NWR contains approximately 10,250 acres of wetlands, native  
32 grasslands, vernal pools and riparian areas (USFWS 2012d). In addition to  
33 providing breeding habitat for Swainson's Hawk, Tricolored Blackbird, Marsh  
34 Wren, and Burrowing Owl; the refuge is host to the largest wintering populations  
35 along the Pacific flyway of Lesser Sandhill Crane and Ross' Goose. Mammals  
36 such as coyote, Ground Squirrel, rabbit, and beaver are found year-round. Vernal  
37 pools are a component of the refuge and are home to many species of vernal pool  
38 plants and invertebrates as well as the California Tiger Salamander. Merced  
39 NWR also includes approximately 300 acres of cultivated corn and winter wheat  
40 crops and more than 500 acres of irrigated pasture for wildlife.

41 *San Joaquin River National Wildlife Refuge*

42 The San Joaquin River NWR encompasses approximately 7,000 acres located  
43 where Tuolumne, Stanislaus, and San Joaquin rivers join, creating a mix of  
44 habitats for terrestrial wildlife and plant species. Initially established to protect

1 and manage habitat for the Aleutian Cackling Goose, the refuge is currently  
2 managed to provide habitat for migratory birds and endangered wildlife species  
3 (USFWS 2012e, 2012f). The refuge includes a mosaic of valley oak riparian  
4 forest, riverine and slough habitats, seasonal and permanent wetlands, vernal  
5 pools, natural uplands, and agricultural fields. Over 500,000 native trees and  
6 shrubs such as willow, cottonwood, oak, blackberry, and rose have been planted  
7 across 2,200 acres of river floodplain within the refuge, creating the largest block  
8 of contiguous riparian woodland in the San Joaquin Valley. Endangered riparian  
9 brush rabbits have been re-introduced to this restored habitat from captive-reared  
10 populations. These woodlands also support a diversity of breeding songbirds  
11 including grosbeak, oriole, flycatcher, warbler, and Least Bell's Vireo; and a  
12 heron/egret rookery. The refuge also provides winter and migration habitat for  
13 Lesser Sandhill Cranes, Greater Sandhill Cranes, Snow Geese, Ross' Geese, and  
14 White-Fronted Goose.

15 Several nonnative invasive plants influence the quality of wildlife habitat on the  
16 refuge including yellow star thistle, perennial pepperweed, poison hemlock,  
17 Russian thistle, milk thistle, and bull thistle. According to the Comprehensive  
18 Conservation Plan for the refuge (USFWS 2006), infestations are greatest in  
19 fallow agricultural fields, roadsides, canal banks, and undergrazed pastures, as  
20 well as other disturbed sites. Perennial pepperweed is established throughout the  
21 riparian areas of the refuge and stands of giant reed are scattered along the banks  
22 of the San Joaquin River. Infestations of water hyacinth seasonally disrupt water  
23 delivery and create impenetrable surfaces in the streams, sloughs, oxbows,  
24 and canals.

#### 25 *Grasslands Wildlife Management Area*

26 The Grasslands Wildlife Management Area is composed entirely of privately  
27 owned lands with perpetual conservation easements to preserve wetland and  
28 grassland habitats, and wildlife-friendly agricultural lands along the San Joaquin  
29 River (GRCD 2014; USFWS 2013c). The Grassland Resource Conservation  
30 District, located within the western portion of the Wildlife Management Area,  
31 contains approximately 75,000 acres of private wetlands and associated  
32 grasslands, and over 30,000 acres of federal National Wildlife Refuges and State  
33 Wildlife Management Area. The area constitutes 30 percent of the remaining  
34 wetland habitat in the Central Valley and is a major wintering ground for  
35 migratory waterfowl and shorebirds of the Pacific Flyway.

36 Grassland Resource Conservation District provides habitat for waterfowl,  
37 shorebirds, wading birds, songbirds, raptors, and other wildlife species (GRCD  
38 2014; USFWS 2013c). The Grassland Resource Conservation District  
39 specifically manages a program to encourage production of natural food plants  
40 (such as swamp grass, smartweed, and watergrass). Habitats include seasonally  
41 flooded wetlands, moist soil impoundments, permanent wetland, irrigated pasture,  
42 and croplands.

1 *Los Banos Wildlife Area*

2 The Los Banos Wildlife Area, located approximately 4 miles northeast of Los  
3 Banos, contains more than 6,200 acres in the San Joaquin River floodplain and is  
4 dominated by seasonal wetlands (CDFW 2014a; Reclamation 2001b). Permanent  
5 and semi-permanent wetlands are also present, along with areas of riparian  
6 vegetation. The Los Banos Wildlife Area also supports native and nonnative  
7 grasslands. Irrigated pasture and croplands are maintained to provide food,  
8 resting, and nesting habitat for waterfowl and other wildlife. Western Pond  
9 Turtle, raccoon, Striped Skunk, beaver, muskrat, and mink; as well as over  
10 200 species of waterfowl, shore birds, upland game birds, and song birds occur  
11 seasonally throughout the area. Seasonal marshes provide habitat for a wide  
12 range of waterbirds, upland birds, and seasonal migrants, including American  
13 bittern, snowy egret, killdeer, American avocet, wood duck, and mallard.

14 *Volta Wildlife Area*

15 The Volta Wildlife Area consists of approximately 2,900 acres. The Wildlife  
16 Area is partially in the Grassland Resource Conservation District (CDFW 2014b;  
17 Reclamation et al. 2001b). The Wildlife Area supports permanent and seasonal  
18 wetlands and valley alkali shrub. Irrigated pasture and crops are grown to provide  
19 food and nesting cover for migratory waterfowl. Beaver, coyote, cottontail, and  
20 150 species of birds, including a wide range of waterfowl and shorebirds, are  
21 found on the Volta Wildlife Area.

22 *Mendota Wildlife Area*

23 The Mendota Wildlife Area contains more than 12,000 acres of flatlands and  
24 floodplain (Huddleston 2001; Reclamation et al. 2001b). The Mendota Wildlife  
25 Area has been managed primarily to provide seasonal wetland habitat. Water is  
26 used to irrigate natural food crops, such as swamp grass, alkali bulrush,  
27 smartweed, and millet, and to flood seasonal and semi-permanent wetlands.  
28 Small grains, corn, and pasture are also irrigated in the upland areas. The  
29 Wildlife Area has significant white-faced ibis and great-blue heron rookeries.  
30 Shorebirds, songbirds, raptors, waterfowl, and wading birds use the wetlands  
31 habitat. Mammals that use the refuge include coyote, muskrat, beaver, mink,  
32 raccoon, weasel, Black-Tailed jackrabbit, Cottontail Rabbit, Spotted Skunk,  
33 Striped Skunks, and Ground Squirrel.

34 *North Grasslands Wildlife Area*

35 The North Grasslands Wildlife Area includes the China Island, Salt Slough, and  
36 Galdwall units which encompass 7,069 acres of wetlands, riparian habitat, and  
37 uplands (CDFW 2014c). Restoration and enhancement actions have focused on  
38 increasing seasonal wetlands, permanent and semi-permanent wetlands, and  
39 riparian habitat on the unit, including habitat for the Swainson's hawk and  
40 sandhill crane.

41 The China Island Unit of the North Grasslands Wildlife Area borders the San  
42 Joaquin River southwest of the confluence with the Merced River (DFG 2011b).  
43 The Salt Slough Unit is located on the west side of Salt Slough, adjacent to the  
44 San Luis NWR Complex and Los Banos Wildlife Area. Before its acquisition,

1 the unit consisted mainly of irrigated pasture and was managed as a cattle ranch  
2 (DFG 2011c). Habitat on both units includes permanent wetlands that are flooded  
3 continuously; semi-permanent wetlands that are flooded in the spring and  
4 summer; moist soil vegetation to produce seeds and sustain invertebrates,  
5 including swamp timothy, watergrass, and smartweed; seasonal wetlands to  
6 provided flooded areas in the fall for waterfowl; riparian habitat, nesting habitat  
7 for resident breeding birds, including Short-Eared Owl, Northern Harrier, ducks,  
8 and pheasants; upland foraging areas; and pasture which provides late winter and  
9 early spring habitat for geese, and other habitat areas for sandhill crane,  
10 pheasants, and raptors.

#### 11 *Kern National Wildlife Refuge Complex*

12 The Kern NWR Complex consists of the Kern NWR and Pixley NWR (USFWS  
13 2013d). The Kern NWR contains approximately 11,249 acres including seasonal  
14 marsh; moist soil units; and uplands (e.g., grasslands, alkali playa, and valley sink  
15 scrub) (USFWS 2013e). Wetlands on the refuge are seasonal in nature. Fall  
16 flooding begins in mid-August, with a peak in flooded marsh habitat by January.  
17 This habitat is maintained through February, after which the wetland areas are  
18 slowly drained. Selected units are irrigated during late spring and early summer  
19 to encourage plants to grow, to provide food for wintering and migrating birds the  
20 following fall (USFWS 2013e). The refuge is the largest wetland area in the  
21 Southern San Joaquin Valley and plays a vital role in the Pacific Flyway for  
22 migrating waterfowl, shorebirds, and songbirds. Uplands occupy the northeastern  
23 and northwestern portions of the refuge, used by threatened and endangered  
24 species, such as San Joaquin Kit Fox, Tipton Kangaroo Rat, and Blunt-Nosed  
25 Leopard Lizard. Artificial dens have been built for endangered San Joaquin Kit  
26 Foxes and artificial burrows have been provided for Burrowing Owls.

27 The Pixley NWR contains 6,389 acres of grasslands, vernal pools, and playas  
28 along the historic Tulare Lake boundaries (USFWS 2014ak). The refuge includes  
29 approximately 300 acres of managed wetlands for waterfowl and shorebirds. San  
30 Joaquin Kit Fox, Blunt-Nosed Leopard Lizard, and Tipton Kangaroo rat use the  
31 upland areas. Vernal pools also occur on the refuge.

#### 32 **10.3.3.4 Delta, Suisun Marsh, and Yolo Bypass**

33 Historically, the natural Delta system was formed by water inflows from upstream  
34 tributaries in the Delta watershed and outflow to Suisun Bay and San Francisco  
35 Bay (SFEI 2012). Upstream of the Delta, during high Sacramento River flows,  
36 water spilled into the geologic formation known as the Yolo Basin which extends  
37 from Knights Landing Ridge upstream of the confluence between the Sacramento  
38 and Feather rivers to the confluence of Cache Slough and the Sacramento River in  
39 the Delta upstream of Rio Vista and Suisun Marsh. The Delta and Suisun Marsh  
40 have a complex web of channels and islands and is located at the confluence  
41 of the Sacramento and San Joaquin rivers. As described below in  
42 subsection 10.3.4.4.1, Yolo Bypass, is a 59,280-acre floodway through the Yolo  
43 Basin that was constructed as part of the Sacramento River Flood Control Project  
44 to protect the cities of Sacramento and West Sacramento and the north Delta from  
45 extreme flood events.



1 The Delta (as legally defined in the Johnston-Baker-Andal-Boatwright Delta  
2 Protection Act of 1992 [California Water Code section 12220]) covers  
3 737,358 acres, including 4,278 acres of the Suisun Marsh and 16,762 acres of the  
4 Yolo Bypass. Individually, the overall Delta, Suisun Marsh, and Yolo Bypass  
5 extend over 737,358 acres, 106,511 acres, and 59,280 acres, respectively. In total,  
6 the Delta, Suisun Marsh, and Yolo Bypass constitute a natural floodplain that  
7 covers approximately 882,200 acres and drains approximately 40 percent of the  
8 state (DWR 2009a).

9 As described in subsection 10.3.2, Overview of Species with Special Status, A  
10 listing of wildlife and plant species with special status that occur or may occur in  
11 portions of the study area affected by the long-term coordinated operation of the  
12 CVP and SWP is provided in Appendix 10A.

#### 13 **10.3.3.4.1 Delta and Suisun Marsh**

14 The Delta overlies the western portions of the Sacramento River and San Joaquin  
15 River watersheds. The Delta is a network of islands, channels, and marshland at  
16 the confluence of the Sacramento and San Joaquin rivers. Major rivers entering  
17 the Delta are the Sacramento River flowing from the north, the San Joaquin River  
18 flowing from the south, and eastside tributaries (Cosumnes, Mokelumne, and  
19 Calaveras rivers). Suisun Marsh is a tidally influenced brackish marsh located  
20 about 35 miles northeast of San Francisco in southern Solano County. It is a  
21 critical part of the San Francisco Bay/Sacramento–San Joaquin Delta (Bay-Delta)  
22 estuary ecosystem. The Delta, together with Suisun Marsh and greater San  
23 Francisco Bay, make up the largest estuary on the west coast of North and South  
24 America (DWR 2009a).

25 The Delta was once composed of extensive freshwater and brackish marshes, with  
26 tules and cattails, broad riparian thickets of scrub willows, buttonwillow, and  
27 native brambles. In addition, there were extensive riparian forests of Fremont  
28 cottonwood, valley oak, Oregon ash, boxelder, white alder, and Goodding’s black  
29 willow. Upland, non-riparian stands of valley oak and coast live oak occurred in  
30 a mosaic with seasonally flooded herbaceous vegetation, including vernal pools  
31 and alkali wetlands (SFEI 2012).

32 Substantial areas of the Delta and Suisun Marsh have been modified by  
33 agricultural, urban and suburban, and recreational land uses (Reclamation et al.  
34 2011; SFEI 2012). Over the past 150 years, levees were constructed in the Delta  
35 and Suisun Marsh to provide lands for agricultural, municipal, industrial, and  
36 recreational land uses. The remaining natural vegetation is fragmented, and  
37 largely restricted to the edges of waterways, flooded islands, and small protected  
38 areas such as parks, wildlife areas, and nature reserves (Hickson and Keeler-Wolf  
39 2007). A substantial portion of the emergent wetlands exists as thin strips along  
40 the margins of constructed levees (SFEI 2012). Current habitat along the Delta  
41 waterways includes seasonal wetlands, tidal wetlands, managed wetlands, riparian  
42 forests, and riparian scrub.

43 Seasonal wetlands historically had occurred along the riparian corridor at  
44 elevations that were inundated during high flow events. Many of the levees were

1 constructed along the riparian corridor edges; and therefore, historic seasonal  
2 wetlands were substantially modified (SFEI 2012). Adjacent areas of perennial  
3 wetlands on the water-side of the riparian corridor were modified as levees were  
4 constructed and channels enlarged. In many of these areas the perennial wetlands  
5 were replaced by seasonal wetlands. The vegetation of seasonal wetlands is  
6 typically composed of wetland generalist species that occur in frequently  
7 disturbed sites such as hyssop loosestrife, cocklebur, dallis grass, Bermuda grass,  
8 barnyard grass, and Italian ryegrass.

9 Alkali-related habitats occur near salt-influenced seasonal and perennial wetlands.  
10 Alkali seasonal wetlands occur on fine-textured soils that contain relatively high  
11 concentrations of dissolved salts. These types of soils are typically found at the  
12 historical locations of seasonal ponds in the Yolo Basin in and around the CDFW  
13 Tule Ranch Preserve, and upland in seasonal drainages that receive salts in runoff  
14 from upslope salt-bearing bedrock such as areas near Suisun Marsh and the  
15 Clifton Court Forebay. Alkali wetlands include saltgrass, alkali weed, saltbush,  
16 alkali heath, and iodine bush. Small stands of alkali sink scrub (also known as  
17 valley sink scrub) are characterized by iodine bush.

18 Tidal wetlands consist of tidal brackish wetlands that occur either as relatively  
19 substantial tracts of complex tidal wetlands, or in narrow bands of fringing tidal  
20 wetlands (Siegel et al. 2010a). Fringing tidal marsh exists along the outboard side  
21 exterior levees and generally has formed since diking for managed wetlands  
22 began. Fringing tidal wetlands vary in size and vegetation composition, exhibit  
23 less geomorphic complexity, and have a low area-to-edge ratio. Fringing marshes  
24 lack connection with the upland transition, are often found in small, discontinuous  
25 segments, and can limit movement of terrestrial marsh species.

26 Plant zones in complex tidal wetlands are influenced by inundation regime and  
27 salinity. Tidal wetlands can be divided into three zones: low marsh, middle  
28 marsh, and high marsh (Reclamation et al. 2011). The low tidal wetland zone is  
29 tidally inundated once or twice per day. At the lowest elevations, vegetation is  
30 inhibited by frequent, prolonged, often deep inundation and by disturbance by  
31 waves or currents. The dominant plant species are bulrushes. Other species  
32 occurring in the low tidal wetland zone are pickleweed, lowclub rush, common  
33 reed, and cattails. The low tidal wetland zone provides foraging habitat for  
34 waterfowl and shorebirds, California Ridgway's Rail, California Black Rail, and  
35 other wading birds.

36 The middle tidal wetland zone is tidally inundated at least once per day; there is  
37 relatively little cover and no refuge from higher tides, which completely flood the  
38 vegetation of the middle marsh. The dominant plant species are pickleweed,  
39 saltgrass, and bulrush. Other species occurring in the middle tidal marsh are  
40 fleshy jaumea, sea milkwort, rushes, salt marsh dodder, alkali heath, cattail,  
41 sneezeweed, and marsh gumplant (Siegel et al. 2010b). The middle tidal wetland  
42 zone provides foraging habitat for salt marsh harvest mouse and Suisun shrew, as  
43 well as common and special status bird species, including waterfowl and  
44 shorebirds, California Ridgway's Rail, California Black Rail, and other wading

1 birds. This zone also provides nesting and foraging habitat for Suisun Song  
2 Sparrow and Salt Marsh Common Yellowthroat (Reclamation et al. 2011).

3 The high tidal wetland zone receives intermittent inundation during the monthly  
4 tidal cycle, with the higher elevations being inundated during only the highest  
5 tides. Historically, the high marsh was an expansive transitional zone between the  
6 tidal wetlands and adjacent uplands. The high marsh and associated upland  
7 transition zone have been significantly affected by land use changes  
8 (e.g., managed wetlands, agriculture). The dominant plants are native species,  
9 such as saltgrass, pickleweed, and Baltic rush, and nonnative species, including  
10 perennial pepperweed, poison hemlock, and fennel. Other species occurring in  
11 the high tidal marsh are saltmarsh dodder, fleshy jaumea, seaside arrowgrass,  
12 alkali heath, brass button, and rabbitsfoot grass.

13 The high tidal marsh provides habitat for special status plants, including Suisun  
14 Marsh aster, Soft bird's beak, and Suisun thistle (Siegel et al. 2010b). The high  
15 marsh zone provides foraging and nesting habitat for waterfowl, shorebirds,  
16 California Ridgway's Rail, California Black Rail, and other birds. It also provides  
17 foraging and nesting habitat for special status species such as Salt Marsh Harvest  
18 Mouse and Suisun Shrew and provides escape cover for Salt Marsh Harvest  
19 Mouse, and Suisun Shrew during periods when the middle and lower portions of  
20 the high tidal wetland zone are inundated (Reclamation et al. 2011).

21 Managed wetlands are primarily located within the Suisun Marsh, Cache Slough,  
22 and near the confluence of the Mokelumne and Sacramento rivers within the  
23 historical limits of the high tidal marsh and adjacent uplands that were diked and  
24 leveled for agricultural purposes and later managed to enhance habitat values for  
25 specific wildlife species (CALFED 2000). Diked managed wetlands and uplands  
26 are the most typical land cover type in the Suisun Marsh area. Managed wetlands  
27 are considered seasonal wetlands because they may be flooded and drained  
28 several times throughout the year. Watergrass and smartweed are typically the  
29 dominant species in managed wetlands that use fresher water. Bulrush, cattail,  
30 and tule are the dominant species in managed wetlands that employ late  
31 drawdown management. Pickleweed, fat hen, and brass buttons are typical in the  
32 higher elevations of the managed wetlands. In marshes with higher soil salinity,  
33 pickleweed, saltgrass, and other salt-tolerant species are dominant. Managed  
34 wetlands are managed specifically as habitat for wintering waterfowl species,  
35 including Northern Pintail, Mallard, American Wigeon, Green-Winged Teal,  
36 Northern Shoveler, Gadwall, Cinnamon Teal, Ruddy, and Canvasback ducks;  
37 White-Fronted Goose, and Canada Goose. Some wetlands are also managed for  
38 breeding waterfowl, especially mallard.

39 Riparian forest areas (excluding willow-dominated riparian habitats) are still  
40 present in some portions of the Delta along many of the major and minor  
41 waterways, oxbows, and levees (CALFED 2000). Riparian forest and woodland  
42 communities dominated by tree species are mostly limited to narrow bands along  
43 sloughs, channels, rivers, and other freshwater features throughout the Delta.  
44 Isolated patches of riparian vegetation are also found on the interior of reclaimed  
45 Delta islands, along drainage channels, along pond margins, and in abandoned,

1 low-lying fields. Cottonwoods and willows, Oregon ash, boxelder, and California  
 2 sycamore, are the most typical riparian trees in central California. Valley oak and  
 3 black walnut are typical in riparian areas in the Delta. Riparian trees are used for  
 4 nesting, foraging, and protective cover by many bird species and riparian canopies  
 5 provide nesting and foraging habitat for a variety of mammals. Understory shrubs  
 6 provide cover for ground-nesting birds that forage among the vegetation and  
 7 leaf litter.

8 Riparian scrub in the Delta and Suisun Marsh consists of woody riparian shrubs in  
 9 dense thickets (SFEI 2012). Riparian scrub thickets are usually associated with  
 10 higher, sloping, better drained edges of marshes or topographic high areas, such  
 11 as levee remnants and elevated flood deposits; and along shorelines of ponds or  
 12 banks of channels in tidal or non-tidal freshwater habitats. Plant species may  
 13 include willow, blackberry, buttonbush, mulefat, and other shrub species.  
 14 Willow-dominated habitat types appear to be increasing in extent in recent years;  
 15 and willows line many miles of artificial levees where waterways historically had  
 16 flowed into freshwater emergent wetland. Nonnative Himalayan blackberry  
 17 thickets are a typical element of riparian scrub communities along levees and  
 18 throughout pastures in the levees. Willow thickets provide habitat for a wide  
 19 range of wildlife species, including the Song Sparrow, Lazuli Bunting, and Valley  
 20 Elderberry Longhorn Beetle.

#### 21 **10.3.3.4.2 Yolo Bypass**

22 The Yolo Bypass is a 59,280-acre floodway through the natural-overflow of the  
 23 Yolo Basin on the west side of the Sacramento River (DWR 2012). As described  
 24 in Chapter 5, Surface Water Resources and Water Supplies, the Yolo Bypass  
 25 generally extends north to south from Fremont Weir along the Sacramento River  
 26 (near Verona) to upstream of Rio Vista along the Sacramento River in the Delta.  
 27 The bypass, part of the Sacramento River Flood Control Project, conveys  
 28 floodwaters around the Sacramento River near the cities of Sacramento and West  
 29 Sacramento. The bypass is utilized as a flood bypass approximately once every  
 30 3 years, generally during the period from November to April. Land use in the  
 31 Yolo Bypass is generally restricted to specific agriculture, managed wetlands, and  
 32 vegetation communities to ensure that floodway function is maintained (CALFED  
 33 et al. 2001; USFWS 2002). Agricultural crops include corn, tomatoes, melons,  
 34 safflower, and rice within the northern bypass; and corn, milo, safflower, beans,  
 35 tomatoes, and sudan grass in the southern bypass. Waterfowl hunting areas are  
 36 generally located in the southern bypass, and include rice fields, permanent open  
 37 water, or a mixture of water and upland habitat. The USACE has developed  
 38 criteria for managing emergent vegetation (e.g., cattails and bulrushes) in the  
 39 Yolo Bypass to maintain flood capacity, including no more than 5 percent of the  
 40 vegetation in seasonal wetlands can be emergent wetlands; no more than  
 41 50 percent of the vegetation in permanent wetlands can be emergent wetlands;  
 42 and riparian vegetation can only occur in specified areas to maintain flood  
 43 capacity (DFG and Yolo Basin Foundation 2008).

44 The Yolo Bypass supports several major terrestrial vegetation types, including  
 45 riparian woodland, valley oak woodland, open water, and wetland. Historically,

1 riparian woodland and freshwater wetland were the dominant habitat types in the  
2 Yolo Basin (CALFED et al. 2001; USFWS 2002). Currently, riparian woodland  
3 and associated riparian scrub habitats are primarily found adjacent to Green's  
4 Lake, Putah Creek, and along the East Toe Drain within the Yolo Bypass Wildlife  
5 Area. Riparian woodland is a tree-dominated community found adjacent to  
6 riparian scrub on older river terraces where flooding frequency and duration is  
7 less. Riparian woodlands include Fremont cottonwood, valley oak, sycamore,  
8 willow, eucalyptus, giant reed, and black oak. The understory is typically sparse  
9 in this community with limited areas of California grape, blackberry, poison oak,  
10 mugwort, grasses, and forbs. The woodland canopy provides habitat for hawks,  
11 owls, American Crow, Great Egret, Great Blue Heron, Red-Tailed Kite, Yellow-  
12 Rumped Warbler, Black Phoebe, woodpecker, Wood Duck, bat, and raccoon.

13 Riparian scrub is a shrub-dominated community typically found along stream  
14 margins and in the streambed, on gravel bars and similar formations (CALFED et  
15 al. 2001; USFWS 2002). This community is typically dominated by  
16 phreatophytes (i.e., deep-rooted plants that obtain their water from the water table  
17 or the layer of soil just above it), such as willows, and other plants representative  
18 of early- to mid-successional stage vegetation communities within riparian areas  
19 in the Central Valley. The species include alder, elderberry, cottonwood, wild  
20 rose, blackberry, and boxelder. This habitat supports Black-Crowned Night  
21 Heron, Snowy Egret, Belted Kingfisher, Black Phoebe, Swallow, and bat.  
22 Riparian scrub habitat frequently occurs adjacent to nonwoody riparian habitat,  
23 including false bamboo, cocklebur, weedy annual grasses, sedges, rushes,  
24 mustard, sweet clover, thistle, and other weedy species. The nonwoody riparian  
25 habitat supports Savannah Sparrow, House Finch, American Goldfinch,  
26 California Ground Squirrel, Gopher Snake, and pond turtle.

27 Remnants of valley oak woodlands and savanna occur on floodplain terraces in  
28 fragmented areas, including downstream of Fremont Weir and along the southern  
29 portion of the Toe Drain (CALFED et al. 2001). The habitat also includes  
30 sycamore, black walnut, wild grape, poison oak, elderberry, blackberry, grass,  
31 and sedge.

32 Depending on the duration of inundation, local soil factors, site history, and other  
33 characteristics, seasonal wetlands typically are dominated by species  
34 characteristic of one of three natural wetland communities: freshwater marshes,  
35 alkali marshes, or freshwater seasonal (often disturbed) wetlands (CALFED et al.  
36 2001). Freshwater marsh communities are typically found in areas subjected to  
37 prolonged flooding during the winter months, and frequently do not dry down  
38 until early summer. Permanent open water is found throughout the Yolo Bypass,  
39 including Gray's Bend near Fremont Weir, Green's Lake near Interstate 80, ponds  
40 in the Yolo Bypass Wildlife Area, along Cache and Prospect sloughs, and within  
41 canals and drainage ditches. The wetlands support duck breeding habitat; and  
42 habitat for many lifestages of grebe, ibis, heron, egret, bittern, coot, rails, raptors,  
43 muskrat, raccoon, opossum, beaver, Ring-Necked Pheasant, garter snake, Pacific  
44 Tree Frog, and bullfrog.

1 Managed wetlands in the Yolo Bypass occur near Fremont Weir, in the  
2 16,770-acre Yolo Bypass Wildlife Area, and within and near Cache Slough. The  
3 managed wetlands are generally flooded in the fall, with standing water  
4 maintained continuously throughout the winter until drawdown occurs in the  
5 following spring (CALFED et al. 2001; DFG and Yolo Basin Foundation 2008).  
6 A primary objective of seasonal wetland management is to provide an abundance  
7 and diversity of seeds, aquatic invertebrates, and other foods for wintering  
8 waterfowl and other wildlife. The wetlands also are managed to control the extent  
9 of tules and cattails; and more recently, water hyacinth. A portion of the managed  
10 wetlands occur within rice fields which are flooded in the winter to provide  
11 waterfowl habitat for feeding and resting habitats. A variety of annual plants  
12 germinate on the exposed mudflats of seasonal wetlands during the spring draw  
13 down, including swamp timothy, watergrass, smartweed, and cocklebur. These  
14 plants are then managed through the timing, duration or absence of summer  
15 irrigation. The mudflats support sandpiper, plover, avocet, stilt, and other  
16 shorebirds.

17 Managed semi-permanent wetlands, commonly referred to as “brood ponds,” are  
18 flooded during the spring and summer, but may experience a 2 to 6 month dry  
19 period each year. These semi-permanent wetlands provide breeding ducks,  
20 ducklings, and other wetland wildlife with protection from predators and  
21 abundant invertebrate food supplies (DFG and Yolo Basin Foundation 2008).  
22 Permanent wetlands remain flooded throughout the year. Due to year-round  
23 flooding, permanent wetlands support a diverse, but usually not abundant,  
24 population of invertebrates. Permanent managed wetlands provide deep water  
25 habitat for diving ducks, such as Ruddy Duck, Scaup, and Goldeneye; and other  
26 water birds, including Pied-Billed Grebe, coot, and moorhen. They often have  
27 dense emergent cover on their edges that is the preferred breeding habitat for  
28 Marsh Wren and Red-Winged Blackbird; and roosting habitat for Black-Crowned  
29 Night Heron, White-Faced Ibis, and egret.

30 The managed wetlands are operated by private hunting clubs; private conservation  
31 entities, including conservation banks; and the Federal and state governments  
32 (CALFED et al. 2001). Some of the hunting clubs have implemented wetland  
33 management agreements with CDFW under the State Presley Program or Wetland  
34 Easement Program to coordinate the timing and patterns of flooding, drawdowns,  
35 irrigation, soil disturbance, and maintenance of brood habitat. The patterns may  
36 be adjusted annually to respond to specific wildlife and hydrologic needs. A  
37 similar program focused on providing spring habitat for breeding is provided by  
38 the Federal Waterbank Program.

39 Habitat in the Yolo Bypass is affected by periodic flooding (CALFED et al.  
40 2001). Following a flood, roads, canals, and ditches may need to be excavated;  
41 debris needs to be removed from habitat, and water delivery facilities may need to  
42 be repaired. Flooding also disrupts nesting and resting activities of birds. During  
43 floods, hunting activities are diminished or ceased.

1     **10.3.3.4.3 Agricultural Lands in the Delta, Suisun Marsh, and Yolo Bypass**

2     Major crops and cover types in agricultural production in the Delta and Suisun  
3     Marsh include small grains (wheat and barley), field crops (corn, sorghum, and  
4     safflower), truck crops (tomato and sugar beet), forage crops (hay and alfalfa),  
5     pastures, orchards, and vineyards. The distribution of seasonal crops varies  
6     annually, depending on crop rotation patterns and market forces. In many areas,  
7     cropping practices result in monotypic stands of vegetation for the growing  
8     season and bare ground in fall and winter. Some farmland is more intensively  
9     managed to provide wildlife habitat in addition to crops. Regular maintenance of  
10    fallow fields, roads, ditches, and levee slopes can reduce the establishment of  
11    ruderal vegetation or native plant communities.

12    Agriculture has been present in the Yolo Bypass since the seasonal wetlands and  
13    perennial marsh and riparian areas were first converted to farms in the mid-1800s.  
14    For many years, grazing was the primary use of agricultural lands in the Yolo  
15    Bypass. In the latter part of the 20th century, irrigation systems were developed  
16    and fields were engineered for the production of row crops (DFG and Yolo Basin  
17    Foundation 2008). Periodic flooding of the bypass limits the types of crops that  
18    can be grown. The Yolo Bypass Wildlife Area utilizes agriculture to manage  
19    habitats while providing income for the management and operation of the  
20    property. Working with local farmers, the Yolo Bypass Wildlife Area provides  
21    fields of milo, corn, and Sudan grass specifically for wildlife forage. Rice is  
22    grown, harvested, and flooded to provide food for thousands of waterfowl. Corn  
23    fields are harvested to provide forage for geese and cranes. Crops such as  
24    safflower are cultivated and mowed to provide seed for upland species such as  
25    Ring-Necked Pheasant and Mourning Dove. Row and truck crops are grown  
26    across the northern half of the Yolo Bypass Wildlife Area. The primary crops  
27    grown include rice, corn, millet, milo, safflower, sunflower, and tomatoes. These  
28    crops are cultivated during the summer months. From fall to spring, some farmed  
29    areas are fallowed and flooded to provide forage for wildlife as well as seasonal  
30    wetland habitat. An extensive area at the southern end of the wildlife area is used  
31    for grazing cattle. Cattle are brought onto the Yolo Bypass Wildlife Area in mid-  
32    spring or early summer after the threat of flooding has passed and are removed by  
33    January. Forage is provided in irrigated pasture, uplands within the bypass and  
34    the annual grassland-vernal pool complex. Alfalfa is only grown in the western  
35    portion of the bypass south of Interstate 80, along with a variety of row crops that  
36    are grown in this region (Yolo County 2013).

37    **10.3.3.4.4 Wildlife Refuges in the Delta, Suisun Marsh, and Yolo Bypass**

38    A number of wildlife areas that could be affected by changes in long-term  
39    operations of CVP and SWP are located in the Delta, Suisun Marsh, and Yolo  
40    Bypass. Conditions in the Yolo Bypass, including the Yolo Bypass Wildlife  
41    Area, are described above and not repeated in this subsection.

42    *Stone Lakes National Wildlife Refuge*

43    The Stone Lakes NWR is located in the Beach-Stone Lakes Basin about 10 miles  
44    south of the city of Sacramento. It was established in 1994 and the refuge area is

1 approximately 18,000 acres, of which about 9,000 acres is in a core refuge area  
2 owned by the USFWS and an approximately 9,000-acres “Cooperative Wildlife  
3 Management Area” where the USFWS seeks to enter into cooperative agreements  
4 or purchase conservation easements from willing landowners. The USFWS  
5 actively manages around 6,000 acres on the refuge (USFWS 2007).

6 The refuge vegetative communities include agricultural lands, open water,  
7 perennial freshwater wetlands, cottonwood-willow riparian, irrigated pasture and  
8 wet meadow, managed permanent and seasonal wetland, orchards, riparian scrub,  
9 upland forest, valley oak riparian woodland, vernal pool, and grasslands that  
10 facilitate wildlife movement and help compensate for habitat fragmentation and  
11 buffers the effects of urbanization on agricultural lands in the Delta region  
12 (USFWS 2007).

13 The diverse vegetation provides habitat for a wide ranges of mammals, birds,  
14 reptiles, and amphibians similar to those described for other sections of the  
15 Sacramento Valley (USFWS 2007). The grasslands, pastures, woodlands support  
16 White-Faced Ibis, Geese, Black-Bellied Plover, Great Blue Heron, Great Egret,  
17 Greater Sand Hill Crane, Northern Harrier, White-Tailed Kite, Red-Shouldered  
18 Hawk, Swainson’s Hawk, Great Horned Owl, Barn Owl, Bald Eagle, Golden  
19 Eagle, American Kestrel, Prairie Falcon, Tree Swallow, Barn Swallow, Cliff  
20 Swallow, songbirds, and birds that use the grasslands, including killdeer, Ring-  
21 Necked Pheasant, Burrowing Owl, Mourning Dove, Brewer’s Blackbird, and  
22 Turkey Vulture. The waterfowl species include Tundra Swan, White-Fronted  
23 Goose, Snow Goose, Canada Goose, Mallard, Northern Pintail, Northern  
24 Shoveler, Cinnamon Teal, Green-Winged Teal, Wood, and Ruddy ducks. The  
25 wetland areas also support Common Yellowthroat, Red-Winged Blackbird, Marsh  
26 Wren, coot, Cormorant, and American White Pelican. Other wildlife species on  
27 this refuge include coyote, Deer Mouse, Pocket Gopher, Black Tailed Hare,  
28 California Vole, California Ground Squirrel, Pacific Tree Frog, bullfrog, pond  
29 turtle, Pond Slider Turtle, Western Fence Lizard, Western Terrestrial Garter  
30 Snake, Gopher Snake, Common Garter Snake, California King Snake, and  
31 Western Toad.

32 The riparian cottonwood forests include Fremont cottonwood, Gooding’s willow,  
33 California grape, California boxelder, California blackberry, white-stemmed  
34 raspberry, buttonbush, and blue elderberry. The mixed riparian forest includes  
35 valley oak with vegetation similar to the riparian cottonwood forest but at lower  
36 densities. The valley oak riparian forest is dominated by valley oak, Oregon ash,  
37 California sycamore, and California black walnut with an understory of grasses,  
38 vines, and shrubs, including California blackberry and wild rose. The perennial  
39 wetlands include cattails, tules, cottonwood, willows, sedges, and rushes with  
40 areas of watergrass, smartweed, and swamp timothy that also occur in seasonal  
41 wetlands. The riparian vegetation provides vast amounts of insects, perches, and  
42 cover to support the wide range of bird species, the valley oak woodlands provide  
43 acorns, insects, and perch and nesting sites. The wetland sites provide foraging  
44 opportunities for waterbirds and upland species.



1 *Miner Slough Wildlife Area*

2 The Miner Slough Wildlife Area within the Delta is about 10 miles north of Rio  
3 Vista at the junction of Miner and Cache sloughs and is accessed by boat (CDFW  
4 2014d). The 37-acre Wildlife Area includes approximately 10 acres of tidal  
5 wetlands which become a narrow peninsula extending from Prospect Island at low  
6 tide. The riparian vegetation of willow, cottonwood, tules, and blackberry  
7 support a wide range of wildlife species including beaver, black-crowned night  
8 heron, and waterfowl.

9 *Decker Island Wildlife Area*

10 Decker Island is a 648-acre island located about 20 feet above sea level  
11 surrounded by the Sacramento River and Horseshoe Bend in the Delta just south  
12 of Rio Vista (DWR 2003; Philipp 2005). The island was created between 1917  
13 and 1937 as part of the actions to implement the Sacramento Deep Water Ship  
14 Channel, as described in Chapter 5, Surface Water Resources and Water Supplies.  
15 CDFW owns the northernmost 33 acres of Decker Island and has been working  
16 with the California Department of Water Resources (DWR) to reestablish and  
17 enhance wetland and upland habitats. The vegetation includes shallow water  
18 channels lined with thick stands of tules, sedges, willow, and alder. Many  
19 mammal species have been observed, including river otter, mink, beaver, coyote,  
20 mice, and voles. Various species of raptors, waterfowl, songbirds, and shorebirds  
21 have also been observed. Amphibians and reptiles such as Pacific Tree Frog,  
22 Western Fence Lizard, and Gopher Snake have been seen. Invasive plants such as  
23 perennial pepperweed, yellow star thistle, water hyacinth, Brazilian water weed  
24 and *Egeria* continue to pose a threat to restoration efforts.

25 *Lower Sherman Island Wildlife Area*

26 The Lower Sherman Island Wildlife Area occupies roughly 3,100 acres, primarily  
27 marsh and open water, at the confluence of the Sacramento and San Joaquin  
28 Rivers in the western Delta (DFG 2007). Riparian vegetation is characterized by  
29 narrow linear strips of trees and shrubs, in single-to multiple story canopies.  
30 Riparian vegetation primarily occurs along the historic levees above elevations  
31 that support tidal marsh. Native woody plant species occurring in the riparian  
32 strip include Fremont cottonwood, willow, red alder, and California wild rose.  
33 The invasive nonnative, Himalayan blackberry infests many of these areas.  
34 Marsh vegetation includes both emergent marsh and areas of floating aquatic  
35 vegetation. Most emergent marsh is dominated by bulrush, cattail, and common  
36 reed. In the northwestern portion of Lower Sherman Island, there is also upper  
37 elevation marsh dominated by pickleweed and saltgrass. Grasslands are  
38 dominated by annual grasses, but also include many perennial species that are  
39 also typical in seasonal wetlands. Pampas grass and perennial pepperweed,  
40 two invasive nonnative species are also found in the grassland areas.

41 At the Lower Sherman Island Wildlife Area, habitat exists for a wide variety of  
42 wildlife species, including numerous bird species, mammals, reptiles, and  
43 amphibians (DFG 2007). Many of the bird species that occur in the wildlife area  
44 are migratory and are there only, or primarily, during the fall and winter months.  
45 Wintering birds include waterfowl, shorebirds, wading birds, and raptors. Other

1 groups that utilize the wildlife area seasonally include upland game species,  
2 cavity-nesting birds, and neotropical migratory birds. Typical mammal species  
3 found in the upland grassland and disturbed areas of the wildlife area include  
4 Striped Skunk, raccoon, squirrel, voles, Pocket Gopher, feral cats, fox, and  
5 coyote. Muskrat and beaver may be found in the marsh vegetation. Typical  
6 reptiles and amphibians include Western Fence Lizard, snake, frog, and toad.

#### 7 *Rhode Island Wildlife Area*

8 Rhode Island Wildlife Area is a 67-acre island, located in Contra Costa County  
9 that is managed by CDFW (CDFW 2014e). The vegetation along the perimeter of  
10 the island includes alder, willow, blackberry, and tule. The interior open water  
11 areas include marsh vegetation of tule and cattail. The island provides habitat for  
12 river otters, beaver, muskrat, and many species of birds including Great Blue  
13 Heron; Black-Crowned Night Heron; egrets; and Mallard, Cinnamon Teal, and  
14 Wood ducks.

#### 15 *White Slough Wildlife Area*

16 The White Slough Wildlife Area, west of Lodi and north of Stockton, is an  
17 880-acre area refuge with open water, freshwater marsh, grassland/upland area,  
18 and riparian habitats (CDFW 2014f). The area supports upland game birds such  
19 as Ring-Necked Pheasant, California Quail, Mourning Dove, and a range of  
20 waterfowl species similar to those described for the Delta and Yolo Bypass.

#### 21 *Hill Slough Wildlife Area*

22 Hill Slough Wildlife Area, located in the northern part of Suisun Marsh, is  
23 operated by CDFW and contains 1,723 acres of saltwater tidal marsh, managed  
24 marshes, slough, and upland grassland (CDFW 2014g). The area supports a wide  
25 variety of waterfowl, including Northern Pintail, Mallard, Northern Shoveler, and  
26 Green-Winged Teal ducks; and American wigeon. Ferruginous Hawks and  
27 Rough-Legged Hawks winter in the area while year-round residents such as  
28 Golden Eagle, Northern Harrier, and Red-Tailed Hawk which forage over the  
29 ponds and upland areas. Mammals including raccoon, jackrabbit, and voles are  
30 found here and are preyed upon by the coyotes that hunt and live in the wildlife  
31 area.

#### 32 *Grizzly Island Wildlife Area*

33 Grizzly Island Wildlife Area is administered by CDFW and consists  
34 approximately 15,300 acres of tidal wetlands and managed marshes within Suisun  
35 Marsh (CDFW 2014h, 2014i). The CDFW manages waterways to create more  
36 than 8,500 acres of seasonal ponds containing alkali bulrush and fat-hen. Grizzly  
37 Island Wildlife Area includes habitats that support Northern Pintail Duck, Green-  
38 Winged Teal Duck, American Widgeon, Tule Goose, egret, Great Blue Heron,  
39 Snowy Egret, Black-Crowned Night Heron, Yellowthroat, Marsh Wren, Suisun  
40 Song Sparrow, American White Pelican, Ferruginous Hawk, Sharp-Shinned  
41 Hawk, white Tailed Kite, Red-Tailed Hawk, Prairie Falcon, Peregrine Falcon,  
42 Northern Harrier, and Short-Eared Owl. The Grizzly Island Wildlife Area also  
43 supports mammals, including Plush River Otter and Tule Elk.

1 *Point Edith Wildlife Area*

2 Point Edith Wildlife Area is located in Contra Costa County, approximately  
3 2.5 miles east of Martinez. The Point Edith Wildlife Area includes approximately  
4 760 acres of marshes which is accessed by boat. The habitat includes open water  
5 and tidal wetlands that support waterfowl, including coot and moorhen (CDFW  
6 2014j).

7 *Fremont Weir Wildlife Area*

8 The Fremont Weir Wildlife Area is located within the Yolo Bypass from the  
9 Sacramento River to downstream of the Fremont Weir. During high flows, water  
10 from the Sacramento River flows into the Yolo Bypass over the Fremont Weir as  
11 part of the Sacramento River Flood Control Project, as described in Chapter 5,  
12 Surface Water Resources and Water Supplies. The 1,461-acre refuge includes  
13 valley oak, willow, cottonwood, brush, and weedy vegetation (CDFW 2014k).  
14 The area supports pheasant, Valley Quail, Mourning Dove, a range of waterfowl  
15 species similar to those described for the Yolo Bypass, Cottontail Rabbit, and  
16 jackrabbit.

17 *Sacramento Bypass Wildlife Area*

18 The Sacramento Bypass Wildlife Area is located along a channel that connects the  
19 Sacramento River to the Yolo Bypass. During high flows, water from the  
20 Sacramento River flows into the Yolo Bypass through the Sacramento Bypass as  
21 part of the Sacramento River Flood Control Project, as described in Chapter 5,  
22 Surface Water Resources and Water Supplies. The 360-acre refuge includes  
23 valley oak, willow, cottonwood, and weedy vegetation (CDFW 2014l). The area  
24 supports raptors, songbirds, pheasant, Mourning Dove, and a range of mammal  
25 species similar to those described for the Yolo Bypass.

26 *Calhoun Cut Ecological Reserve*

27 The Calhoun Cut Ecological Reserve is located within the Cache Slough area and  
28 is only accessed by boat through Lindsay Slough (CDFW 2014m). Vegetation in  
29 Calhoun Cut includes grasslands, marshes, and riparian vegetation (Witham and  
30 Karacfelas 1994). The grasslands include native purple needlegrass grasslands  
31 and vernal pools.

32 **10.3.4 San Francisco Bay Area Region**

33 The San Francisco Bay Area Region includes portions of Contra Costa, Alameda,  
34 Santa Clara, San Benito, and Napa counties that are within the CVP and SWP  
35 service areas. The CVP and SWP water supplies are used in the San Francisco  
36 Bay Region by Contra Costa Water District, East Bay Municipal Utility District,  
37 Zone 7 Water Agency, Alameda County Water District, Santa Clara Valley Water  
38 District, San Benito County Flood Control and Water Conservation District, and  
39 Napa County Flood Control and Water Conservation District. The majority of the  
40 CVP and SWP water uses in the San Francisco Bay Area Region are for  
41 municipal and industrial land uses. Agricultural areas that use CVP and SWP  
42 water are located within coastal valleys, especially within the Livermore-Amador

1 valleys of Alameda County, southern Santa Clara County, and northern San  
2 Benito County.

3 Many of these agencies store the CVP and/or SWP water supplies in surface  
4 water reservoirs, including CVP Contra Loma and San Justo reservoirs; the SWP  
5 Bethany Reservoir and Lake Del Valle; the Contra Costa Water District Los  
6 Vaqueros Reservoir; and the East Bay Municipal Utility District Upper San  
7 Leandro, San Pablo, Briones, and Lafayette reservoirs and Lake Chabot. CVP  
8 and SWP are generally not stored in reservoirs within Santa Clara County  
9 (SCVWD 2010). Operation of the reservoirs is dependent upon the volume of  
10 CVP and/or SWP water blended with other water supplies used by these agencies.  
11 Surface water streams are not used to convey the water from the CVP and/or SWP  
12 facilities to the reservoirs. As described in subsection 10.3.2, Overview of  
13 Species with Special Status, A listing of wildlife and plant species with special  
14 status that occur or may occur in portions of the study area affected by the long-  
15 term coordinated operation of the CVP and SWP is provided in Appendix 10A.

16 The USFWS has approved two habitat conservation plans in the areas served by  
17 CVP and SWP water supplies, including the East Contra Costa County Habitat  
18 Conservation Plan/Natural Community Conservation Plan and the Santa Clara  
19 Valley Habitat Plan (ECCCHCPA 2006; Reclamation et al. 2009; Santa Clara  
20 County et al. 2012).

#### 21 **10.3.4.1 Central Valley Project Reservoirs**

22 The CVP reservoirs in the San Francisco Bay Area Region include Contra Loma  
23 and San Justo reservoirs.

##### 24 **10.3.4.1.1 Contra Loma Reservoir**

25 The Contra Loma Reservoir is a CVP facility in Contra Costa County that  
26 provides offstream storage along the Contra Costa Canal, as described in  
27 Chapter 5, Surface Water Resources and Water Supplies. The 80-acre reservoir is  
28 part of 661-acre Contra Loma Regional Park and Antioch Community Park  
29 (Reclamation 2014a). The Contra Loma Reservoir area includes open space and  
30 recreation facilities. In the open space, vegetative communities include  
31 grasslands, blue oak woodland, valley foothill riparian, fresh emergent wetlands,  
32 riverine, and open water communities. The annual grasslands include smooth  
33 brome, slender wild oats, Italian ryegrass, yellow star thistle, white-stem filaree,  
34 and mouse-ear chickweed. Valley foothill riparian occurs along intermittent  
35 streams and includes valley oaks, cottonwoods, red willows, Himalayan  
36 blackberry, poison oak, and mulefat. The riverine and fresh emergent wetland  
37 communities include ryegrass, curly dock, hyssop, loosestrife, Baltic rush,  
38 flowering quillwort, cattails, rushes, dallis grass, nutsedge, and cocklebur.  
39 Watermilfoil occurs along portions of the shoreline. Recreation areas include  
40 urban trees with Oregon ash, black walnut, Fremont cottonwood, blue oak, valley  
41 oak, interior live oak, fig, and eucalyptus. East Bay Regional Parks District has  
42 initiated restoration actions to improve native grasslands and riparian and provide  
43 habitat for quail.

1 Wildlife in the grasslands areas include Burrowing Owl, Horned Lark, Western  
2 Meadowlark, Turkey Vulture, Northern Harrier, American Kestrel, White-Tailed  
3 Kite, Red-Tailed Hawk, Brewer’s Blackbird, Mourning Dove, Western Fence  
4 Lizard, Common Garter Snake, Western Rattlesnake, Black-Tailed Jackrabbit,  
5 California Ground Squirrel, Botta’s Pocket Gopher, Western Harvest Mouse,  
6 California Vole, American Badger, Mule Deer, and coyote (Reclamation 2014a).  
7 The valley foothill riparian and blue oak woodland vegetation support a wide  
8 range of birds including Northern Flicker, Yellow Warbler, Acorn Woodpeckers,  
9 Western Scrub Jay, White-Tailed kite, Cooper’s Hawk, Red-Shouldered Hawk,  
10 American Kestrel, Great Horned Owl, Song Sparrow, Black Phoebe, European  
11 Starling, Western Bluebird, and Tree Swallow. The valley foothill riparian and  
12 blue oak woodland vegetation also support Pacific Tree Frog, Red-legged Frog,  
13 Sharp-Tailed Snake, California Alligator Lizard, Common Garter Snake, Mule  
14 Deer, Raccoon, Coyote, Striped Skunk, Deer Mouse, Harvest Mouse, Dusky-  
15 Footed Woodrat, and Gray Fox. Riverine and wetlands, and open water support  
16 Brewer’s Blackbird, Red-Winged Blackbird, Brown-Headed Cowbird, Great Blue  
17 Heron, Great Egret, ducks, American Coot, Common Merganser, Double-Crested  
18 Cormorant, American Wigeon, Canada Goose, Western Grebe, and gull; Pacific  
19 Tree Frog, Red-legged Frog, Bullfrog, California Tiger Salamander, Western  
20 Pond Turtle, Western Toad, and Garter Snake; Deer Mouse, California Vole,  
21 Long-Tailed Weasel, and other mammals that use the adjacent woodlands  
22 and grasslands.

23 **10.3.4.1.2 San Justo Reservoir**

24 The San Justo Reservoir is a CVP facility in San Benito County that provides  
25 offstream storage as part of the San Felipe Division, as described in Chapter 5,  
26 Surface Water Resources and Water Supplies. The reservoir is surrounded by  
27 steep hills with recreational facilities on the northeast side reservoir and  
28 intermittent streams, wetlands, and open water downslope of the reservoir  
29 (SBCWD 2012). Adjacent land uses are dominated by irrigated row crops,  
30 orchards, and rangeland. Vegetation and wildlife resources of the reservoir area  
31 are consistent with grasslands vegetation on uplands.

32 **10.3.4.2 State Water Project Reservoirs**

33 Bethany Reservoir, Patterson Reservoir, and Lake Del Valle are SWP facilities  
34 associated with the South Bay Aqueduct in Alameda County, as described in  
35 Chapter 5, Surface Water Resources and Water Supplies.

36 Vegetative communities around Bethany Reservoir are characterized by nonnative  
37 grasses with several areas of woodland habitat (DWR 2014). The grassland  
38 habitat includes slender oat, ripgut brome, soft chess, wild barley, Italian ryegrass,  
39 black mustard, bull thistle, redstem filaree, dissected geranium, English plantain,  
40 and tumble mustard; and forbs, including sweet fennel, Great Valley gumweed,  
41 Mediterranean linseed, and Ithuriel’s spear. The woodland habitat includes white  
42 ironbark, Casuarina, and Bishop pine. Coyote bush occurs along the water edge.  
43 The grasslands provide habitat for Mourning Dove, Western Scrub-Jay, Finches,  
44 Sparrows, Owls, Hawks, California Ground Squirrel, Black-Tailed Jackrabbit,

1 Audubon's Cottontail, Botta's Pocket Gopher, California vole, mice, frogs, toads,  
2 salamanders, snakes, lizards, and turtles. The woodlands support Red-Tailed  
3 Hawk, Osprey, Owls, Black Phoebe, Bullock's Oriole, Yellow Warbler,  
4 amphibians and reptiles, and coyote. Emergent vegetation does not occur along  
5 the shoreline at Bethany Reservoir (DWR 2005).

6 Patterson Reservoir is a small, 100-acre-foot, SWP reservoir located along the  
7 South Bay Aqueduct between Bethany Reservoir and Lake Del Valle. Vegetation  
8 around Patterson Reservoir is characterized by grasslands and upland habitat.  
9 Red-legged Frog has been observed in the vicinity of Patterson Reservoir (DWR  
10 2014).

11 Lake Del Valle is a 77,100 acre-foot SWP facility located along the South Bay  
12 Aqueduct (DWR 2001). Vegetation around Lake Del Valle includes grasslands,  
13 chaparral, shrub, oak woodland, and riparian and freshwater habitats (EBRPD  
14 1996, 2001, 2012, 2013). The grasslands include nonnative grasses and native  
15 perennial bunchgrass. The nonnative grasslands include grasses such as wild  
16 oats, bromes, ryegrass, wild barley, silver hairgrass, and dogtail grass; forbs,  
17 including filaree, clover, and plantain; and lupine, yarrow, and soap plant. Native  
18 grasses include annual and perennial fescues, needlegrass, wild ryes, junegrass,  
19 and California brome. The coastal scrub and chaparral vegetation includes  
20 coyote brush-scrub, California sagebrush, manzanita, black sage, cream bush,  
21 California coffeeberry, yerba santa, blackberry, bush monkeyflower, and poison  
22 oak. The oak woodlands and riparian woodlands include coast live oak, black  
23 oak, valley oak, scrub oak, California bay, and California buckeye. Mixed  
24 deciduous riparian woodlands occur along perennial streams, including white  
25 alder, big-leaf maple, western sycamore, willow, and Fremont cottonwood.  
26 Along springs and seeps, the vegetation includes rabbitsfoot grass, saltgrass,  
27 bentgrasses, rushes, tules, sedges, horsetails, and cattail, buttercup, brass-button,  
28 mint, duckweed, pondweed, and ferns.

#### 29 **10.3.4.3 Contra Costa Water District Los Vaqueros Reservoir**

30 Los Vaqueros Reservoir is a Contra Costa Water District offstream storage  
31 facility in Contra Costa County, as described in Chapter 5, Surface Water  
32 Resources and Water Supplies. The area around the Los Vaqueros reservoir  
33 includes grasslands, upland scrub, valley and foothill woodlands, freshwater  
34 wetlands, and open water habitats (Reclamation et al. 2009). The grasslands  
35 include perennial and alkali habitats with wild oats, ripgut brome, yellow star  
36 thistle, fescue, filaree, mustard, fiddleneck, lupine, popcorn flower, and California  
37 poppy. The grasslands support Northern Harrier, Burrowing Owl, Western  
38 Meadowlark, California Horned Lark, Turkey Vulture, Red-Tailed Hawk,  
39 American Kestrel, White-Tailed Kite, Western Fence Lizard, Common Garter  
40 Snake, Western Rattlesnake, California Tiger Salamander, Western Harvest  
41 Mouse, California Ground Squirrel, Black-Tailed Jackrabbit, Black-Tailed Deer,  
42 and San Joaquin Kit Fox.

43 The upland scrub habitat is dominated by evergreen chaparral species and coastal  
44 scrub, including chamise, California sagebrush, black sage, poison oak, bush

1 monkeyflower, and California buckwheat underlain by annual grasses and purple  
2 needlegrass (Reclamation et al. 2009). This habitat supports California Quail,  
3 Western Scrub-Jay, Bushtit, California Thrasher, Spotted Towhee, Sage Sparrow,  
4 Western Fence Lizard, Common Garter Snake, Common King Snake, Western  
5 Rattlesnake, California Mouse, Deer Mouse, and feral pig.

6 The valley and foothill woodlands and riparian woodlands includes willow,  
7 Fremont cottonwood, valley oak, sycamore, black walnut, California buckeye,  
8 Mexican elderberry, and Himalayan blackberry which occur along much of  
9 Kellogg Creek (Reclamation et al. 2009). This habitat supports many birds,  
10 reptiles, amphibians, and mammals, including red-legged frog. The freshwater  
11 emergent habitat includes meadows with wetland species and stream channels.  
12 The vegetation includes tules, bulrushes, and cattail. Wildlife that occurs in this  
13 area include Marsh Wren, Common Yellowthroat, Red-Winged Blackbird, Red-  
14 legged Frog, and Western Pond Turtle. The open water habitat of the Los  
15 Vaqueros Reservoir provides forage, winter, and brood habitat for Canada Goose;  
16 American Wigeon; Wood., Gadwall, Mallard, Northern Shoveler, Northern  
17 Pintail, Green-Winged Teal, Canvasback, Redhead, Ring-Necked, Greater Scaup,  
18 Lesser Scaup, Bufflehead, Common Goldeneye, Hooded Merganser, Common  
19 Merganser, and Ruddy ducks; and other habitat values for grebe, sandpiper,  
20 pelican, cormorant, egret, heron, and gull.

#### 21 **10.3.4.4 East Bay Municipal Utility District Reservoirs**

22 The East Bay Municipal Utility District reservoirs in Alameda and Contra Costa  
23 County used to store water within and near the East Bay Municipal Utility District  
24 service area include Briones Reservoir, San Pablo Reservoir, Lafayette Reservoir,  
25 Upper San Leandro Reservoir, and Lake Chabot. Water stored in these reservoirs  
26 includes water from local watersheds, the Mokelumne River watershed, and  
27 CVP water supplies, as described in Chapter 5, Surface Water Resources and  
28 Water Supplies.

29 The Briones Reservoir watershed is characterized by grasslands, chaparral,  
30 coastal scrub, oak and bay woodlands, riparian, and freshwater wetlands  
31 (EBMUD 1999; EBRPD 1996, 2001, 2013). The San Pablo Reservoir watershed  
32 is characterized by grasslands, hardwood forest, coastal scrub, Monterey pine  
33 planted along the reservoir shoreline, riparian woodland, and eucalyptus. The  
34 Lafayette Reservoir watershed is characterized by grasslands, oak and bay  
35 woodland, and coastal scrub. The Upper San Leandro Reservoir watershed  
36 includes grasslands, chamise-black sage chaparral, coastal scrub, oak and bay  
37 woodland, redwood forest, knobcone forest with a dense manzanita understory,  
38 and an 18-acre freshwater marsh. The Lake Chabot watershed includes  
39 grasslands, coastal scrub, oak and bay woodland, and riparian and freshwater  
40 vegetation.

41 The grasslands vegetative communities generally include nonnative grasses and  
42 native perennial bunchgrass (EBMUD 1999; EBRPD 1996, 2001). The nonnative  
43 grasslands include grasses such as wild oat, bromegrass, ryegrass, wild barley,  
44 bluegrass, silver hairgrass, and dogtail grass; forbs, including filaree, bur clover,

1 clovers, owls clover, cat's ear, and English plantain; and brodiaeas, lupine,  
 2 mariposa lilies, mule's ear, yarrow, farewell to spring, and soap plant. Native  
 3 grasses include annual and perennial fescues, needlegrass, wild rye, California  
 4 oatgrass, junegrass, bluegrass, squirreltail, meadow barley, and California  
 5 bromegrass. Grasslands are used by wildlife similar to those described for other  
 6 San Francisco Bay Area reservoirs, including hawks, owls, shrikes, swallows,  
 7 turkey vulture, reptiles, coyote, fox, bobcat, and mice.

8 The coastal scrub and chaparral vegetation includes coyote brush-scrub,  
 9 California sagebrush, bitter cherry scrub, manzanita, chamise-black sage, cream  
 10 bush, California coffeeberry, wild lilac, yerba santa, blackberry, bush  
 11 monkeyflower, and poison oak (EBMUD 1999; EBRPD 1996, 2001). The  
 12 woodlands include native and nonnative plants. The native redwood and  
 13 knobcone pine forests are located at Upper San Leandro Reservoir and provide  
 14 unique habitat. Nonnative eucalyptus and Monterey pine forests occur at San  
 15 Pablo Reservoir and Lake Chabot. The eucalyptus trees provide specific habitat  
 16 for hummingbird, Bald Eagle, Great Blue Heron, and Great Egret. The oak and  
 17 bay woodlands and oak savannas include coast live oak, black oak, valley oak,  
 18 blue oak, interior live oak, canyon live oak, California bay, California buckeye,  
 19 and madrone.

20 Mixed deciduous riparian woodland occur along perennial streams, including  
 21 white alder, big-leaf maple, western sycamore, Fremont cottonwood, and black  
 22 cottonwood that supports frogs, newts, and other amphibians; coast live oak,  
 23 California bay, and willow woodlands on steep slopes along intermittent streams;  
 24 and willow riparian scrub along perennial and intermittent streams (EBMUD  
 25 1999; EBRPD 1996, 2001). Along springs and seeps, the vegetation includes  
 26 grasses, includes rabbitsfoot grass, saltgrass, bentgrasses, rushes, tules, sedges,  
 27 horsetails, and cattail; and forbs includes buttercup, watercress, stinging nettle,  
 28 brass-buttons, mints, duckweed, and pondweed.

### 29 **10.3.5 Central Coast Region**

30 The Central Coast Region includes portions of San Luis Obispo and Santa  
 31 Barbara counties served by the SWP. The SWP water is provided to the Central  
 32 Coast Region by the Central Coast Water Authority (CCWA 2013). The facilities  
 33 divert water from the SWP California Aqueduct at Devil's Den and convey the  
 34 water to a water treatment plant at Polonto Pass. The treated water is conveyed to  
 35 municipal water users in San Luis Obispo and Santa Barbara counties to reduce  
 36 groundwater overdraft in these areas. Water is delivered to southern Santa  
 37 Barbara County communities through Cachuma Lake.

38 As described in subsection 10.3.2, Overview of Species with Special Status, A  
 39 listing of wildlife and plant species with special status that occur or may occur in  
 40 portions of the study area affected by the long-term coordinated operation of the  
 41 CVP and SWP is provided in Appendix 10A.



1     **10.3.5.1 Cachuma Lake**

2 Cachuma Lake is a facility owned and operated by Reclamation in Santa Barbara  
3 County, as described in Chapter 5, Surface Water Resources and Water Supplies.  
4 The Cachuma Lake watershed is located in the Coast Range and extends into the  
5 Los Padres National Forest. The primary habitats include hardwood woodland,  
6 chaparral, coastal sage scrub, nonnative grassland, and riparian woodland and  
7 scrub (Reclamation 2010c). The hardwood woodlands includes oak woodland,  
8 oak savannah, and pine woodland with blue oak, coast live oak, gray pine, skunk  
9 brush, and poison oak. The chaparral and coastal sage scrub includes mountain  
10 mahogany, greenbark ceonothus, blue oak, interior live oak, scrub oak, holly leaf  
11 redberry, buck brush, toyon, chaparral mallow, chamise, California sage brush,  
12 purple sage, deer weed, and coyote brush-scrub with understory of grasses and  
13 forbs. Birds that use the hardwood woodlands and savannah include Turkey  
14 Vulture; raptors including Red-Tailed Hawk and Bald Eagle; woodpecker,  
15 California Quail, Rufous-Crowned Sparrow, wren, California Thrasher, and  
16 Spotted Towhee. Nonnative grasslands are dominated by rip-gut brome and dove  
17 weed. Native grasses include purple needlegrass, blue-eyed grass, Johnny-jump-  
18 up, Chinese houses, rusty popcorn flower, slender cottonseed, forget-me-not,  
19 lupine, mountain dandelion, checkerbloom, narrow-leaved milkweed, fleabane,  
20 vinegar weed, California milkweed, and verbena.

21 Riparian habitat along streams and stream terraces include arroyo willow, red  
22 willow, yellow willow, black willow, sycamore, oak, cottonwood, Pacific  
23 blackberry, California rose, poison oak, elderberry, mulefat, California goldenrod,  
24 California brome, black mustard, mugwort, clover, stinging nettle, red brome, and  
25 California buckwheat (Reclamation 2010c). Habitat near the shoreline of  
26 Cachuma Lake includes willows, tamarisk, cattail, mulefat, and mugwort.  
27 Disturbed lands around the lake are characterized by weedy species, including  
28 yellow star thistle, Spanish broom, tamarisk, giant reed, pampas grass, scotch  
29 broom, veldt grass, perennial pepperweed, red brome, fennel, and cheatgrass.  
30 Marginal vegetation, reedy marshes, and riparian woodland support killdeer,  
31 spotted Sandpiper, Red-Winged Blackbird, Common Yellowthroat, Song  
32 Sparrow, Marsh Wren, Warbling Vireo, Yellow Warbler, Yellow-Breasted Chat,  
33 and Brown-Headed Cowbird. The open water of Cachuma Lake supports diving  
34 birds, including diving duck, American Coot, Pied-Billed Grebe, Western Grebe,  
35 Clark's Grebe, Double-Crested Cormorant, Heron, Egret, pelican, Osprey, and  
36 Bald Eagle. Amphibians and reptiles that occur near Cachuma Lake include  
37 Monterey Salamander, California Slender Salamander, Western Spadefoot,  
38 California Toad, Pacific Tree Frog, Bullfrog, Red-legged Frog, Yellow-Legged  
39 Frog, Southwestern Pond Turtle, Western Skink, and Southern Alligator Lizard.  
40 Mammals which depend upon habitat near Cachuma Lake include bat, hare,  
41 rabbit, pika, bear, coyote, fox, weasel, raccoon, cats, chipmunk, squirrel, marmot,  
42 shrew, mice, rat, mule deer, and feral pig.

43     **10.3.6 Southern California Region**

44 The Southern California Region includes portions of Ventura, Los Angeles,  
45 Orange, San Diego, Riverside, and San Bernardino counties served by the SWP.

1 The SWP water supplies generally are conveyed to Southern California  
 2 municipal, industrial, and agricultural water users in canals and pipelines. There  
 3 are six SWP reservoirs along the main canal, West Branch, and East Branch of the  
 4 California Aqueduct and many other reservoirs owned and operated by regional  
 5 and local agencies. The Metropolitan Water District of Southern California's  
 6 Diamond Valley Lake and Lake Skinner primarily store water from the SWP.  
 7 Other reservoirs store SWP water, including United Water Conservation District's  
 8 Lake Piru; City of Escondido's Dixon Lake; City of San Diego's San Vicente  
 9 Reservoir and Lower Otay Reservoir; Helix Water District's Lake Jennings; and  
 10 Sweetwater Authority's Sweetwater Reservoir.

11 As described in subsection 10.3.2, Overview of Species with Special Status, A  
 12 listing of wildlife and plant species with special status that occur or may occur in  
 13 portions of the study area affected by the long-term coordinated operation of the  
 14 CVP and SWP is provided in Appendix 10A.

15 The USFWS has approved several habitat conservation plans in the Southern  
 16 California Region within areas served by CVP and SWP water, including the  
 17 following plans (County of Orange 1996; Riverside County 2003; Riverside  
 18 County Habitat Conservation Agency 2014; SDCWA and USFWS 2010;  
 19 San Diego County 2014a, 2014b, 2015; SANDAG 2003; CVAG 2007).

- 20 • County of Orange Central and Coastal Subregion Natural Community  
 21 Conservation Plan and Habitat Conservation Plan.
- 22 • Western Riverside County Multiple Species Conservation Plan.
- 23 • Habitat Conservation Plan for the Stephen's Kangaroo Rat in Western  
 24 Riverside County which is administered by the Riverside County Habitat  
 25 Conservation Agency for Riverside County and the cities of Corona, Hemet,  
 26 Lake Elsinore, Menifee, Moreno Valley, Murrieta, Perris, Riverside,  
 27 Temecula, and Vail Lake, and which includes areas around Diamond Valley  
 28 Lake and Lake Skinner.
- 29 • San Diego County Water Authority Subregional Natural Community  
 30 Conservation Plan/Habitat Conservation Plan (NCCP/HCP).
- 31 • San Diego County Multiple Species Conservation Plan including the initial  
 32 area which includes the lands served by the City of San Diego Wastewater  
 33 Sewer System; future North County Plan expansion (extends from the areas  
 34 near the cities of Oceanside, Encinitas, San Marcos, Vista, and Escondido to  
 35 the Cleveland National Forest and Riverside County boundary), and  
 36 remaining land within the county (including lands from Alpine east to the  
 37 Imperial and Riverside counties boundaries).
- 38 • Multiple Habitat Conservation Program for the cities of Carlsbad, Encinitas,  
 39 Escondido, Oceanside, San Marcos, Solana Beach, and Vista.
- 40 • Coachella Valley Multiple Species Habitat Conservation Plan.

1     **10.3.6.1   State Water Project Reservoirs**

2     The SWP reservoirs include Quail Lake, Pyramid Lake, and Castaic Lake in Los  
3     Angeles County; Silverwood Lake and Crafton Hills Reservoir in San Bernardino  
4     County; and Lake Perris in Riverside County, as described in Chapter 5, Surface  
5     Water Resources and Water Supplies.

6     Quail Lake was formed by seismic activity on the San Andres Fault and enlarged  
7     by the Department of Water Resources (DWR) as part of the West Branch of the  
8     SWP (DWR 1997). Quail Lake is bordered by the Tehachapi and Liebre  
9     Mountains. The area is characterized by cottonwood and oak woodlands that  
10    support Crested Sparrow, Red-Winged Blackbird, Golden Eagle, Red-Tailed  
11    Hawk, fox, coyote, deer, squirrel, and Pronghorn Antelope. The open water  
12    habitat support Canada Geese, egrets and Blue Herons

13    Pyramid Lake is located in the Angeles and Los Padres National Forests, as  
14    described in Chapter 15, Recreation Resources. Upland areas around Pyramid  
15    Lake are assumed to be similar to upland areas around Middle Piru Creek  
16    downstream of Pyramid Dam (DWR 2004c). The vegetative communities  
17    include coastal sage scrub and chaparral with oak woodlands and nonnative  
18    grasslands. Water is released from Pyramid Lake to provide habitat flows in Piru  
19    Creek, including flows to support habitat for the Arroyo Toad.

20    Terrestrial resources for Castaic Lake include coastal scrub, red shank-chamise  
21    chaparral, and chaparral scrub (DWR 2007b). Castaic Lagoon is located  
22    immediately downstream of Castaic Dam and is surrounded by coastal scrub.  
23    Vegetation includes pines, eucalyptus, and nonnative and native grasses. The  
24    habitat is used by Western Grebe, Canada Goose, Mallard Duck, gull, American  
25    Coot, Bald Eagle, and Western Mastiff Bat.

26    Silverwood Lake is located in the San Bernardino National Forest and surrounded  
27    by the Silverwood Lake State Recreation Area at the edge of the Mojave Desert  
28    and at the base of the San Bernardino Mountains. The area contains a wide  
29    variety of vegetative communities including live oak and scrub oak woodlands,  
30    ponderosa pine and Douglas-fir forests, mixed scrub, chaparral, and riparian  
31    hardwood (State Parks 2006, 2009). Chamise, interior live oak, manzanita,  
32    mountain mahogany, and ceanothus are found along the shoreline and willow,  
33    alders, and sycamores grow along area streams. The forest, chaparral, and  
34    riparian woodland habitats support a wide variety of small mammals, reptiles, and  
35    amphibians including rabbit, squirrel, woodrat, Western Fence Lizard,  
36    Rattlesnake, Pacific Tree Frog, California Toad, coyote, Mule Deer, bobcat,  
37    beaver, and skunk. The open water supports Great Blue Heron, Western Grebe,  
38    Avocet, Egret, Canada Goose, and ducks. A number of raptors are found around  
39    the lake including Bald Eagle, Osprey, owls, Cooper's Hawk, and Red-Tailed  
40    hawk.

41    The Crafton Hills Reservoir area includes 4.5 acres of open water and 1.9 acres of  
42    open space (DWR 2009b). The open space is characterized by chaparral scrub  
43    and grass species, including chamise, golden yarrow, hoaryleaf ceanothus,  
44    brittlebush, California sagebush, California buckwheat, deerweed, black sage,

1 purple needlegrass, heartleaf penstemon, ripgut grass, soft chess, foxtail chess,  
 2 wild oat, Italian thistle, tocalote, short-pod mustard, and wild oat. The area is  
 3 used by Mallard Duck, Killdeer, Red-Tailed Hawk, Cassin's Kingbird, and  
 4 Wrentit; California Toad, Pacific Tree Frog, Western Fence Lizard, Common  
 5 Side-Blotched Lizard, and California Kingsnake; and Desert Cottontail, Desert  
 6 Woodrat, coyote, raccoon, and bobcat.

7 Lake Perris is located adjacent to the cities of Moreno Valley and Perris and the  
 8 Perris Fairgrounds which includes a motor sports complex (DWR 2010a). Lake  
 9 Perris is located within the Lake Perris State Recreation Area which provides  
 10 extensive recreational opportunities, as described in Chapter 15, Recreation  
 11 Resources. The open space areas are characterized by willow and sage scrub,  
 12 willow and eucalyptus woodland, and nonnative grassland. The scrub areas  
 13 include California sagebrush, lemonadeberry, sugarbush, yellow bush penstemon,  
 14 coyote brush, Mexican elderberry, sweetbush, boxthorn, tall prickly-pear,  
 15 California buckwheat, red brome, bur ragweed, California aster, ripgut brome,  
 16 sticky monkeyflower, prickly sow thistle, and Russian thistle. The willow  
 17 woodland includes Goodding's black willow, red willow, narrow leaved willow,  
 18 Fremont's cottonwood, California sycamore, gooseberry, mulefat, tarragon,  
 19 curley dock, ragweed, southwestern spinyrush, and bromes. Eucalyptus  
 20 woodland includes eucalyptus underlain by nonnative grassland. Nonnative  
 21 grasslands includes soft chess, wild oat, foxtail barley, mustard, sweet fennel,  
 22 California sagebrush, and California buckwheat. Habitat has been restored within  
 23 the grasslands to provide habitat for the Stephen's Kangaroo Rat. Mourning  
 24 Dove, Anna's Hummingbird, raven, California Kingsnake, Raccoon, Black-Tailed  
 25 Deer, Striped Skunk, coyote, and bobcat use the shoreline. The woodland is used  
 26 by Ash-Throated Flycatcher, Western Kingbird, Least Bell's Vireo, House Wren,  
 27 California Towhee, Spotted Towhee, Black-Headed Grosbeak, Blue Grosbeak,  
 28 Song Sparrow, Bullock's Oriole, House Finch, Lesser Goldfinch, Nuttall's  
 29 Woodpecker, Red-Tailed Hawk, Red-Shouldered Hawk, Cooper's Hawk,  
 30 Cottontail Rabbit, Black-Tailed Jackrabbit, raccoon, and Long-Tailed Weasel.  
 31 The scrub supports California Quail, Greater Roadrunner, White-Throated Swift,  
 32 Rock Wren, California Towhee, Western Fence Lizard, Gopher Snake, Red  
 33 Diamond Rattlesnake, Southern Pacific Rattlesnake, Side Blotched Lizard,  
 34 Granite Spiny Lizard, Coastal Western Whiptail, Black-Tailed Jackrabbit, bobcat,  
 35 coyote, and rodents.

### 36 **10.3.6.2 Non-SWP Reservoirs in Riverside County**

37 Non-SWP reservoirs in Riverside County that store SWP water include Diamond  
 38 Valley Lake and Lake Skinner that are owned and operated by Metropolitan  
 39 Water District of Southern California, and Vail Lake that is owned and operated  
 40 by Rancho California Water District, as described in Chapter 5, Surface Water  
 41 Resources and Water Supplies.

42 Diamond Valley Lake is located adjacent to the City of Hemet along the northern  
 43 boundary, and adjacent to pasture and dairies along the eastern and western  
 44 boundaries (City of Hemet 2012). Sage scrub and nonnative grasslands occur  
 45 between the lake and the City of Hemet. Chaparral with sage scrub occur along

1 the southern boundary of the lake. Riversidean sage scrub includes California  
2 sagebrush, flat top buckwheat, black sage, and California encelia. Wildlife  
3 movement corridors occur around Diamond Valley Lake. Open space around  
4 Lake Skinner is also characterized by grassland and sage scrub vegetation  
5 (USFWS 2004).

6 Diamond Valley Lake and Lake Skinner are located within the Southwestern  
7 Riverside County Multi-Species Reserve, an area of 11,000 acres surrounding and  
8 connecting Diamond Valley Lake and Lake Skinner through the Dr. Roy Shipley  
9 Reserve (MWD 2014). At least eight types of habitat are found in the reserve, but  
10 coastal sage scrub, nonnative grassland, and chaparral are dominant. There are  
11 smaller areas of coast live oak woodland, willow scrub with live oak, and  
12 cottonwood-willow riparian forests. The reserve is home to the California  
13 Gnatcatcher, Bell's Sage Sparrow, San Diego Horned Lizard, Payson's  
14 Jewelflower, and Parry's Spineflower.

15 Areas around Vail Lake support habitat for Bald Eagle, Golden Eagle, and Great  
16 Blue Heron (RCWD 2015).

#### 17 **10.3.6.3 Non-SWP Reservoir in Ventura County**

18 Lake Piru, located in Ventura County, is used to store SWP water by United  
19 Water Conservation District, as described in Chapter 5, Surface Water Resources  
20 and Water Supplies (UWCD 1999, 2014). The area surrounding the lake is  
21 characterized by chaparral on the hills and coast live oak woodlands along the  
22 stream channels.

#### 23 **10.3.6.4 Non-SWP Reservoirs in San Diego County**

24 Reservoirs in San Diego County that are used to store SWP water include the City  
25 of Escondido Dixon Lake; City of San Diego San Vicente, El Capitan, Lower  
26 Otay, and Lake Hodges reservoirs; Lake Jennings owned by Helix Water District;  
27 and Sweetwater Reservoir owned by Sweetwater Authority.

28 Dixon Lake is located in the hills above the City of Escondido within the  
29 Escondido Multiple Habitat Conservation Plan area (City of Escondido 2012).  
30 Habitat around Lake Dixon is characterized by coastal sage scrub and chaparral.  
31 The coastal sage scrub includes California sagebrush, flat-top buckwheat, white  
32 sage, laurel sumac, black sage, California encelia, San Diego County viguiera,  
33 goldenbush, coast prickly-pear, and lemonadeberry and sugarbush. Chaparral  
34 includes chamise, scrub oak, toyon, thick-leaf ceanothus, black sage, wild  
35 cucumber, morning glory, saw-toothed goldenbush, and nonnative grasses.

36 The San Vicente Reservoir is characterized by rocky or coarse sand, with  
37 occasional willow trees and mulefat (SDCWA and USACE 2008). The  
38 constantly fluctuating water levels make it difficult for wetland or riparian  
39 vegetation to become established. Much of the shoreline around San Vicente  
40 Reservoir, therefore, is a non-vegetated fringe. Outside of the fringe, the area  
41 around the reservoir is primarily sage scrub with nonnative grassland and coast  
42 live oak woodland. Along the stream channel, vegetation includes southern  
43 willow scrub and live oak riparian forest with chaparral. Submerged aquatic

1 vegetation occurs in an intermittent band surrounding almost the entire reservoir.  
 2 Freshwater marsh vegetation of cattail, bulrush, and sedges occurs between the  
 3 open water and lakeshore fringe. Birds associated with the open water include  
 4 grebe, cormorant, heron, egret, ducks and geese, coot, plover, sandpiper, gull, and  
 5 tern. Other birds associated with open water and riparian habitats include the bald  
 6 eagle, osprey, and kingfisher. The uplands support rabbit, snakes, lizards, ground  
 7 squirrel, pocket gopher, raccoon, mule deer, bats, mice, fox, skunk, bobcat, and  
 8 mountain lion.

9 El Capitan Reservoir is located within Diegan coastal sage scrub with areas of oak  
 10 woodlands and chaparral (San Diego County 2011; SDRWWG 2005; SDRP  
 11 2015). The Lower Otay Reservoir, Lake Hodges, and Lake Jennings are located  
 12 within coastal sage scrub. Sweetwater Reservoir is surrounded by coastal sage  
 13 scrub and chaparral with riparian forest along stream channels.

#### 14 **10.3.6.5 Non-SWP Reservoir in San Bernardino County**

15 Lake Arrowhead, in San Bernardino County, is used to store SWP water by the  
 16 Lake Arrowhead Community Services District (County of San Bernardino 2011;  
 17 LACSD 2014a, 2014b). Lake Arrowhead is located within chaparral, sage scrub,  
 18 oak woodlands, oak and sycamore woodlands, dogwood tree along the lake,  
 19 cottonwood and willow forests along stream channels, Ponderosa pine forests, and  
 20 wetlands. The habitat supports Stellar Jay, blue jay, quail, ducks, western  
 21 Tanager, Northern Tanager, woodpecker, chickadee, Barn Owl, Bald Eagle,  
 22 hawks, rattlesnake, coyote, bobcat, Black Bear, Gray Squirrel, Ground Squirrel,  
 23 chipmunk, raccoon, mountain lion, skunk, and cougar.

## 24 **10.4 Impact Analysis**

25 This section describes the potential mechanisms and analytical methods for  
 26 change in terrestrial resources; results of the impact analysis; potential mitigation  
 27 measures; and cumulative effects.

### 28 **10.4.1 Potential Mechanisms for Change and Analytical Methods**

29 As described in Chapter 4, Approach to Environmental Analysis, the impact  
 30 analysis considers changes in terrestrial resources conditions related to changes in  
 31 CVP and SWP operations under the alternatives as compared to the No Action  
 32 Alternative and Second Basis of Comparison.

33 Changes in CVP and SWP operations under the alternatives as compared to the  
 34 No Action Alternative and Second Basis of Comparison could change surface  
 35 water resources affected by CVP and SWP operations.

#### 36 **10.4.1.1 Changes in CVP and SWP Reservoir Elevations**

37 Changes in surface water elevations at the CVP and SWP reservoirs would  
 38 influence the extent of the drawdown zone (the area of shoreline between the full  
 39 inundation elevation and the water level), which can influence the availability and  
 40 quality of nesting habitat for some ground-nesting birds (e.g., waterfowl) and

1 possibly the prey base for nesting fish-eating raptors (e.g., Bald Eagle and  
2 Osprey) in March through June. The creation of barren zones through reservoir  
3 drawdown can also affect the ability of wildlife species to access water, which  
4 could cause them to be more vulnerable to predation.

5 As described in Chapter 5, Surface Water Resources and Water Supplies, surface  
6 water elevations would be similar in all months and all water year types at Trinity  
7 Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir  
8 under Alternatives 1 through 5 as compared to the No Action Alternative and the  
9 Second Basis of Comparison. Surface water elevations would change at San Luis  
10 Reservoir under Alternatives 1 through 5 as compared to the No Action  
11 Alternative and the Second Basis of Comparison. However, it does not appear  
12 that nesting fish-eating raptors or ground-nesting waterfowl use the San Luis  
13 Reservoir shoreline during these nesting lifestages (Reclamation 2013).  
14 Therefore, changes in CVP and SWP operations under the alternatives would  
15 result in similar conditions (within 5 percent change) for terrestrial resources at  
16 CVP and SWP reservoirs; and these factors are not analyzed in this EIS.

#### 17 **10.4.1.2 Changes in Rivers Downstream of the CVP and SWP Reservoirs**

18 Operation of the CVP and SWP would influence flow regimes that renew and  
19 support adjacent riparian and wetland plant and wildlife communities. For  
20 example, certain riparian plants (e.g., willows) require a specific sequence and  
21 timing of flow events to prepare the seedbed and to support germination and  
22 seedling growth in March through May. Changes in flow that support or interfere  
23 with these processes could influence riparian vegetation and its value as wildlife  
24 habitat. The analysis is focused on Trinity, Sacramento, Feather, American, and  
25 Stanislaus rivers because these rivers are used to convey water from the reservoirs  
26 to CVP and SWP water users. Therefore, changes in CVP and SWP operations  
27 could result in substantial changes in flow patterns in these rivers. At other  
28 reservoirs that are used to store CVP and SWP water supplies (e.g., San Luis  
29 Reservoir), the CVP and SWP water are conveyed from the reservoirs in canals or  
30 pipelines. The reservoirs may be operated to provide minimum flows to support  
31 habitat in streams adjacent to these reservoirs; however, changes in CVP and  
32 SWP operations would not affect the minimum instream flow releases.  
33 Therefore, changes in terrestrial resources in these streams is not analyzed in  
34 this EIS.

35 Channel maintenance flows to improve adjacent floodplain habitat conditions  
36 would occur along Clear Creek under the No Action Alternative and Alternatives  
37 2 and 5, to the extent possible. The high-flow, short-duration pulse flows would  
38 be released, if physically possible, from Whiskeytown Lake to mobilize  
39 streambed material in Clear Creek in accordance with the 2009 NMFS Biological  
40 Opinion (BO).

#### 41 **10.4.1.3 Changes in Sacramento, American, and Stanislaus Rivers** 42 **Habitats due to Fish Passage at Dams**

43 Fish passage would be provided under the No Action Alternative and  
44 Alternative 5 around Shasta, Folsom, and New Melones dams. Salmon runs play

1 an important role in the transfer of large quantities of marine-derived nutrients to  
2 adjacent forest ecosystems with substantial effects on plant and wildlife  
3 production. Spawning salmon contribute to the release of nutrients into streams  
4 through normal metabolic processes, release of gametes during spawning, decay  
5 of their carcasses following death, and through consumption of their flesh by  
6 predators and scavengers (Merz and Moyle 2006). Returning fish to the upper  
7 stream segments, fish passage could influence the forest ecosystem and associated  
8 wildlife in the upper watersheds and result in less nutrients along the rivers  
9 downstream of the dams. This analysis would assume that the objectives of the  
10 2009 NMFS BO were achieved by 2030, including implementation of fish  
11 passage at these CVP reservoirs. However, any changes in nutrients in the stream  
12 corridors are expected to be minimal based on information in Merz and Moyle  
13 (2006). Therefore, habitat conditions related to changes in nutrient loading  
14 associated with fish passage actions would be the same under Alternatives 1  
15 through 5 as under the No Action Alternative and the Second Basis of  
16 Comparison. Therefore, this potential change is not analyzed in this EIS.

#### 17 **10.4.1.4 Changes in River and Delta Floodplains**

18 Alternative 4 assumes additional institutional requirements for development  
19 within the floodplain and floodways that would require compliance with  
20 Endangered Species Act in defining floodplain map revisions, allow for  
21 improvements in floodplain management criteria to support natural and beneficial  
22 functions, and prohibit new development and substantial improvements to  
23 existing development within any designated floodway or within 170 feet of the  
24 ordinary high water line of any floodway. However, as described in Chapter 13,  
25 Land Use, in 2030, development along major river corridors in the Central Valley  
26 would continue to be limited by state regulations implemented by the Central  
27 Valley Flood Protection Board and the USACE.

28 Within the Delta, the floodways are further regulated by the Delta Protection  
29 Commission and Delta Stewardship Council to preserve and protect the natural  
30 resources of the Delta; and prevent encroachment into Delta floodways. These  
31 regulations, as implemented in all alternatives and the Second Basis of  
32 Comparison, would prevent development within the Delta floodplains and  
33 floodways and in the Sacramento, Feather, American, and San Joaquin rivers  
34 corridors upstream of the Delta, as described in Chapter 13. Provisions in  
35 Alternative 4 would require additional setbacks along the floodways as compared  
36 to other alternatives and the Second Basis of Comparison. The qualitative  
37 analysis considers the potential changes in habitat due to these changes in  
38 floodplain and floodway development regulations.

39 Another potential change in Delta habitat would occur under Alternative 4,  
40 additional vegetation would remain along the levees in the Delta as compared to  
41 conditions under the other alternatives, the No Action Alternative, and the Second  
42 Basis of Comparison, as described in Chapter 3, Description of Alternatives.  
43 Under Alternatives 1, 2, 3, and 5; the No Action Alternative; and the Second  
44 Basis of Comparison existing vegetation would remain along the Delta levees  
45 until the levees are repaired. Following repairs, vegetation would be removed



1 along the riparian corridor to improve the structural reliability of the levees in  
2 accordance with USACE requirements. It is assumed that by 2030, much of the  
3 vegetation would be removed from the levees due to levee repairs.

4 **10.4.1.5 Changes in Flows over Fremont Weir into the Yolo Bypass**

5 All of the alternatives, including the No Action Alternative and the Second Basis  
6 of Comparison, include operations of an operable gate at Fremont Weir, as  
7 described in Chapter 3, Description of Alternatives. However, the flow patterns  
8 into the Yolo Bypass would change based upon the magnitude of flows in the  
9 Sacramento River at Fremont Weir.

10 **10.4.1.6 Changes in Wetlands Habitat**

11 The No Action Alternative, Alternatives 1 through 5, and Second Basis of  
12 Comparison all include implementation of restoration of more than 10,000 acres  
13 of intertidal and associated subtidal wetlands in Suisun Marsh and Cache Slough;  
14 17,000 to 20,000 acres of seasonal floodplain restoration in the Yolo Bypass; and  
15 continued delivery of refuge water supplies under the Central Valley Project  
16 Improvement Act. There would be no changes in wetlands habitat between  
17 Alternatives 1 through 5 as compared to the No Action Alternative, and the  
18 Second Basis of Comparison. Therefore, changes to wetland habitats are not  
19 analyzed in this EIS.

20 **10.4.1.7 Changes in Delta Habitat**

21 Changes in CVP and SWP operations under the alternatives as compared to the  
22 No Action Alternative and Second Basis of Comparison would change the Delta  
23 salinity which could affect survival of riparian vegetation. The analysis evaluates  
24 changes in salinity by comparing the end of month X2 position.

25 Another potential change in Delta habitat would occur under Alternative 4, due to  
26 additional vegetation along the levees in the Delta as compared to conditions  
27 under the other alternatives, the No Action Alternative, and the Second Basis of  
28 Comparison, as described in Chapter 3, Description of Alternatives.

29 **10.4.1.8 Changes in Irrigated Agricultural Acreage Habitats in Areas that  
30 use CVP and SWP Water**

31 As described in Section 10.3, Affected Environment, agricultural lands provide  
32 considerable value to terrestrial wildlife, which varies with crop type and wildlife  
33 species. Generally, rice production provides high habitat value for some species  
34 because it supports many of the attributes of wetlands. Most notably, flooded rice  
35 fields during the growing season provide foraging and nesting habitat for  
36 waterfowl and shorebirds, as well as habitat for the federally listed Giant Garter  
37 Snake. In the fall and early winter, flooding for rice straw decomposition plays an  
38 important role in providing habitat for migrating waterbirds. Other crops, such as  
39 alfalfa and irrigated pasture, also provide habitat value, primarily because of their  
40 perennial nature and the application of flood irrigation. These crops provide  
41 valuable foraging habitat for species such as the state-listed Swainson's Hawk.  
42 Grain crops provide seasonal value to species such as Greater Sandhill Crane and

1 others, but orchards, vineyards, vegetable, and truck crops generally provide  
2 relatively low habitat value for terrestrial species.

3 Changes in CVP and SWP operations under the alternatives could change the  
4 extent of irrigated acreage and associated habitats over the long-term average  
5 condition and in dry and critical dry years as compared to the No Action  
6 Alternative and Second Basis of Comparison, as described in Chapter 12,  
7 Agricultural Resources. However, irrigated acreage under Alternatives 1  
8 through 5 would be similar (within 5 percent change) to irrigated acreage under  
9 the No Action Alternative and the Second Basis of Comparison. Therefore, there  
10 would be no change in terrestrial habitat at the irrigated acreage; and this factor is  
11 not analyzed in this EIS.

#### 12 **10.4.1.9 Effects due to Cross Delta Water Transfers**

13 Historically water transfer programs have been developed on an annual basis.  
14 The demand for water transfers is dependent upon the availability of water  
15 supplies to meet water demands. Water transfer transactions have increased over  
16 time as CVP and SWP water supply availability has decreased, especially during  
17 drier water years.

18 Parties seeking water transfers generally acquire water from sellers who have  
19 available surface water and who can make the water available through releasing  
20 previously stored water, pumping groundwater instead of using surface water  
21 (groundwater substitution); idling crops; or substituting crops that uses less water  
22 in order to reduce normal consumptive use of surface water.

23 Water transfers using CVP and SWP Delta pumping plants and south of Delta  
24 canals generally occur when there is unused capacity in these facilities. These  
25 conditions generally occur during drier water year types when the flows from  
26 upstream reservoirs plus unregulated flows are adequate to meet the Sacramento  
27 Valley water demands and the CVP and SWP export allocations. In non-wet  
28 years, the CVP and SWP water allocations would be less than full contract  
29 amounts; therefore, capacity may be available in the CVP and SWP conveyance  
30 facilities to move water from other sources.

31 Projecting future terrestrial resources conditions related to water transfer activities  
32 is difficult because specific water transfer actions required to make the water  
33 available, convey the water, and/or use the water would change each year due to  
34 changing hydrological conditions, CVP and SWP water availability, specific local  
35 agency operations, and local cropping patterns. Reclamation recently prepared a  
36 long-term regional water transfer environmental document which evaluated  
37 potential changes in conditions related to water transfer actions (Reclamation  
38 2014d). Results from this analysis were used to inform the impact assessment of  
39 potential effects of water transfers under the alternatives as compared to the No  
40 Action Alternative and the Second Basis of Comparison.

1 **10.4.2 Conditions in Year 2030 without Implementation of**  
2 **Alternatives 1 through 5**

3 This EIS includes two bases of comparison, as described in Chapter 3,  
4 Description of Alternatives: the No Action Alternative and the Second Basis of  
5 Comparison. Both of these bases are evaluated at 2030 conditions.

6 Changes that would occur over the next 15 years without implementation of the  
7 alternatives are not analyzed in this EIS. However, the changes to terrestrial  
8 resources that are assumed to occur by 2030 under the No Action Alternative and  
9 the Second Basis of Comparison are summarized in this section. Many of the  
10 changed conditions would occur in the same manner under both the No Action  
11 Alternative and the Second Basis of Comparison.

12 **10.4.2.1 Common Changes in Conditions under the No Action**  
13 **Alternative and Second Basis of Comparison**

14 Conditions in 2030 would be different than existing conditions due to:

- 15 • Climate change and sea level rise
- 16 • General plan development throughout California, including increased water  
17 demands in portions of Sacramento Valley.
- 18 • Implementation of reasonable and foreseeable water resources management  
19 projects to provide water supplies, including general plan development, future  
20 water management and supply projects, and river and Delta floodplain  
21 development.

22 **10.4.2.1.1 Climate Change and Sea Level Rise**

23 It is anticipated that climate change would result in more short-duration high-  
24 rainfall events and less snowpack in the winter and early spring months. The  
25 reservoirs would be full more frequently by the end of April or May by 2030 than  
26 in recent historical conditions. However, as the water is released in the spring,  
27 there would be less snowpack to refill the reservoirs. This condition would  
28 reduce reservoir storage and available water supplies to downstream uses in the  
29 summer. The reduced end of September storage also would reduce the ability to  
30 release stored water to downstream regional reservoirs. These conditions would  
31 occur for all reservoirs in the California foothills and mountains, including non-  
32 CVP and SWP reservoirs.

33 These changes would result in a decline of the long-term average CVP and SWP  
34 water supply deliveries by 2030 as compared to recent historical long-term  
35 average deliveries under the No Action Alternative and the Second Basis of  
36 Comparison. However, the CVP and SWP water deliveries would be less under  
37 the No Action Alternative as compared to the Second Basis of Comparison, as  
38 described in Chapter 5, Surface Water Resources and Water Supplies, which  
39 could result in more crop idling.

40 The Delta estuarine habitat is complex due to the freshwater-saltwater interface  
41 that supports numerous terrestrial species that require freshwater conditions  
42 primarily in the winter and spring and may withstand periods of higher salinity in

1 the late summer and fall months. Climate change and sea level rise and CVP and  
 2 SWP operations would change the location of the freshwater-saltwater interface in  
 3 the Delta which would affect the survivability of vegetation within that area,  
 4 especially in the western Delta and Suisun Marsh. Operations of the CVP and  
 5 SWP would continue to maintain freshwater conditions in the spring in  
 6 accordance with the State Water Resources Control Board Decision 1641.  
 7 However, higher salinity conditions would occur in the summer months and in the  
 8 fall of drier years which would affect the types of riparian vegetation in the  
 9 western Delta and in Suisun Marsh under the No Action Alternative and Second  
 10 Basis of Comparison in 2030 as compared to recent historical conditions.

#### 11 **10.4.2.1.2 Reasonable and Foreseeable Projects and Programs**

12 Under the No Action Alternative and the Second Basis of Comparison, land uses  
 13 in 2030 would occur in accordance with adopted general plans. Development  
 14 under the general plans would change terrestrial resources, especially near  
 15 municipal areas.

16 The No Action Alternative and the Second Basis of Comparison assumes  
 17 completion of water resources management and environmental restoration  
 18 projects that would have occurred without implementation of Alternatives 1  
 19 through 5, including regional and local recycling projects, surface water and  
 20 groundwater storage projects, conveyance improvement projects, and desalination  
 21 projects, as described in Chapter 3, Description of Alternatives. The No Action  
 22 Alternative and the Second Basis of Comparison also assumes implementation of  
 23 actions included in the 2008 U.S. Fish and Wildlife Service (USFWS) Biological  
 24 Opinion (BO) and 2009 National Marine Fisheries Service (NMFS) BO that  
 25 would have been implemented without the BOs by 2030, as described in  
 26 Chapter 3, Description of Alternatives. These projects would include several  
 27 projects that would affect terrestrial resources, including:

- 28 • Habitat Restoration includes restoration of more than 10,000 acres of  
 29 intertidal and associated subtidal wetlands in Suisun Marsh and Cache Slough;  
 30 and at least 17,000 to 20,000 acres of seasonal floodplain restoration in Yolo  
 31 Bypass.
- 32 • Sacramento River, American River, and Clear Creek Spawning Gravel  
 33 Augmentation.
- 34 • Battle Creek Restoration.
- 35 • Lower American River Flow Management Standard.

#### 36 **10.4.2.1.3 Changes in River and Delta Floodplains**

37 It is assumed that under the No Action Alternative and the Second Basis of  
 38 Comparison, the State of California would continue to implement flood  
 39 management projects to reduce flood risks along the Sacramento and San Joaquin  
 40 rivers and in the Delta (DWR 2013b). These programs would be implemented in  
 41 a manner that would be coordinated with opportunities to restore or maintain the  
 42 function of natural systems with consideration of future conditions with climate

1 change and sea level rise. However, terrestrial resources would be changed by  
2 2030 as compared to recent historical conditions.

3 Terrestrial resources along Delta levees also would be affected through  
4 implementation of USACE policies for vegetation on levees. Historically, the  
5 USACE has allowed brush and small trees to be located on the waterside of  
6 federal flood management project levees if the vegetation would preserve, protect,  
7 and/or enhance natural resources, and/or protect rights of Native Americans,  
8 while maintaining the safety, structural integrity, and functionality of the levee  
9 (DWR 2011). After Hurricane Katrina in 2005, the USACE issued a policy and  
10 draft policy guidance to remove substantial vegetation from these levees  
11 throughout the nation (USACE 2009). This policy requires federally authorized  
12 levee systems that have maintenance agreements with the USACE (including  
13 Delta levees along the Sacramento and San Joaquin rivers) and other levees that  
14 are eligible for the federal Rehabilitation and Inspection Program (Public  
15 Law 84-99) to remove vegetation in the following manner.

- 16 • Removal of all vegetation from the upper third of the waterside slope of the  
17 levee, the top of the levee, landside slope of the levee, or within 15 feet of the  
18 toe of the levee on the landside (“toe” is where the levee slope meets the  
19 ground surfaces).
- 20 • Removal of all vegetation over 2 inches in diameter on the lower two-thirds of  
21 the waterside slope of the levee and within 15 feet of the toe of the levee on  
22 the waterside along benches above the water surface.

23 In 2010, the USACE issued a draft policy guidance letter, *Draft Process for*  
24 *Requesting a Variance from Vegetation Standards for Levees and Floodwalls—*  
25 *75 Federal Register 6364-68* (USACE 2010) that included procedures for State  
26 and local agencies to request variances on a site-specific basis. DWR has been in  
27 negotiations with USACE to remove vegetation on the upper third of the  
28 waterside slope, top, and landside of the levees, and continue to allow vegetation  
29 on the lower two-thirds of the waterside slope of the levee and along benches  
30 above the water surface (DSC 2011). By 2030, it is anticipated that much of the  
31 existing vegetation on the upper third of the waterside slopes, tops, landside  
32 slopes, and within 15 feet of the landside toe of the levees would be removed.

33 By 2030 under the No Action Alternative and the Second Basis of Comparison,  
34 development along major river corridors in the Central Valley would continue to  
35 be limited by state regulations implemented by the Central Valley Flood  
36 Protection Board and the USACE. Within the Delta, the floodways would  
37 continue to be regulated by the Delta Protection Commission and Delta  
38 Stewardship Council to preserve and protect the natural resources of the Delta;  
39 and prevent encroachment into Delta floodways. These requirements would  
40 prevent development within the Delta floodplains and floodways and in the  
41 Sacramento, Feather, American, and San Joaquin rivers corridors upstream of  
42 the Delta.

1 **10.4.3 Evaluation of Alternatives**

2 As described in Chapter 4, Approach to Environmental Analysis, Alternatives 1  
3 through 5 have been compared to the No Action Alternative; and the No Action  
4 Alternative and Alternatives 1 through 5 have been compared to the Second Basis  
5 of Comparison.

6 **10.4.3.1 No Action Alternative**

7 As described in Chapter 4, Approach to Environmental Analysis, the No Action  
8 Alternative is compared to the Second Basis of Comparison.

9 **10.4.3.1.1 Trinity River Region**

10 *Changes in Rivers Downstream of CVP and SWP Reservoirs*

11 River flows in Trinity River downstream of Lewiston Dam in the critical period  
12 for terrestrial resources of March through May would be similar under the No  
13 Action Alternative and the Second Basis of Comparison, as described in  
14 Chapter 5, Surface Water Resources and Water Supplies. Therefore, terrestrial  
15 resources habitat conditions along the Trinity River and lower Klamath River  
16 riparian corridors would be similar under the No Action Alternative and Second  
17 Basis of Comparison.

18 **10.4.3.1.2 Central Valley Region**

19 *Changes in Rivers Downstream of CVP and SWP Reservoirs*

20 Flows in the spring months would be similar in the Sacramento River at Keswick  
21 and Freeport and American River downstream of Nimbus Dam; increased flows  
22 in the Stanislaus River downstream of Goodwin Dam (over 100 percent); and  
23 reduced in the Feather River downstream of Thermalito Complex (25 to  
24 30 percent) under the No Action Alternative as compared to the Second Basis of  
25 Comparison. This analysis does not include site specific evaluation of all  
26 terrestrial resources along these riparian corridors. However, the changes in flows  
27 are indicative of the potential for change in the terrestrial resources. Therefore,  
28 under the No Action Alternative as compared to the Second Basis of Comparison,  
29 the potential for similar or improved terrestrial resources would occur along the  
30 Sacramento, American, and Stanislaus rivers; and the potential for reduced  
31 terrestrial resources would occur along the Feather River.

32 Monthly Clear Creek flows under the No Action Alternative as compared to the  
33 Second Basis of Comparison are identical except in May. In May, under the No  
34 Action Alternative, flows are up to 40.7 percent higher than under the Second  
35 Basis of Comparison in accordance with the 2009 NMFS BO. Terrestrial  
36 resources habitat in the floodplains of lower Clear Creek would be slightly  
37 improved under the No Action Alternative as compared to the Second Basis of  
38 Comparison.

39 *Potential Effects on Special Status Species*

40 Habitat changes along the riparian corridors related to changes in spring flows  
41 that support riparian vegetation recruitment would affect numerous bird species  
42 that use the riparian corridor, including Black Tern, Least Bell's Vireo, Least

1 Bittern, Swainson's Hawk, Tricolored Blackbird, Western Yellow-billed Cuckoo,  
2 White-tailed Kite, Yellow Warbler, Ringtail, Western Pond Turtle, Valley  
3 Elderberry Longhorn Beetle, and Delta Button-celery. Potential adverse effects  
4 could occur to these species due to reduced flows in the spring months on the  
5 Feather River.

6 *Changes in River and Delta Floodplains*

7 It is assumed that under the No Action Alternative and the Second Basis of  
8 Comparison, the State of California would continue to implement flood  
9 management projects to reduce flood risks along the Sacramento and San Joaquin  
10 rivers and in the Delta with consideration for opportunities to restore or maintain  
11 the function of natural ecosystems. The related terrestrial habitat conditions  
12 would be similar under the No Action Alternative and the Second Basis of  
13 Comparison.

14 *Changes in Flows over Fremont Weir into the Yolo Bypass*

15 Flows from the Sacramento River into the Yolo Bypass at Fremont Weir are  
16 similar under the No Action Alternative and the Second Basis of Comparison;  
17 therefore, terrestrial habitat could be similar.

18 *Changes in Delta Habitat due to Changes in Water Quality*

19 Under the No Action Alternative, the freshwater interface would be similar to  
20 conditions under the Second Basis of Comparison in all months in below normal,  
21 dry, and critical dry years; and from January through August in wet and above  
22 normal years. In the fall months in wet years, the X2 location would be 9 to  
23 14 kilometers towards the west in September through December under the No  
24 Action Alternative as compared to the Second Basis of Comparison.

25 *Potential Effects on Special Status Species*

26 Lower Delta salinity under the No Action Alternative as compared to the Second  
27 Basis of Comparison would improve habitat for Bolander's Water Hemlock,  
28 Delta Button-celery, Delta Tule Pea, Mason's Lilaeopsis, Soft Birds-beak, Suisun  
29 Marsh Aster, Salt Marsh Harvest Mouse, and Suisun Shrew.

30 *Effects Related to Cross Delta Water Transfers*

31 Potential effects to terrestrial resources could be similar to those identified in a  
32 recent environmental analysis conducted by Reclamation for long-term water  
33 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014d).  
34 Potential effects to terrestrial resources were identified as changes in stream flows  
35 due declining groundwater levels along streams due to the use of groundwater  
36 substitution to provide transfer water. The analysis indicated that these potential  
37 impacts would not be substantial due to the inclusion of a monitoring and  
38 mitigation program.

39 Under the No Action Alternative, the timing of cross Delta water transfers would  
40 be limited to July through September and include annual volumetric limits, in  
41 accordance with the 2008 USFWS BO and 2009 NMFS BO. Under the Second  
42 Basis of Comparison, water could be transferred throughout the year without an  
43 annual volumetric limit. Overall, the potential for cross Delta water transfers

1 would be less under the No Action Alternative than under the Second Basis of  
2 Comparison.

### 3 **10.4.3.2 Alternative 1**

4 Alternative 1 is identical to the Second Basis of Comparison. As described in  
5 Chapter 4, Approach to Environmental Analysis, Alternative 1 is compared to the  
6 No Action Alternative and the Second Basis of Comparison. However, because  
7 water resource conditions under Alternative 1 are identical to water resource  
8 conditions under the Second Basis of Comparison; Alternative 1 is only compared  
9 to the No Action Alternative.

#### 10 **10.4.3.2.1 Alternative 1 Compared to the No Action Alternative**

##### 11 *Trinity River Region*

##### 12 *Changes in Rivers Downstream of CVP and SWP Reservoirs*

13 River flows in Trinity River downstream of Lewiston Dam in the critical period  
14 for terrestrial resources of March through May would be similar under  
15 Alternative 1 and the No Action Alternative. Therefore, terrestrial resources  
16 habitat conditions along the Trinity River and lower Klamath River riparian  
17 corridors would be similar under Alternative 1 as compared to the No Action  
18 Alternative.

##### 19 *Central Valley Region*

##### 20 *Changes in Rivers Downstream of CVP and SWP Reservoirs*

21 Flows in the spring months would be similar in the Sacramento River at Keswick  
22 and Freeport and American River downstream of Nimbus Dam; increased in the  
23 Feather River downstream of Thermalito Complex (35 percent); and reduced  
24 flows in the Stanislaus River downstream of Goodwin Dam (60 percent) under  
25 Alternative 1 as compared to the No Action Alternative. This analysis does not  
26 include site specific evaluation of all terrestrial resources along these riparian  
27 corridors. However, the changes in flows are indicative of the potential for  
28 change in the terrestrial resources. Therefore, under Alternative 1 as compared to  
29 the No Action Alternative, the potential for similar or improved terrestrial  
30 resources would occur along the Sacramento, American, and Feather rivers; and  
31 the potential for reduced terrestrial resources would occur along the  
32 Stanislaus River.

33 Monthly Clear Creek flows under Alternative 1 as compared to the No Action  
34 Alternative are identical except in May. In May, under Alternative 1, flows are  
35 up to 29 percent lower as compared to the No Action Alternative. Terrestrial  
36 resources habitat in the floodplains of lower Clear Creek could be decreased  
37 under Alternative 1 as compared to the No Action Alternative.

##### 38 *Potential Effects on Special Status Species*

39 Habitat changes along the riparian corridors related to changes in spring flows  
40 that support riparian vegetation recruitment would affect numerous bird species  
41 that use the riparian corridor, including Black Tern, Least Bell's Vireo, Least  
42 Bittern, Swainson's Hawk, Tricolored Blackbird, Western Yellow-billed Cuckoo,



1 White-tailed Kite, Yellow Warbler, Ringtail, Western Pond Turtle, Valley  
2 Elderberry Longhorn Beetle, and Delta Button-celery. Potential adverse effects  
3 could occur to these species due to reduced flows in the spring months on the  
4 Stanislaus River.

5 *Changes in River and Delta Floodplains*

6 It is assumed that under Alternative 1 and the No Action Alternative, the State of  
7 California would continue to implement flood management projects to reduce  
8 flood risks along the Sacramento and San Joaquin rivers and in the Delta with  
9 consideration for opportunities to restore or maintain the function of natural  
10 ecosystems. The related terrestrial habitat conditions that would occur due to  
11 implementation of the flood management projects would be the same under  
12 Alternative 1 and the No Action Alternative.

13 *Changes in Flows over Fremont Weir into the Yolo Bypass*

14 Flows from the Sacramento River into the Yolo Bypass at Fremont Weir would  
15 be similar or higher under Alternative 1 as compared to the No Action  
16 Alternative; therefore, terrestrial habitat could be similar or increased depending  
17 upon the flow pattern.

18 *Changes in Delta Habitat due to Changes in Water Quality*

19 Under Alternative 1, the freshwater interface would be similar to conditions under  
20 the No Action Alternative in all months in below normal, dry, and critical dry  
21 years; and from January through August in wet and above normal years. In the  
22 fall months in wet years, the X2 location would be 9 to 14 kilometers towards the  
23 east in September through December under Alternative 1 as compared to the No  
24 Action Alternative. This could adversely affect terrestrial species that have  
25 acclimated to freshwater conditions.

26 *Potential Effects on Special Status Species*

27 Higher Delta salinity under Alternative 1 as compared to the No Action  
28 Alternative would reduce habitat conditions for Bolander's Water Hemlock, Delta  
29 Button-celery, Delta Tule Pea, Mason's Lilaeopsis, Soft Birds-beak, Suisun  
30 Marsh Aster, Salt Marsh Harvest Mouse, and Suisun Shrew.

31 *Effects Related to Cross Delta Water Transfers*

32 Potential effects to terrestrial resources could be similar to those identified in a  
33 recent environmental analysis conducted by Reclamation for long-term water  
34 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014d).  
35 Potential effects to terrestrial resources were identified as changes in stream flows  
36 due declining groundwater levels along streams due to the use of groundwater  
37 substitution to provide transfer water. The analysis indicated that these potential  
38 impacts would not be substantial due to the inclusion of a monitoring and  
39 mitigation program.

40 Under Alternative 1, water could be transferred throughout the year without an  
41 annual volumetric limit. Under the No Action Alternative, the timing of cross  
42 Delta water transfers would be limited to July through September and include  
43 annual volumetric limits, in accordance with the 2008 USFWS BO and 2009

1 NMFS BO. Overall, the potential for cross Delta water transfers would be greater  
2 under Alternative 1 as compared to the No Action Alternative.

### 3 **10.4.3.2.2 Alternative 1 Compared to the Second Basis of Comparison**

4 Alternative 1 is identical to the Second Basis of Comparison.

### 5 **10.4.3.3 Alternative 2**

6 The CVP and SWP operations under Alternative 2 are identical to the CVP and  
7 SWP operations under the No Action Alternative; therefore, Alternative 2 is only  
8 compared to the Second Basis of Comparison.

### 9 **10.4.3.3.1 Alternative 2 Compared to the Second Basis of Comparison**

10 The CVP and SWP operations under Alternative 2 are identical to the CVP and  
11 SWP operations under the No Action Alternative. Therefore, changes in  
12 terrestrial resources under Alternative 2 as compared to the Second Basis of  
13 Comparison would be the same as the impacts described in Section 10.4.3.1, No  
14 Action Alternative.

### 15 **10.4.3.4 Alternative 3**

16 As described in Chapter 3, Description of Alternatives, CVP and SWP operations  
17 under Alternative 3 are similar to the Second Basis of Comparison with modified  
18 Old and Middle River flow criteria and New Melones Reservoir operations. As  
19 described in Chapter 4, Approach to Environmental Analysis, Alternative 3 is  
20 compared to the No Action Alternative and the Second Basis of Comparison.

### 21 **10.4.3.4.1 Alternative 3 Compared to the No Action Alternative**

#### 22 *Trinity River Region*

#### 23 *Changes in Rivers Downstream of CVP and SWP Reservoirs*

24 River flows in Trinity River downstream of Lewiston Dam in the critical period  
25 for terrestrial resources of March through May would be similar under  
26 Alternative conditions along the Trinity River and lower Klamath River  
27 riparian corridors would be similar under Alternative 3 as compared to the  
28 No Action Alternative.

#### 29 *Central Valley Region*

#### 30 *Changes in Rivers Downstream of CVP and SWP Reservoirs*

31 Flows in the spring months would be similar in the Sacramento River at Keswick  
32 and Freeport and American River downstream of Nimbus Dam; increased in the  
33 Feather River downstream of Thermalito Complex (25 to 35 percent); and  
34 reduced flows in the Stanislaus River downstream of Goodwin Dam (60 percent)  
35 under Alternative 3 as compared to the No Action Alternative. This analysis does  
36 not include site specific evaluation of all terrestrial resources along these riparian  
37 corridors. However, the changes in flows are indicative of the potential for  
38 change in the terrestrial resources. Therefore, under Alternative 3 as compared to  
39 the No Action Alternative, the potential for similar or improved terrestrial  
40 resources would occur along the Sacramento, American, and Feather rivers; and

1 the potential for reduced terrestrial resources would occur along the  
2 Stanislaus River.

3 Monthly Clear Creek flows under Alternative 3 as compared to the No Action  
4 Alternative are identical except in May. In May, under Alternative 3, flows are  
5 up to 29 percent lower as compared to the No Action Alternative. Terrestrial  
6 resources habitat in the floodplains of lower Clear Creek would be decreased  
7 under Alternative 3 as compared to the No Action Alternative.

8 *Potential Effects on Special Status Species*

9 Habitat changes along the riparian corridors related to changes in spring flows  
10 that support riparian vegetation recruitment would affect numerous bird species  
11 that use the riparian corridor, including Black Tern, Least Bell's Vireo, Least  
12 Bittern, Swainson's Hawk, Tricolored Blackbird, Western Yellow-billed Cuckoo,  
13 White-tailed Kite, Yellow Warbler, Ringtail, Western Pond Turtle, Valley  
14 Elderberry Longhorn Beetle, and Delta Button-celery. Potential adverse effects  
15 could occur to these species due to reduced flows in the spring months on the  
16 Stanislaus River.

17 *Changes in River and Delta Floodplains*

18 It is assumed that under Alternative 3 and the No Action Alternative, the State of  
19 California would continue to implement flood management projects to reduce  
20 flood risks along the Sacramento and San Joaquin rivers and in the Delta with  
21 consideration for opportunities to restore or maintain the function of natural  
22 ecosystems. The related terrestrial habitat that would occur due to  
23 implementation of the flood management projects would be the same under  
24 Alternative 3 and the No Action Alternative.

25 *Changes in Flows over Fremont Weir into the Yolo Bypass*

26 Flows from the Sacramento River into the Yolo Bypass at Fremont Weir would  
27 be similar or higher (10 to 30 percent) under Alternative 3 as compared to the No  
28 Action Alternative. Terrestrial habitat could be similar or increased due to the  
29 flow patterns.

30 *Changes in Delta Habitat due to Changes in Water Quality*

31 Under Alternative 3, the freshwater interface would be similar to conditions under  
32 the No Action Alternative in all months in below normal, dry, and critical dry  
33 years; and from January through August in wet and above normal years. In the  
34 fall months in wet years, the X2 location would be 9 to 14 kilometers towards the  
35 east in September through December under Alternative 3 as compared to the No  
36 Action Alternative.

37 *Potential Effects on Special Status Species*

38 Higher Delta salinity under Alternative 3 as compared to the No Action  
39 Alternative would reduce habitat conditions for Bolander's Water Hemlock, Delta  
40 Button-celery, Delta Tule Pea, Mason's Lilaeopsis, Soft Birds-beak, Suisun  
41 Marsh Aster, Salt Marsh Harvest Mouse, and Suisun Shrew.

1        *Effects Related to Cross Delta Water Transfers*

2 Potential effects to terrestrial resources could be similar to those identified in a  
 3 recent environmental analysis conducted by Reclamation for long-term water  
 4 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014d).  
 5 Potential effects to terrestrial resources were identified as changes in stream flows  
 6 due declining groundwater levels along streams due to the use of groundwater  
 7 substitution to provide transfer water. The analysis indicated that these potential  
 8 impacts would not be substantial due to the inclusion of a monitoring and  
 9 mitigation program.

10 Under Alternative 3, water could be transferred throughout the year without an  
 11 annual volumetric limit. Under the No Action Alternative, the timing of cross  
 12 Delta water transfers would be limited to July through September and include  
 13 annual volumetric limits, in accordance with the 2008 USFWS BO and 2009  
 14 NMFS BO. Overall, the potential for cross Delta water transfers would be greater  
 15 under Alternative 3 as compared to the No Action Alternative.

16    **10.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison**

17    *Trinity River Region*

18        *Changes in Rivers Downstream of CVP and SWP Reservoirs*

19 River flows in Trinity River downstream of Lewiston Dam in the critical period  
 20 for terrestrial resources of March through May would be similar under  
 21 Alternative 3 and the Second Basis of Comparison. Therefore, terrestrial  
 22 resources habitat conditions along the Trinity River and lower Klamath River  
 23 riparian corridors would be similar under Alternative 3 as compared to the Second  
 24 Basis of Comparison.

25    *Central Valley Region*

26        *Changes in Rivers Downstream of CVP and SWP Reservoirs*

27 Flows in the spring months would be similar in the Sacramento River at Keswick  
 28 and Freeport, Feather River downstream of Thermalito Complex, and American  
 29 River downstream of Nimbus Dam; and reduced flows in the Stanislaus River  
 30 downstream of Goodwin Dam (6 to 52 percent, depending upon water year type)  
 31 under Alternative 3 as compared to the Second Basis of Comparison. This  
 32 analysis does not include site specific evaluation of all terrestrial resources along  
 33 these riparian corridors. However, the changes in flows are indicative of the  
 34 potential for change in the terrestrial resources. Therefore, under Alternative 3 as  
 35 compared to the Second Basis of Comparison, the potential for similar terrestrial  
 36 resources habitat would occur along the Sacramento, American, and Feather  
 37 rivers; and the potential for reduced terrestrial resources would occur along the  
 38 Stanislaus River.

39 Monthly Clear Creek flows under Alternative 3 as compared to the Second Basis  
 40 of Comparison are identical under Alternative 3; therefore, terrestrial resources  
 41 habitat in the floodplains of lower Clear Creek would be similar under  
 42 Alternative 3 as compared to the Second Basis of Comparison.

1            *Potential Effects on Special Status Species*

2    Habitat changes along the riparian corridors related to changes in spring flows  
3    that support riparian vegetation recruitment would affect numerous bird species  
4    that use the riparian corridor, including Black Tern, Least Bell's Vireo, Least  
5    Bittern, Swainson's Hawk, Tricolored Blackbird, Western Yellow-billed Cuckoo,  
6    White-tailed Kite, Yellow Warbler, Ringtail, Western Pond Turtle, Valley  
7    Elderberry Longhorn Beetle, and Delta Button-celery. Potential adverse effects  
8    could occur to these species due to reduced flows in the spring months on the  
9    Stanislaus River.

10          *Changes in River and Delta Floodplains*

11    It is assumed that under Alternative 3 and the Second Basis of Comparison, the  
12    State of California would continue to implement flood management projects to  
13    reduce flood risks along the Sacramento and San Joaquin rivers and in the Delta  
14    with consideration for opportunities to restore or maintain the function of natural  
15    ecosystems. The related terrestrial habitat conditions that would occur due to  
16    implementation of the flood management projects would be the same under  
17    Alternative 3 and the Second Basis of Comparison.

18          *Changes in Flows over Fremont Weir into the Yolo Bypass*

19    Flows from the Sacramento River into the Yolo Bypass at Fremont Weir and  
20    associated terrestrial habitat would be similar under Alternative 3 as compared to  
21    the Second Basis of Comparison.

22          *Changes in Delta Habitat due to Changes in Water Quality*

23    Under Alternative 3, the freshwater-saltwater interface would be similar to  
24    conditions under the Second Basis of Comparison in all months and in all water  
25    year types.

26          *Potential Effects on Special Status Species*

27    Delta salinity under Alternative 3 as compared to the Second Basis of Comparison  
28    would result in similar habitat conditions for Bolander's Water Hemlock, Delta  
29    Button-celery, Delta Tule Pea, Mason's Lilaepsis, Soft Birds-beak, Suisun  
30    Marsh Aster, Salt Marsh Harvest Mouse, and Suisun Shrew.

31          *Effects Related to Cross Delta Water Transfers*

32    Potential effects to terrestrial resources could be similar to those identified in a  
33    recent environmental analysis conducted by Reclamation for long-term water  
34    transfers from the Sacramento to San Joaquin valleys (Reclamation 2014d).  
35    Potential effects to terrestrial resources were identified as changes in stream flows  
36    due declining groundwater levels along streams due to the use of groundwater  
37    substitution to provide transfer water. The analysis indicated that these potential  
38    impacts would not be substantial due to the inclusion of a monitoring and  
39    mitigation program.

40    Under Alternative 3 and the Second Basis of Comparison, water could be  
41    transferred throughout the year without an annual volumetric limit. Overall, the  
42    potential for cross Delta water transfers would be similar under Alternative 3 as  
43    compared to the Second Basis of Comparison.

1    **10.4.3.5   Alternative 4**

2    The CVP and SWP operations under Alternative 4 are identical to the CVP and  
3    SWP operations under the Second Basis of Comparison and Alternative 1.  
4    Alternative 4 also includes additional institutional requirements for development  
5    within the floodplain and floodways, including the following items.

- 6    • Compliance with Endangered Species Act in defining floodplain map  
7    revisions.
- 8    • Improvements in floodplain management criteria to support natural and  
9    beneficial functions.
- 10   • Prohibition of new development and substantial improvements to existing  
11   development within any designated floodway or within 170 feet of the  
12   ordinary high water line of any floodway.
- 13   • Modification of USACE requirements to remove vegetation along portions of  
14   the waterside of levees, as described in Section 10.4.3.1, No Action  
15   Alternative.

16   Alternative 4 is compared to the No Action Alternative and the Second Basis of  
17   Comparison.

18   **10.4.3.5.1   Alternative 4 Compared to the No Action Alternative**

19   These actions would not change CVP and SWP operations; and would only affect  
20   the Changes in River and Delta Floodplains. Therefore, changes in terrestrial  
21   resources due to changes in CVP and SWP under Alternative 4 as compared to the  
22   No Action Alternative would be the same as the impacts described in  
23   Section 10.4.3.2.1, Alternative 1 Compared to the No Action Alternative.

24    *Changes in River and Delta Floodplains*

25   It is assumed that under the No Action Alternative, the State of California would  
26   continue to implement flood management projects to reduce flood risks along the  
27   Sacramento and San Joaquin rivers and in the Delta with consideration for  
28   opportunities to restore or maintain the function of natural ecosystems. The  
29   USACE policies for vegetation on levees would be implemented; and by 2030,  
30   much of the vegetation along Delta channels would have been removed.

31   Under Alternative 4, implementation of institutional provisions would result in  
32   development of the floodplains and floodways, especially in the Delta, that would  
33   be similar to development under the No Action Alternative. Under the No Action  
34   Alternative, as described in Chapter 13, Land Use, development along major river  
35   corridors in the Central Valley would be limited by state regulations implemented  
36   by the Central Valley Flood Protection Board and the USACE. Within the Delta,  
37   the floodways are further regulated by the Delta Protection Commission and Delta  
38   Stewardship Council to preserve and protect the natural resources of the Delta;  
39   and prevent encroachment into Delta floodways. These regulations would  
40   prevent development within the Delta floodplains and floodways and in the  
41   Sacramento, Feather, American, and San Joaquin rivers corridors upstream of the  
42   Delta. Under Alternative 4, development would be prevented within 170 feet

1 from the ordinary high water line of any floodway. This setback area could  
2 provide opportunities to establish vegetative corridors.

3 Under Alternative 4 and the No Action Alternative, vegetation management along  
4 the Delta levees would include removal of all vegetation from the upper third of  
5 the waterside slope of the levee, the top of the levee, landside slope of the levee,  
6 and within 15 feet on the landside of the toe of the levee (“toe” is where the levee  
7 slope meets the ground surfaces). Under Alternative 4, vegetation could be  
8 maintained on the lower two-thirds of the waterside slope of the levee and within  
9 15 feet of the toe of the levee on the waterside along benches above the water  
10 surface. This would provide shaded riverine aquatic habitat and riparian  
11 vegetation along many of the Delta channels as compared to the No Action  
12 Alternative.

13 Overall, Alternative 4 would result in increased vegetation along the riparian  
14 corridors related to recruitment of riparian vegetation in the Delta watershed as  
15 compared to the No Action Alternative.

#### 16 **10.4.3.5.2 Alternative 4 Compared to the Second Basis of Comparison**

17 The changes in river and Delta floodplain actions would not change CVP and  
18 SWP operations which would be identical under Alternative 4 and under the  
19 Second Basis of Comparison.

##### 20 *Changes in River and Delta Floodplains*

21 It is assumed that under the Second Basis of Comparison, the State of California  
22 would continue to implement flood management projects to reduce flood risks  
23 along the Sacramento and San Joaquin rivers and in the Delta with consideration  
24 for opportunities to restore or maintain the function of natural ecosystems. The  
25 USACE policies for vegetation on levees would be implemented; and by 2030,  
26 much of the vegetation along Delta channels would have been removed.

27 Under Alternative 4, implementation of institutional provisions would result in  
28 development of the floodplains and floodways, especially in the Delta, that would  
29 be similar to development under the Second Basis of Comparison. Under the  
30 Second Basis of Comparison, as described in Chapter 13, Land Use, development  
31 along major river corridors in the Central Valley would be limited by state  
32 regulations implemented by the Central Valley Flood Protection Board and the  
33 USACE. Within the Delta, the floodways are further regulated by the Delta  
34 Protection Commission and Delta Stewardship Council to preserve and protect the  
35 natural resources of the Delta; and prevent encroachment into Delta floodways.  
36 These regulations would prevent development within the Delta floodplains and  
37 floodways and in the Sacramento, Feather, American, and San Joaquin rivers  
38 corridors upstream of the Delta. Under Alternative 4, development would be  
39 prevented within 170 feet from the ordinary high water line of any floodway.  
40 This setback area could provide opportunities to establish vegetative corridors.

41 Under Alternative 4 and the Second Basis of Comparison, vegetation  
42 management along the Delta levees would include removal of all vegetation from  
43 the upper third of the waterside slope of the levee, the top of the levee, landside

1 slope of the levee, and within 15 feet on the landside of the toe of the levee (“toe”  
 2 is where the levee slope meets the ground surfaces). Under Alternative 4,  
 3 vegetation could be maintained on the lower two-thirds of the waterside slope of  
 4 the levee and within 15 feet of the toe of the levee on the waterside along benches  
 5 above the water surface. This would provide shaded riverine aquatic habitat and  
 6 riparian vegetation along many of the Delta channels as compared to the Second  
 7 Basis of Comparison.

8 Overall, Alternative 4 would result in increased terrestrial resources along the  
 9 riparian corridors related to recruitment of riparian vegetation in the Delta  
 10 watershed as compared to the Second Basis of Comparison.

#### 11 **10.4.3.6 Alternative 5**

12 As described in Chapter 3, Description of Alternatives, CVP and SWP operations  
 13 under Alternative 5 are similar to the No Action Alternative with modified Old  
 14 and Middle River flow criteria and New Melones Reservoir operations. As  
 15 described in Chapter 4, Approach to Environmental Analysis, Alternative 5 is  
 16 compared to the No Action Alternative and the Second Basis of Comparison.

#### 17 **10.4.3.6.1 Alternative 5 Compared to the No Action Alternative**

##### 18 *Trinity River Region*

##### 19 *Changes in Rivers Downstream of CVP and SWP Reservoirs*

20 River flows in Trinity River downstream of Lewiston Dam in the critical period  
 21 for terrestrial resources of March through May would be similar under  
 22 Alternative 5 and the No Action Alternative. Therefore, terrestrial resources  
 23 habitat conditions along the Trinity River and lower Klamath River riparian  
 24 corridors would be similar under Alternative 5 as compared to the No  
 25 Action Alternative.

##### 26 *Central Valley Region*

##### 27 *Changes in Rivers Downstream of CVP and SWP Reservoirs*

28 Flows in the spring months would be similar in the Sacramento River at Keswick  
 29 and Freeport, Feather River downstream of Thermalito Complex, American River  
 30 downstream of Nimbus Dam; and flows in the Stanislaus River downstream of  
 31 Goodwin Dam would increase 22 to 40 percent in some spring months and 8 to  
 32 18 percent in other spring months, depending upon water year type under  
 33 Alternative 5 as compared to the No Action Alternative. This analysis does not  
 34 include site specific evaluation of all terrestrial resources along these riparian  
 35 corridors. However, the changes in flows are indicative of the potential for  
 36 change in the terrestrial resources. Therefore, under Alternative 5 as compared to  
 37 the No Action Alternative, the potential for similar or improved terrestrial  
 38 resources habitat would occur along the Sacramento, Feather, and American  
 39 rivers; and the potential for both increased and reduced terrestrial resources  
 40 habitat would occur along the Stanislaus River.

41 Monthly Clear Creek flows would be identical under Alternative 5 as compared to  
 42 the No Action Alternative; therefore, terrestrial resources habitat in the



1 floodplains of lower Clear Creek would be similar under Alternative 5 as  
2 compared to the Second Basis of Comparison.

3 *Potential Effects on Special Status Species*

4 Habitat changes along the riparian corridors related to changes in spring flows  
5 that support riparian vegetation recruitment would affect numerous bird species  
6 that use the riparian corridor, including Black Tern, Least Bell's Vireo, Least  
7 Bittern, Swainson's Hawk, Tricolored Blackbird, Western Yellow-billed Cuckoo,  
8 White-tailed Kite, Yellow Warbler, Ringtail, Western Pond Turtle, Valley  
9 Elderberry Longhorn Beetle, and Delta Button-celery. Potential adverse effects  
10 could occur to these species due to reduced flows in the spring months on the  
11 Stanislaus River.

12 *Changes in River and Delta Floodplains*

13 It is assumed that under Alternative 5 and the No Action Alternative, the State of  
14 California would continue to implement flood management projects to reduce  
15 flood risks along the Sacramento and San Joaquin rivers and in the Delta with  
16 consideration for opportunities to restore or maintain the function of natural  
17 ecosystems. The related terrestrial habitat conditions that would occur due to  
18 implementation of the flood management projects would be the same under  
19 Alternative 5 and the No Action Alternative.

20 *Changes in Flows over Fremont Weir into the Yolo Bypass*

21 Flows from the Sacramento River into the Yolo Bypass at Fremont Weir and  
22 associated terrestrial habitat would be similar under Alternative 5 as compared to  
23 the No Action Alternative.

24 *Changes in Delta Habitat due to Changes in Water Quality*

25 Under Alternative 5, the freshwater interface would be similar to conditions under  
26 the No Action Alternative in all months and in all water year types.

27 *Potential Effects on Special Status Species*

28 Similar Delta salinity under Alternative 5 as compared to the No Action  
29 Alternative would result in similar habitat conditions for Bolander's Water  
30 Hemlock, Delta Button-celery, Delta Tule Pea, Mason's Lilaeopsis, Soft Birds-  
31 beak, Suisun Marsh Aster, Salt Marsh Harvest Mouse, and Suisun Shrew.

32 *Effects Related to Cross Delta Water Transfers*

33 Potential effects to terrestrial resources could be similar to those identified in a  
34 recent environmental analysis conducted by Reclamation for long-term water  
35 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014d).  
36 Potential effects to terrestrial resources were identified as changes in stream flows  
37 due declining groundwater levels along streams due to the use of groundwater  
38 substitution to provide transfer water. The analysis indicated that these potential  
39 impacts would not be substantial due to the inclusion of a monitoring and  
40 mitigation program.

41 Under Alternative 5 and the No Action Alternative, the timing of cross Delta  
42 water transfers would be limited to July through September and include annual

1 volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO.  
 2 Overall, the potential for cross Delta water transfers would be similar under  
 3 Alternative 5 as compared to the No Action Alternative.

#### 4 **10.4.3.6.2 Alternative 5 Compared to the Second Basis of Comparison**

##### 5 *Trinity River Region*

##### 6 *Changes in Rivers Downstream of CVP and SWP Reservoirs*

7 River flows in Trinity River downstream of Lewiston Dam in the critical period  
 8 for terrestrial resources of March through May would be similar under  
 9 Alternative 5 and the Second Basis of Comparison. Therefore, terrestrial  
 10 resources habitat conditions along the Trinity River and lower Klamath River  
 11 riparian corridors would be similar under Alternative 5 as compared to the Second  
 12 Basis of Comparison.

##### 13 *Central Valley Region*

##### 14 *Changes in Rivers Downstream of CVP and SWP Reservoirs*

15 Flows in the spring months would be similar in the American River downstream  
 16 of Nimbus Dam; increased flows in the Stanislaus River downstream of Goodwin  
 17 Dam (over 100 percent); and reduced in the Sacramento River at Keswick and  
 18 Freeport and Feather River downstream of Thermalito Complex (8 to 13 percent  
 19 and 25 to 45 percent, respectively) under Alternative 5 as compared to the Second  
 20 Basis of Comparison. This analysis does not include site specific evaluation of all  
 21 terrestrial resources along these riparian corridors. However, the changes in flows  
 22 are indicative of the potential for change in the terrestrial resources. Therefore,  
 23 under Alternative 5 as compared to the Second Basis of Comparison, the potential  
 24 for similar or improved terrestrial resources habitat would occur along the  
 25 American and Stanislaus rivers; and the potential for reduced terrestrial resources  
 26 habitat would occur along the Sacramento and Feather rivers.

27 Monthly Clear Creek flows under Alternative 5 as compared to the Second Basis  
 28 of Comparison are identical except in May. In May, under Alternative 5, flows  
 29 are up to 40.7 percent higher than under the Second Basis of Comparison in  
 30 accordance with the 2009 NMFS BO. Terrestrial resources habitat in the  
 31 floodplains of lower Clear Creek would be improved under Alternative 5 as  
 32 compared to the Second Basis of Comparison.

##### 33 *Potential Effects on Special Status Species*

34 Habitat changes along the riparian corridors related to changes in spring flows  
 35 that support riparian vegetation recruitment would affect numerous bird species  
 36 that use the riparian corridor, including Black Tern, Least Bell's Vireo, Least  
 37 Bittern, Swainson's Hawk, Tricolored Blackbird, Western Yellow-billed Cuckoo,  
 38 White-tailed Kite, Yellow Warbler, Ringtail, Western Pond Turtle, Valley  
 39 Elderberry Longhorn Beetle, and Delta Button-celery. Potential adverse effects  
 40 could occur to these species due to reduced flows in the spring months on the  
 41 Sacramento and Feather rivers.

1            *Changes in River and Delta Floodplains*

2    It is assumed that under Alternative 5 and the Second Basis of Comparison, the  
3    State of California would continue to implement flood management projects to  
4    reduce flood risks along the Sacramento and San Joaquin rivers and in the Delta  
5    with consideration for opportunities to restore or maintain the function of natural  
6    ecosystems. The related terrestrial habitat conditions that would occur due to  
7    implementation of the flood management projects would be the same under  
8    Alternative 5 and the Second Basis of Comparison.

9            *Changes in Flows over Fremont Weir into the Yolo Bypass*

10   Flows from the Sacramento River into the Yolo Bypass at Fremont Weir would  
11   similar or lower (24 percent) under Alternative 5 as compared to the Second Basis  
12   of Comparison. The decrease in the extent of flow inundation in the Yolo Bypass  
13   could cause degradation of terrestrial habitat as compared to the Second Basis of  
14   Comparison.

15           *Changes in Delta Habitat due to Changes in Water Quality*

16   Under Alternative 5, the freshwater interface would be similar to conditions under  
17   the Second Basis of Comparison in all months in below normal, dry, and critical  
18   dry years; and from January through August in wet and above normal years. In  
19   the fall months in wet years, the X2 location would be 9 to 14 kilometers towards  
20   the west in September through December under Alternative 5 as compared to the  
21   Second Basis of Comparison.

22           *Potential Effects on Special Status Species*

23   Lower Delta salinity under Alternative 5 as compared to the Second Basis of  
24   Comparison would improve habitat conditions for Bolander's Water Hemlock,  
25   Delta Button-celery, Delta Tule Pea, Mason's Lilaepsis, Soft Birds-beak, Suisun  
26   Marsh Aster, Salt Marsh Harvest Mouse, and Suisun Shrew.

27           *Effects Related to Cross Delta Water Transfers*

28   Potential effects to terrestrial resources could be similar to those identified in a  
29   recent environmental analysis conducted by Reclamation for long-term water  
30   transfers from the Sacramento to San Joaquin valleys (Reclamation 2014d).  
31   Potential effects to terrestrial resources were identified as changes in stream flows  
32   due declining groundwater levels along streams due to the use of groundwater  
33   substitution to provide transfer water. The analysis indicated that these potential  
34   impacts would not be substantial due to the inclusion of a monitoring and  
35   mitigation program.

36   Under Alternative 5, the timing of cross Delta water transfers would be limited to  
37   July through September and include annual volumetric limits, in accordance with  
38   the 2008 USFWS BO and 2009 NMFS BO. Under Second Basis of Comparison,  
39   water could be transferred throughout the year without an annual volumetric limit.  
40   Overall, the potential for cross Delta water transfers would be less under  
41   Alternative 5 as compared to the Second Basis of Comparison.

1 **10.4.3.7 Summary of Environmental Consequences**

2 The results of the environmental consequences of implementation of  
 3 Alternatives 1 through 5 as compared to the No Action Alternative and the  
 4 Second Basis of Comparison are presented in Tables 10.2 and 10.3.

5 **Table 10.2 Comparison of Alternatives 1 through 5 to No Action Alternative**

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	<p>Similar or increased flows along Trinity, Sacramento, American, and Feather rivers in the spring to support riparian terrestrial habitat. Reduced flows along the Stanislaus River in the spring; therefore, could be reduced terrestrial habitat conditions.</p> <p>Similar terrestrial conditions in Yolo Bypass related to water that flows from the Sacramento River at the Fremont Weir.</p> <p>Increased salt water habitat in the western Delta in the fall months of wet and above normal water years could adversely affect species that have acclimated to freshwater conditions.</p>	<p>No mitigation measures identified at this time to reduce flow reduction impacts on the Stanislaus River, and adverse impacts due to increased salinity in the western Delta in the fall months of wet and above normal water year types.</p>
Alternative 2	No effects on terrestrial resources.	None needed
Alternative 3	<p>Similar or increased flows along Trinity, Sacramento, American, and Feather rivers in the spring to support riparian terrestrial habitat. Reduced flows along the Stanislaus River in the spring; therefore, could be reduced terrestrial habitat conditions.</p> <p>Similar or improved terrestrial conditions in Yolo Bypass related to water that flows from the Sacramento River at the Fremont Weir.</p> <p>Increased salt water habitat in the western Delta in the fall months of wet and above normal water years could adversely affect species that have acclimated to freshwater conditions.</p>	<p>No mitigation measures identified at this time to reduce flow reduction impacts on the Stanislaus River, and adverse impacts due to increased salinity in the western Delta in the fall months of wet and above normal water year types.</p>
Alternative 4	<p>Same effects as described for Alternative 1 compared to the No Action Alternative; except for increased terrestrial vegetation along the riparian corridors related to recruitment of riparian vegetation.</p>	<p>No mitigation measures identified at this time to reduce flow reduction impacts on the Stanislaus River, and adverse impacts due to increased salinity in the western Delta in the fall months of wet and above normal water year types.</p>

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<b>Alternative</b>	<b>Potential Change</b>	<b>Consideration for Mitigation Measures</b>
Alternative 5	<p>Similar flows along Trinity, Sacramento, American, and Feather rivers in the spring to support riparian terrestrial habitat. Increased flows along the Stanislaus River in the spring; therefore, could be improved terrestrial habitat conditions.</p> <p>Similar terrestrial conditions in Yolo Bypass related to water that flows from the Sacramento River at the Fremont Weir.</p> <p>Similar freshwater and salt water habitats.</p>	None needed.

Note: Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools, incremental differences of 5 percent or less between alternatives and the No Action Alternative are considered to be “similar.”

1 **Table 10.3 Comparison of No Action Alternative and Alternatives 1 through 5 to**  
 2 **Second Basis of Comparison**

<b>Alternative</b>	<b>Potential Change</b>	<b>Consideration for Mitigation Measures</b>
No Action Alternative	<p>Similar or increased flows along Trinity, Sacramento, American, and Stanislaus rivers in the spring to support riparian terrestrial habitat. Reduced flows along the Feather River in the spring; therefore, could be reduced terrestrial habitat conditions.</p> <p>Similar terrestrial conditions in Yolo Bypass related to water that flows from the Sacramento River at the Fremont Weir.</p> <p>Increased freshwater habitat in the western Delta.</p>	Not considered for this comparison.
Alternative 1	No effects on terrestrial resources.	Not considered for this comparison.
Alternative 2	Same effects as described for No Action Alternative as compared to the Second Basis of Comparison.	Not considered for this comparison.
Alternative 3	<p>Similar or increased flows along Trinity, Sacramento, American, and Feather rivers in the spring to support riparian terrestrial habitat. Reduced flows along the Stanislaus River in the spring; therefore, could be reduced terrestrial habitat conditions.</p> <p>Similar terrestrial conditions in Yolo Bypass related to water that flows from the Sacramento River at the Fremont Weir.</p> <p>Similar freshwater and salt water habitats.</p>	Not considered for this comparison.
Alternative 4	Similar effects except for increased terrestrial vegetation along the riparian corridors related to recruitment of riparian vegetation.	Not considered for this comparison.

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 5	<p>Similar or increased flows along Trinity, American, and Stanislaus rivers in the spring to support riparian terrestrial habitat. Reduced flows along the Sacramento and Feather rivers in the spring; therefore, could be reduced terrestrial habitat conditions.</p> <p>Similar or decreased terrestrial conditions in Yolo Bypass related to similar or lower water that flows from the Sacramento River at the Fremont Weir.</p> <p>Increased freshwater habitat in the western Delta.</p>	Not considered for this comparison.

Note: Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools, incremental differences of 5 percent or less between alternatives and the No Action Alternative are considered to be “similar.”

1     **10.4.3.8 Potential Mitigation Measures**

2 Mitigation measures are included in EISs to avoid, minimize, rectify, reduce,  
3 eliminate, or compensate for adverse environmental effects of alternatives as  
4 compared to the No Action Alternative. Mitigation measures are not included in  
5 this EIS to address adverse impacts under the alternatives as compared to the  
6 Second Basis of Comparison because this analysis was included in this EIS for  
7 information purposes only.

8 Changes in CVP and SWP operations under Alternatives 1, 3, and 4 as compared  
9 to the No Action Alternative would result in adverse changes in terrestrial  
10 resources along Stanislaus River when spring flows are less than under the No  
11 Action Alternative; and when the salinity increases in the western Delta.

12 However, mitigation measures have not been identified at this time to reduce the  
13 adverse effects of flow reductions in the spring on the Stanislaus River and of  
14 increased salinity in the western Delta in the fall months of wet and above normal  
15 water year types under Alternatives 1, 3, and 4.

16     **10.4.3.9 Cumulative Effects Analysis**

17 As described in Chapter 3, the cumulative effects analysis considers projects,  
18 programs, and policies that are not speculative; and are based upon known or  
19 reasonably foreseeable long-range plans, regulations, operating agreements, or  
20 other information that establishes them as reasonably foreseeable.

21 The cumulative effects analysis Alternatives 1 through 5 for Terrestrial Resources  
22 are summarized in Table 10.4.

1 **Table 10.4 Summary of Cumulative Effects on Terrestrial Resources of Alternatives**  
 2 **1 through 5 as Compared to the No Action Alternative**

Scenarios	Actions	Cumulative Effects of Actions
<p>Past &amp; Present, and Future Actions Included in the No Action Alternative and in All Alternatives in Year 2030</p>	<p>Consistent with Affected Environment conditions plus:</p> <p>Actions in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives) including climate change and sea level rise</p> <p>Actions not included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives):</p> <ul style="list-style-type: none"> <li>- Implementation of Federal and state policies and programs, including Clean Water Act (e.g., Total Maximum Daily Loads); Safe Drinking Water Act; Clean Air Act; and flood management programs</li> <li>- General plans for 2030.</li> <li>- Trinity River Restoration Program.</li> <li>- Central Valley Project Improvement Act programs</li> <li>- Folsom Dam Water Control Manual Update</li> <li>- FERC Relicensing for the Middle Fork of the American River Project</li> <li>- San Joaquin River Restoration Program</li> <li>- Contra Loma Recreation Resource Management Plan</li> <li>- San Luis Reservoir State Recreation Area Resource Management Plan/General Plan</li> </ul>	<p><u>These effects would be the same under all alternatives.</u></p> <p>Climate change and sea level rise and development under the general plans are anticipated to reduce carryover storage in reservoirs and changes in stream flow patterns in a manner that would change shoreline, riparian, and floodplain habitat.</p> <p>Other actions, including restoration projects, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to improve shoreline, riparian, and floodplain habitat.</p>
<p>Future Actions Considered as Cumulative Effects Actions in All Alternatives in Year 2030</p>	<p>Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives):</p> <ul style="list-style-type: none"> <li>- Bay-Delta Water Quality Control Plan Update</li> <li>- FERC Relicensing Projects</li> <li>- Bay Delta Conservation Plan (including the California WaterFix alternative)</li> <li>- Shasta Lake Water Resources, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations</li> <li>- El Dorado Water and Power Authority Supplemental Water Rights Project</li> <li>- Semitropic Water Storage District Delta Wetlands</li> <li>- North Bay Aqueduct Alternative Intake</li> <li>- Irrigated Lands Regulatory Program</li> </ul>	<p><u>These effects would be the same under all alternatives.</u></p> <p>Some of the future reasonably foreseeable actions to improve water quality and FERC Relicensing projects would improve shoreline, riparian, and floodplain habitat.</p> <p>Other future reasonably foreseeable actions, such as expanded or new reservoirs, would reduce some types of terrestrial habitat and increase other types of terrestrial habitat within the reservoir area.</p>

Scenarios	Actions	Cumulative Effects of Actions
<p>No Action Alternative with Associated Cumulative Effects Actions in Year 2030</p>	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO</p> <p>Full implementation of the USACE vegetation standards for levees</p>	<p>Implementation of No Action Alternative with future reasonably foreseeable actions would result in changes in stream flows and levee vegetation policies that would result in changes to related terrestrial resources as compared to conditions prior to the BOs.</p> <p>Reduced riparian habitat along levees within the federally authorized levee systems that have maintenance agreements with the USACE as compared to recent conditions.</p>
<p>Alternative 1 with Associated Cumulative Effects Actions in Year 2030</p>	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)</p> <p>Full implementation of the USACE vegetation standards for levees</p>	<p>Implementation of Alternative 1 with future reasonably foreseeable actions would result in changes in stream flows along the Stanislaus River in all water year types, and in salinity in the western Delta fall months of wet and above normal water year types that could result in adverse terrestrial conditions as compared to the No Action Alternative with the added actions.</p> <p>Similar riparian habitat along levees within the federally authorized levee systems that have maintenance agreements with the USACE as compared to the No Action Alternative with the added actions.</p>
<p>Alternative 2 with Associated Cumulative Effects Actions in Year 2030</p>	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions</p> <p>No implementation of structural improvements or other actions that require further study to develop a more detailed action description.</p> <p>Full implementation of the USACE vegetation standards for levees</p>	<p>Implementation of Alternative 2 with future reasonably foreseeable actions for terrestrial resources would be the same as for the No Action Alternative with the added actions.</p>



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Scenarios	Actions	Cumulative Effects of Actions
<p>Alternative 3 with Associated Cumulative Effects Actions in Year 2030</p>	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)</p> <p>Slight increase in positive Old and Middle River flows in the winter and spring months</p> <p>Full implementation of the USACE vegetation standards for levees</p>	<p>Implementation of Alternative 3 with future reasonably foreseeable action would result in changes in stream flows along the Stanislaus River in all water year types, and in salinity in the western Delta fall months of wet and above normal water year types that could result in adverse terrestrial conditions as compared to the No Action Alternative with the added actions.</p> <p>Similar riparian habitat along levees within the federally authorized levee systems that have maintenance agreements with the USACE as compared to the No Action Alternative with the added actions.</p>
<p>Alternative 4 with Associated Cumulative Effects Actions in Year 2030</p>	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)</p> <p>No implementation of the USACE vegetation standards for levees</p>	<p>Implementation of Alternative 4 with future reasonably foreseeable actions would result in changes in stream flows along the Stanislaus River in all water year types, and in salinity in the western Delta fall months of wet and above normal water year types that could result in adverse terrestrial conditions as compared to the No Action Alternative with the added actions.</p> <p>Implementation of Alternative 4 also would result in increased riparian habitat along effected levees</p> <p>Increased riparian habitat along levees within the federally authorized levee systems that have maintenance agreements with the USACE as compared to the No Action Alternative with the added actions.</p>
<p>Alternative 5 with Associated Cumulative Effects Actions in Year 20530</p>	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO</p> <p>Positive Old and Middle River flows and increased Delta outflow in spring months</p> <p>Full implementation of the USACE vegetation standards for levees</p>	<p>Implementation of Alternative 5 with future reasonably foreseeable actions for terrestrial resources would be similar as under the No Action Alternative with the added actions.</p>

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Chapter 10: Terrestrial Biological Resources

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**Chapter 11****1 Geology and Soils Resources****2 11.1 Introduction**

3 This chapter describes the geology and soils resources in the project area; and  
4 potential changes that could occur as a result of implementing the alternatives  
5 evaluated in this Environmental Impact Statement (EIS). Implementation of  
6 alternatives could affect geology and soils resources through potential changes in  
7 operation of the Central Valley Project (CVP) and State Water Project (SWP).

**8 11.2 Regulatory Environment and Compliance  
9 Requirements**

10 Potential actions that could be implemented under the alternatives evaluated in  
11 this EIS could affect reservoirs, streams, and lands served by CVP and SWP  
12 water supplies located on lands affected by seismic, landslide, and liquefaction  
13 hazards; subsidence; and unstable soils. Actions located on public agency lands;  
14 or implemented, funded, or approved by Federal and state agencies would need to  
15 be compliant with appropriate Federal and state agency policies and regulations,  
16 as summarized in Chapter 4, Approach to Environmental Analysis.

**17 11.3 Affected Environment**

18 This section describes the geological, regional seismic, and soils characteristics  
19 and subsidence potential that could be potentially affected by the implementation  
20 of the alternatives considered in this EIS. Changes in soils characteristics due to  
21 changes in CVP and SWP operations may occur in the Trinity River, Central  
22 Valley, San Francisco Bay Area, and Central Coast and Southern California  
23 regions. Geomorphic provinces in California are shown on Figure 11.1.

**24 11.3.1 Trinity River Region**

25 The Trinity River Region includes the area in Trinity County along the Trinity  
26 River from Trinity Lake to the confluence with the Klamath River; and in  
27 Humboldt and Del Norte counties along the Klamath River from the confluence  
28 with the Trinity River to the Pacific Ocean.

**29 11.3.1.1 Geologic Setting**

30 The Trinity River Region is located within the southwest area of the Klamath  
31 Mountains Geomorphic Province and the northwest area of the Coast Ranges  
32 Geomorphic Province, as defined by the U.S. Geological Survey (USGS)  
33 geomorphic provinces (CGS 2002a). The Klamath Mountains Geomorphic  
34 Province covers approximately 12,000 square miles of northwestern California

1 between the Coast Range on the west and the Cascade Range on the east and is  
2 considered to be a northern extension of the Sierra Nevada (CGS 2002a,  
3 Reclamation 1997).

4 The Klamath Mountains trend mostly northward. The province is primarily  
5 formed by the eastern Klamath Mountain belt, central metamorphic belt, the  
6 western Paleozoic and Triassic, and the western Jurassic belt. Rocks in this  
7 province include Paleozoic meta-sedimentary and meta-volcanic rocks, Mesozoic  
8 igneous rocks, Ordovician to Jurassic aged marine deposits in the Klamath belt,  
9 Paleozoic hornblend, mica schists and ultramafic rocks in the central  
10 metamorphic belt and slightly metamorphosed sedimentary and volcanic rocks in  
11 the western Jurassic, Paleozoic, and Triassic belt (Reclamation 1997).

12 The Trinity River watershed is located within the Klamath Mountain Geomorphic  
13 Province. Although the Trinity River watershed includes portions of both the  
14 Coast Ranges Province and the Klamath Mountains Province, the Trinity River  
15 riverbed is underlain by rocks of the Klamath Mountains Province  
16 (NCRWQCB et al. 2009). The Klamath Mountains Province formations  
17 generally dip towards the east and are exposed along the riverbed. Downstream  
18 of Lewiston Dam to Deadwood Creek, the area is underlain by the Eastern  
19 Klamath Terrane of the Klamath Mountains Province. The rocks in this area are  
20 primarily Copley Greenstone, metamorphosed volcanic sequence with  
21 intermediate and mafic volcanic rocks; and Bragdon formation, metamorphosed  
22 sedimentary formation with gneiss and amphibolite. Along the Trinity River  
23 between Lewiston Dam and Douglas City, outcrops of the Weaverville Formation  
24 occur. The Weaverville Formation, a series of nonmarine deposits, includes  
25 weakly consolidated mudstone, sandstone, and conglomerate of clays matrix and  
26 sparse beds of tuff. Downstream of Douglas City, the Trinity River is underlain  
27 by the Northfork and Hayfork terranes. The Northfork Terrane near Douglas City  
28 includes silicious tuff, chert, mafic volcanic rock, phyllite, and limestone  
29 sandstone and pebble conglomerate with serpentine intrusions. As the riverbed  
30 extends towards the Klamath River, the geologic formation extends into the  
31 Hayfork Terrane that consists of metamorphic and meta-volcanic rock. Terraces  
32 of sand and gravel from glacial erosion along the Trinity River flanks near  
33 Lewiston Dam contribute sediment into Trinity River.

34 The Trinity River flows into the Klamath River near Weitchpec. Downstream of  
35 the Weitchpec, the Klamath River flows to the Pacific Ocean through the Coast  
36 Ranges Geomorphic Province. The geology along the Klamath River in the Coast  
37 Ranges Geomorphic Province is characterized by the Eastern Belt of the  
38 Franciscan Complex and portions of the Central Belt of this complex. The  
39 Franciscan Complex consists of sandstone with some shale, chert, limestone,  
40 conglomerate, serpentine, and blueschist. The Eastern Belt is composed of schist  
41 and meta-sedimentary rocks with minor amounts of shale, chert, and  
42 conglomerate. The Central Belt is primarily composed of an argillite-matrix  
43 m $\acute{e}$ lange with slabs of greenstone, serpentine, graywacke, chert, high-grade  
44 metamorphics, and limestone.

1     **11.3.1.2 Regional Seismicity**

2     The areas along the Trinity River have been categorized as regions that are distant  
3     from known, active faults and generally would experience infrequent, low levels  
4     of shaking. However, infrequent earthquakes with stronger shaking could occur  
5     (CGS 2008). The closest areas to the Trinity River with known seismic active  
6     areas capable of producing an earthquake with a magnitude of 8.5 or greater are  
7     the northern San Andreas Fault Zone and the Cascadia Subduction Zone which  
8     are approximately 62 and 124 miles away, respectively (NCRWQCB et al. 2009).

9     The areas along the lower Klamath River downstream of the confluence with the  
10    Trinity River have a slightly higher potential for greater ground shaking than  
11    areas along the Trinity River (CGS 2008). The lower Klamath River is closer  
12    than the Trinity River to the offshore Cascadia Subduction Zone, which runs  
13    offshore of Humboldt and Del Norte counties and Oregon and Washington states.  
14    The Klamath River is approximately 30 to 40 miles from the Trinidad Fault,  
15    which extends from the area near Trinidad northwest to the coast near Trinidad  
16    State Beach. The Trinidad Fault is potentially capable of generating an  
17    earthquake with a moment magnitude of 7.3 (Humboldt County 2012).

18    The San Andreas Fault, under the Pacific Ocean in a northwestern direction from  
19    the Humboldt and Del Norte counties, is where the Pacific Plate moves towards  
20    the northwest relative to North America (Humboldt County 2012). The Cascadia  
21    Subduction Zone, located under the Pacific Ocean offshore from Cape Mendocino  
22    in southwest Humboldt County to Vancouver Island in British Columbia, has  
23    produced numerous earthquakes with magnitudes greater than 8. The Cascadia  
24    Subduction Zone is where the Gorda Plate and the associated Juan de Fuca Plate  
25    descend under the North American Plate.

26    **11.3.1.3 Regional Volcanic Potential**

27    Active centers of volcanic activity occur in the vicinity of Mount Shasta, located  
28    near the northeastern edge of the Trinity River Region. Mount Shasta is located  
29    about 45 miles north of Shasta Lake. Over the past 10,000 years, Mount Shasta  
30    erupted about once every 800 years. During the past 4,500 years, Mount Shasta  
31    erupted about once every 600 years with the most recent eruption in 1786. Lava  
32    flows, dome, and mudflows occurred during the eruptions (Reclamation 2013a).

33    **11.3.1.4 Soil Characteristics**

34    Soils in the southern region of the Klamath Mountain Geomorphic Province,  
35    where the Trinity River is located, are generally composed of gravelly loam with  
36    some alluvial areas with dredge tailings, river wash, and xerofluvents  
37    (NCRWQCB et al. 2009).

38    Soils along the lower Klamath River are generally composed of gravelly clay  
39    loam and gravelly sandy loam with sand and gravels within the alluvial deposits  
40    (DOI and DFG 2012). Alluvial deposits (river gravels) and dredge tailings  
41    provide important spawning habitat for salmon and steelhead.

42    **11.3.1.5 Subsidence**

43    Land subsidence is not a major occurrence in the Trinity River Region.

1 **11.3.2 Central Valley Region**

2 The Central Valley Region extends from above Shasta Lake to the Tehachapi  
3 Mountains, and includes the Sacramento Valley, San Joaquin Valley, Delta, and  
4 Suisun Marsh.

5 **11.3.2.1 Geologic Setting**

6 The Central Valley Region is bounded by the Klamath Mountains, Cascade  
7 Range, Great Valley, Coast Ranges, and Sierra Nevada geomorphic provinces  
8 (CGS 2002a).

9 The Klamath Mountains Geomorphic Province was described in subsection  
10 11.3.2, Trinity River Region. The Cascade Range Geomorphic Province consists  
11 of volcanic rocks of the Miocene to Pleistocene age. Several volcanoes within the  
12 Cascade Range Geomorphic Province and the Central Valley Region include  
13 Mount Shasta and Lassen Peak (Reclamation 2013a).

14 The Great Valley Geomorphic Province is an approximately 400 mile long,  
15 50 mile wide valley that extends from the northwest to the southeast between the  
16 Sierra Nevada and Coast Ranges geomorphic provinces. The faulted and folded  
17 sediments of the Coast Range extend eastward beneath most of the Central  
18 Valley; and the igneous and metamorphic rocks of the Sierra Nevada extend  
19 westward beneath the eastern Central Valley (Reclamation 1997). The valley  
20 floor is an alluvial plain of sediments that have been deposited since the Jurassic  
21 age (CGS 2002a). Below these deposits are Cretaceous Great Valley Sequence  
22 shales and sandstones and upper Jurassic bedrock of metamorphic and igneous  
23 rocks associated in the east with the Sierra Nevada and in the west with the Coast  
24 Ranges (DWR 2007). Sediments deposited along the submarine fans within the  
25 Great Valley Geomorphic Province include mudstones, sandstones, and  
26 conglomerates from the Klamath Mountains and Sierra Nevada geomorphic  
27 provinces.

28 The valley floor in the Great Valley Geomorphic Province includes dissected  
29 uplands, low alluvial fans and plains, river floodplains and channels, and overflow  
30 lands and lake bottoms. The dissected uplands include consolidated and  
31 unconsolidated Tertiary and Quaternary continental deposits. The alluvial fans  
32 along the western boundary include poorly sorted fine sand, silt, and clay. The  
33 alluvial fans along the eastern boundary consist of well sorted gravel and sand  
34 along major tributaries, and poorly sorted materials along intermittent streams.  
35 River and floodplains primarily consist of coarse sands and fine silts. The lake  
36 bottoms primarily occur in the in the southern San Joaquin Valley and composed  
37 of clay layers (Reclamation 1997).

38 The Sierra Nevada Geomorphic Province along the eastern boundary of the Great  
39 Valley Geomorphic Province is composed of pre-Tertiary igneous and  
40 metamorphic rocks. The Sierra Nevada Geomorphic Province is an uplifted fault  
41 block nearly 400 miles long with a series of metamorphic rock on the east and  
42 deep river cuts on a gentle slope, which disappears under sediments of the Central  
43 Valley on the west. Gold-bearing veins are present in the northwest trending

1 Mother Lode metamorphic bedrock. The province is bordered by the Cascade  
 2 Range on the north (Placer County 2007).

3 The Coast Ranges Geomorphic Province is composed of pre-Tertiary and Tertiary  
 4 semiconsolidated to consolidated marine sedimentary rocks. The Coast Ranges  
 5 Province is characterized by active uplift related to the San Andreas Fault and  
 6 plate boundary system tectonics. The province extends westward toward the  
 7 coastline and eastward toward the Great Valley Geomorphic Province. Rocks in  
 8 this region include mafic and ultramafic rock associated with the Coast Range  
 9 ophiolite, and Miocene volcanic rocks (Sonoma Volcanics) and marine and  
 10 terrestrial sedimentary from the Cretaceous to the Neogene period (Reclamation  
 11 et al. 2010).

### 12 **11.3.2.1.1 Sacramento Valley Geological Setting**

13 Major watersheds within the Sacramento Valley that could be affected by CVP  
 14 and SWP operations include the Sacramento River, Feather River, and the Lower  
 15 American River watersheds.

#### 16 *Sacramento River Watershed Geological Setting*

17 The Sacramento River flows from Shasta Lake to the Delta. The area along the  
 18 Sacramento River from Shasta Lake to downstream of Red Bluff is characterized  
 19 by loosely consolidated deposits of Pliocene and or Pleistocene age sandstone,  
 20 shale, and gravel. Downstream of Red Bluff to the Delta, the river flows through  
 21 Quaternary age alluvium, lake, playa, and terrace deposits that are unconsolidated  
 22 or poorly consolidated with outcrops of resistant, cemented alluvial units such as  
 23 the Modesto and Riverbank formations (CALFED 2000).

24 The active river channel maintains roughly constant dimensions as it migrates  
 25 across the floodplain within the limits of the meander belt which is constrained  
 26 only by outcrops of resistant units or artificial bank protection. Sediment loads in  
 27 the tributary streams and lower reaches of the Sacramento River occur due to past  
 28 and current land use practices on the tributary streams.

#### 29 *Feather River Watershed Geological Setting*

30 Portions of the Feather River watershed analyzed in this EIS extend from  
 31 Antelope Lake, Lake Davis, and Frenchman Lake upstream of Lake Oroville,  
 32 through Lake Oroville and the Thermalito Reservoir complex, and along the  
 33 Feather River to the confluence with the Sacramento River. The Yuba and Bear  
 34 rivers are the major tributaries to the Feather River downstream of Thermalito  
 35 Dam.

36 The Feather River watershed upstream of Thermalito Dam is located in the  
 37 Cascade Range Geomorphic Province and the metamorphic belt of the Sierra  
 38 Nevada Geomorphic Province. The lower watershed downstream of Thermalito  
 39 Dam is located in the Great Valley Geomorphic Province.

40 West of Lake Oroville, scattered sedimentary and volcanic deposits cover the  
 41 older bedrock, including (from oldest to youngest) the marine Chico formation  
 42 from the upper Cretaceous; the auriferous gravels and mostly non-marine Ione

1 formation of the Eocene Epoch; the extrusive volcanic Lovejoy basalt of the late  
2 Oligocene to early Miocene; and volcanic flows and volcanoclastic rocks of the  
3 Tuscan formation of the late Pliocene. Late Tertiary and Quaternary units in this  
4 area include alluvial terrace and fan deposits of the Plio-Pleistocene Laguna  
5 formation, the Riverbank and Modesto formations of the Pleistocene, riverbed  
6 sediments of the Holocene, and historical dredge and mine tailings from  
7 20th century mining activities (DWR 2007).

8 Alluvium deposits occur in active channels of the Feather, Bear, and Yuba rivers  
9 and tributary streams. These deposits contain clay, silt, sand, gravel, cobbles, and  
10 boulders in various layers and mixtures. Historical upstream hydraulic mining  
11 significantly increased the sediment covering the lower Feather River riverbed  
12 with a thick deposit of fine clay-rich, light yellow-brown slickens (i.e., powdery  
13 matter from a quartz mill or residue from hydraulic mining). More recent  
14 floodplain deposits cover these slickens in the banks along most of the Feather  
15 River. Cobbles and coarse gravel dredge tailings constitute most of the banks,  
16 slowing the bank erosion process between the cities of Oroville and Gridley. The  
17 river is wide and shallow, with low sinuosity and a sand bed between Honcut Creek  
18 and the mouth of the Feather River.

#### 19 *American River Watershed Geological Setting*

20 The Folsom Lake area is located within the Sierra Nevada and the Great Valley  
21 Geomorphic Province at the confluence of the North and South Forks of the  
22 American River. The Folsom Lake region primarily consists of rolling hills and  
23 upland plateaus between major river canyons. Three major geologic divisions  
24 within the area include a north-northwest trending belt of metamorphic rocks,  
25 granitic plutons that have intruded and obliterated some of the metamorphic belt,  
26 and deposits of volcanic ash, debris flows, and alluvial fans that are relatively flat  
27 lying. These deposits overlie older rocks (Reclamation et al. 2006).

28 Igneous, metamorphic, and sedimentary rock types are present within the Folsom  
29 Lake area. Major rock divisions are ultramafic intrusive rocks, metamorphic  
30 rocks, granodiorite intrusive rocks, and volcanic mud flows and alluvial deposits.  
31 Ultramafic rocks are most common on Flagstaff Mountain (Hill) on the Folsom  
32 Reservoir Peninsula located on a peninsula between the North Fork American  
33 River and South Fork American River. This rock division may contain trace  
34 amounts of serpentine minerals, chromite, minor nickel, talc, and naturally  
35 occurring asbestos (Reclamation et al. 2006).

36 Metamorphic rocks are found in a north-northwest trending band primarily on the  
37 eastern portions of the Folsom Lake area through most of the peninsula between  
38 the North Fork American River and South Fork American River (CGS 2010).

39 The Metamorphic rocks are mainly composed of Copperhill Volcanics  
40 (metamorphosed basaltic breccia, pillow lava, and ash) and Ultramafic rocks, two  
41 formations that may contain trace amounts of naturally occurring asbestos  
42 (Reclamation et al. 2006).

43 Granodiorite intrusive rocks occur in the Rocklin Pluton on both sides of Folsom  
44 Lake extending to Lake Natoma, and the Penryn Pluton upstream of the Rocklin

1 Pluton. Granodiorite intrusive rocks are composed of a coarse-grained crystalline  
2 matrix with slightly more iron and magnesium-bearing minerals and less quartz  
3 than granite. Of the granodiorite, the feldspar and hornblend are less resistant  
4 than the quartz crystals and easily weathers. When weathering occurs, the  
5 remaining feldspars separate from the quartz resulting in decomposed granite  
6 (Reclamation et al. 2006).

7 Volcanic mud flows and alluvial deposits are present downstream of Folsom Lake  
8 in the southwest corner of two major formations, the Mehrten and Laguna  
9 Formation. The Mehrten Formation contains volcanic conglomerate, sandstone,  
10 and siltstone; all derived from andesitic sources and portions are gravels deposited  
11 by ancestral streams. The Laguna Formation, deposited predominately as debris  
12 flow on the Mehrten Formation, is a sequence of gravel, sand and silt derived  
13 from granitic sources (Reclamation et al. 2006).

14 The area along the American River downstream of Folsom Lake and Nimbus  
15 Reservoir is located in the Great Valley Geomorphic Province. The area includes  
16 several geomorphic land types including dissected uplands and low foothills, low  
17 alluvial fans and plains, and river floodplains and channels. The dissected  
18 uplands consist of consolidated and unconsolidated continental deposits of  
19 Tertiary and Quaternary that have been slightly folded and faulted (Reclamation  
20 2005).

21 The alluvial fans and plains consist of unconsolidated continental deposits that  
22 extend from the edges of the valleys toward the valley floor (Reclamation 2005).  
23 The alluvial plains in the American River watershed include older Quaternary  
24 deposits (Sacramento County 2010). River flood plains and channels lay along  
25 the American River and smaller streams that flow into the Sacramento River  
26 south of the American River. Some floodplains are well-defined, where rivers are  
27 incised into their alluvial fans. These deposits tend to be coarse and sandy in the  
28 channels and finer and silty in the floodplains (Reclamation 2005; Sacramento  
29 County 2010).

### 30 **11.3.2.1.2 Delta Geological Setting**

31 The Delta is a northwest-trending structural basin, separating the primarily  
32 granitic rock of the Sierra Nevada from the primarily Franciscan Formation rock  
33 of the California Coast Range (CWDD 1981). The Delta is a basin within the  
34 Great Valley Geomorphic Province that is filled with a 3- to 6-mile thick layer of  
35 sediment deposited by streams originating in the Sierra Nevada, Coast Ranges,  
36 and South Cascade Range. Surficial geologic units throughout the Delta include  
37 peat and organic soils, alluvium, levee and channel deposits, dune sand deposits,  
38 older alluvium, and bedrock.

39 The historical delta at the confluence of the Sacramento River and San Joaquin  
40 River is referred to as the Sacramento–San Joaquin Delta, or Delta. The Delta is a  
41 flat-lying river delta that evolved at the inland margin of the San Francisco Bay  
42 Estuary as two overlapping and coalescing geomorphic units: the Sacramento  
43 River Delta to the north and the San Joaquin River Delta to the south. During  
44 large river-flood events, silts and sands were deposited adjacent to the river



1 channel, formed as a tidal marsh with few natural levees, and was dominated by  
2 tidal flows, allowing for landward accumulation of sediment behind the bedrock  
3 barrier at the Carquinez Strait. The sediment formed marshlands, which consisted  
4 of approximately 100 islands that were surrounded by hundreds of miles of  
5 channels. Generally, mineral soils formed near the channels during flood  
6 conditions and organic soils formed on marsh island interiors as plant residues  
7 accumulated faster than they could decompose (Weir 1949).

8 In the past, because the San Joaquin River Delta had less well-defined levees than  
9 under current conditions, sediments were deposited more uniformly across the  
10 floodplain during high water, creating an extensive tule marsh with many small,  
11 branching tributary channels. Because of the differential amounts of inorganic  
12 sediment supply, the peat of the San Joaquin River Delta grades northward into  
13 peaty mud and mud toward the natural levees and flood basins of the Sacramento  
14 River Delta (Atwater et al. 1980).

15 The Delta has experienced several cycles of deposition, nondeposition, and  
16 erosion that have resulted in the thick accumulation of poorly consolidated to  
17 unconsolidated sediments overlying the Cretaceous and Tertiary formations since  
18 late Quaternary time. Shlemon and Begg (1975) calculated that the peat and  
19 organic soils in the Delta began to form about 11,000 years ago during an episode  
20 of sea level rise. Tule marshes established on peat and organic soils in many  
21 portions of the Delta. Additional peat and other organic soils formed from  
22 repeated inundation and accumulation of sediment of the tules and other marsh  
23 vegetation.

#### 24 **11.3.2.1.3 Suisun Marsh Geological Setting**

25 The Suisun Marsh area is located within the Coast Ranges Geomorphic Province.  
26 The Suisun Marsh is bounded by the steep Coast Range on the west and by the  
27 rolling Montezuma Hills on the east. The Montezuma Hills consist of uplifted  
28 Pleistocene sedimentary layers with active Holocene age alluvium in stream  
29 drainages that divide the uplift. Low-lying flat areas of the marshland are covered  
30 by Holocene age Bay Mud deposits. The topographically higher central portions  
31 of Grizzly Island in the marshlands north of the Suisun Bay are formed by the  
32 Potrero Hills. These hills primarily consist of folded and faulted Eocene marine  
33 sedimentary rocks and late Pleistocene alluvial fan deposits  
34 (Reclamation et al. 2010).

#### 35 **11.3.2.1.4 San Joaquin Valley Geological Setting**

36 The San Joaquin Valley is located within the southern half of the Great Valley  
37 Geomorphic Province. The 250-mile-long and 50-to-60-mile-wide valley lies  
38 between the Coast Ranges on the west, the Sierra Nevada on the east, and extends  
39 northwestward to the Delta near the City of Stockton. The San Joaquin Valley is  
40 the southern portion of a large, northwest-to-southeast-trending asymmetric  
41 trough filled with up to six vertical miles of Jurassic to Holocene age sediments.  
42 The trough is primarily made up of Tertiary and Quaternary continental rocks,  
43 and deposits, which become separated by lacustrine, marsh, and floodplain

1 deposits of varying thicknesses. The continental deposits, which include the  
2 Mehrten, Kern River, Laguna, San Joaquin, Tulare, Tehama, Turlock, Riverbank,  
3 and Modesto formations, form the San Joaquin Valley aquifer (Ferriz 2001,  
4 Reclamation et al. 2011, Reclamation 2009).

5 Dissected uplands, low alluvial fans and plains, river floodplains and channels,  
6 and overflow lands and lake bottoms are the several geomorphic land types within  
7 the San Joaquin Valley. Dissected uplands consist of slightly folded and faulted,  
8 consolidated and unconsolidated, Tertiary and Quaternary age continental  
9 deposits. The alluvial fans and plains, which cover most of the valley floor,  
10 consist of unconsolidated continental deposits that extend from the edges of the  
11 valleys toward the valley floor. In general, alluvial sediments of the western and  
12 southern parts of the San Joaquin Valley tend to have lower permeability than  
13 deposits on the eastern side. River floodplains and channels lie along the major  
14 rivers and are well-defined where rivers incise their alluvial fans. Typically, these  
15 deposits are coarse and sandy in the channels and finer and silty in the floodplains  
16 (Reclamation et al. 2011).

17 Lake bottoms of overflow lands in the San Joaquin Valley include historic beds of  
18 Tulare Lake, Buena Vista Lake, and Kern Lake as well as other less defined areas  
19 in the valley trough. Near the valley trough, fluvial deposits of the east and west  
20 sides grade into fine-grained deposits. The largest lake deposits in the Central  
21 Valley are found beneath the Tulare Lake bed where up to 3,600 feet of lacustrine  
22 and marsh deposits form the Tulare Formation. This formation is composed of  
23 widespread clay layers, the most extensive being the Cocoran Clay member which  
24 also is found in the western and southern portions of the San Joaquin Valley. The  
25 Cocoran Clay member is a confining layer that separates the upper semi-confined  
26 to unconfined aquifer from the lower confined aquifer (Reclamation 1997).

27 The valley floor and foothills portions of the San Joaquin Valley and San Joaquin  
28 River area, and the Stanislaus River watershed could be affected by CVP and  
29 SWP operations. The Stanislaus River watershed originates in the Sierra Nevada  
30 Geomorphic Province, including the area with New Melones Reservoir, and  
31 extends into the Great Valley Geomorphic Province. New Melones Reservoir is  
32 oriented along a northwest trend that is produced by the Foothill Metamorphic  
33 Belt in the Sierra Nevada Geomorphic Province (Reclamation 2010). The area is  
34 underlain by Cenozoic sedimentary rocks which dip towards the southwest and  
35 overlies the Cretaceous sedimentary rocks of the Great Valley sequence and older  
36 metamorphic basement rocks along the edges of the Sierra Nevada. Tertiary  
37 sedimentary formations were deposited along the Stanislaus River from an area  
38 east of Knights Ferry to Oakdale (CGS 1977). The oldest Tertiary geologic unit,  
39 Eocene Ione Formation, primarily consists of quartz, sandstone, and interbedded  
40 kaolinitic clays with a maximum thickness of about 200 feet near Knights Ferry.  
41 The Oligocene-Miocene Valley Springs Formation of rhyolitic ash, sandy clay,  
42 and gravel deposits overlay the Ione Formation. Andestic flows, lahars, and  
43 volcanic sediments of the Mehrten Formation were deposited by volcanism,  
44 especially from Table Mountain (CGS 1977; Reclamation 2010). Three major  
45 alluvial fan deposits occurred along the Stanislaus River after deposition of the

1 Mehrten Formation, including the Turlock Lake Formation (between Orange  
2 Blossom Road and Oakdale) composed of fine sand and silt with some clay, sand,  
3 and gravel; Riverbank Formation (between Oakdale and Riverbank) composed of  
4 silt and clay; and Modesto Formation (between Riverbank and the confluence  
5 with the San Joaquin River) composed of sand, silt, clay, and gravel.

### 6 **11.3.2.2 Regional Seismicity**

7 Most of the areas in the Central Valley Region have been categorized as regions  
8 that are distant from known, active faults and generally would experience  
9 infrequent, low levels of shaking. However, infrequent earthquakes with stronger  
10 shaking could occur (CGS 2008). Areas within and adjacent to the Delta Region  
11 and along Interstate 5 in the San Joaquin Valley have a higher potential for  
12 stronger ground shaking due to their close proximity to the San Andreas Fault  
13 Zone.

14 The San Andreas Fault Zone is located to the west of the Central Valley Region  
15 along a 150-mile northwest-trending fault zone (Reclamation 2013a). The fault  
16 zone extends from the Gulf of California to Point Reyes where the fault extends  
17 under the Pacific Ocean (CGS 2006). The fault zone is the largest active fault in  
18 California (Reclamation 2005d).

19 In the Sacramento Valley, the major fault zones include the Battle Creek Fault  
20 Zone located to the east of the Sacramento River, Corning Fault that extends from  
21 Red Bluff to Artois parallel to the Corning Canal, Dunnigan Hills Fault located  
22 west of Interstate 5 near Dunnigan, Cleveland Fault located near Oroville, and  
23 Great Valley Fault system along the west side of the Sacramento Valley  
24 (Reclamation 2005a, Reclamation 2013a).

25 The Delta and Suisun Marsh are located in proximity to several major fault  
26 systems, including the San Andreas, Hayward-Rodgers Creek, Calaveras,  
27 Concord-Green Valley, and Greenville faults (DWR et al. 2013a). There are also  
28 many named and unnamed regional faults in the vicinity. The majority of seismic  
29 sources underlying the Delta and Suisun Marsh are “blind” thrusts that are not  
30 expected to rupture to the ground surface during an earthquake. The known blind  
31 thrusts in the Delta and Suisun Marsh area include the Midland, Montezuma Hills,  
32 Thornton Arch, Western Tracy, Midland, and Vernalis faults. Blind thrust faults  
33 with discernible geomorphic expression/trace located at the surface occur near the  
34 southwestern boundary of the Delta include Black Butte and Midway faults. Two  
35 surface crustal fault zones (e.g., areas with localized deformation of geologic  
36 features near the surface) are located within the Suisun Marsh, including the  
37 Pittsburgh-Kirby Hills fault which occurs along an alignment between Fairfield  
38 and Pittsburg, and Concord-Green Valley fault which crosses the western portion  
39 of the Suisun Marsh. The Cordelia fault is a surface crustal fault zone that occurs  
40 near the western boundary of the Suisun Marsh. Since 1800, no earthquakes with  
41 a magnitude greater than 5.0 have been recorded in the Delta or Suisun Marsh.

42 In the San Joaquin Valley, the eastern foothills are characterized by strike-slip  
43 faults that occur because the rock underlying the valley sediment is slowly  
44 moving downward relative to the Sierra Nevada Block to the east. An example of

1 this type of faulting is the Kings Canyon lineament which crosses the valley north  
 2 of Chowchilla and continues nearly to Death Valley in southeastern California  
 3 (Reclamation et al. 2011). Uplift and tilting of the Sierra Nevada block towards  
 4 the west and tilting of the Coast Ranges block to the east appear to be causing  
 5 gradual downward movement of the valley basement rock, in addition to  
 6 subsidence caused by aquifer compaction and soil compaction discussed below.  
 7 The San Joaquin Valley is bounded by the Stockton Fault of the Stockton Arch on  
 8 the north and the Bakersfield Arch on the south. Most of the fault zones in the  
 9 San Joaquin Valley do not appear to be active. However, numerous faults may  
 10 not be known until future seismic events, such as the Nunez reverse fault which  
 11 was not known until the 1983 Coalinga earthquake. In areas adjacent to the San  
 12 Joaquin Valley, the dominant active fault structure is the Great Valley blind thrust  
 13 associated with San Andreas Fault. Other active faults occur along the western  
 14 boundary of the San Joaquin Valley, including the Hayward, Concord-Green  
 15 Valley, Coast Ranges-Sierra Block boundary thrusts, Mount Diablo, Greenville,  
 16 Ortigalita, Rinconada, and Hosgri faults (Reclamation 2005d).

### 17 **11.3.2.3 Regional Volcanic Potential**

18 Active centers of volcanic activity occur in the vicinity of Mount Shasta and  
 19 Lassen Peak in the Central Valley Region. Mount Shasta is located about 45  
 20 miles north of Shasta Lake. Over the past 10,000 years, Mount Shasta erupted  
 21 about once every 800 years. During the past 4,500 years, Mount Shasta erupted  
 22 about once every 600 years with the last eruption in 1786. Lava flows, domes,  
 23 and mudflows occurred during the eruptions (Reclamation 2013a).

24 Lassen Peak, located about 50 miles southeast of Shasta Lake, is a cluster of  
 25 dacitic domes and vents that have formed during eruptions over the past  
 26 250,000 years. The last eruptions were relatively small and occurred between  
 27 1914 and 1917. The most recent large eruption occurred about 1,100 years ago.  
 28 Large eruptions appear to occur about once every 10,000 years (USGS 2000a).

### 29 **11.3.2.4 Soil Characteristics**

30 The Central Valley Region includes the Sacramento Valley, Delta, Suisun Marsh,  
 31 and San Joaquin Valley. The soil characteristics are similar in many aspects in  
 32 the Sacramento and San Joaquin valleys; therefore, the descriptions are combined  
 33 in the following sections.

#### 34 **11.3.2.4.1 Sacramento Valley and San Joaquin Valley Soil Characteristics**

35 The Sacramento Valley and San Joaquin Valley contain terrace land and upland  
 36 soils along the foothills; and alluvial, Aeolian, clayey, and saline/alkaline soils in  
 37 various locations along the valley floors (CALFED 2000, Reclamation 1997).

38 Foothills soils, located on well-drained, hilly-to-mountainous terrain along the  
 39 east side of the Central Valley, form through in-place weathering of the  
 40 underlying rock. Soils in the northern Sacramento Valley near Shasta Lake are  
 41 different than soils along other foothills in the Sacramento and San Joaquin  
 42 valleys. The soils near Shasta Lake are related to the geologic formations of the  
 43 Klamath Mountains, Cascade Ranges, and Sierra Nevada geomorphic provinces.

1 These soils are formed from weathered metavolcanic and metasedimentary rocks  
2 and from intrusions of granitic rocks, serpentine, and basalt. These soils are  
3 generally shallow with numerous areas of gravels, cobbles, and stones; therefore,  
4 they do not have high water-holding capacity or support topsoil productivity for  
5 vegetation (Reclamation 2013a). Soils derived from in-place weathering of  
6 granitic rock, referred to as decomposed granite, are coarse-grained, quartz-rich  
7 and erodible.

8 Upland soils along other foothills in the Sacramento and San Joaquin valleys are  
9 formed from the Sierra Nevada and Coast ranges geomorphic provinces. Along  
10 the western boundary of the Central Valley, the soils primarily are formed from  
11 sedimentary rocks. Along the eastern boundary of the Central Valley, the soils  
12 primarily are formed from igneous and metamorphic rock. The soils include  
13 serpentine soils (which include magnesium, nickel, cobalt, chromium, iron, and  
14 asbestos); sedimentary sandstones; shales; conglomerates; and sandy loam, loam,  
15 and clay loam soils above bedrock (Reclamation 1997, Reclamation et al. 2011,  
16 Reclamation 2013a, DWR 2007). Erosion occurs in the upland soils around  
17 reservoirs and rivers especially downgradient of urban development where paving  
18 increases the peak flow, volume, and velocity of precipitation runoff (GCI 2003).

19 Along the western boundary of the Sacramento Valley and the southeastern  
20 boundary of the San Joaquin Valley, the terrace lands include brownish loam, silt  
21 loam, and/or clayey loam soils. The soils are generally loamy along the  
22 Sacramento Valley terraces, and more clayey along the San Joaquin Valley  
23 terraces. Along the eastern boundaries of Sacramento and San Joaquin valleys,  
24 the terraces are primarily red silica-iron cemented hardpan and clays, sometimes  
25 with calcium carbonate (also known as “lime”) (DWR 2007, Reclamation 1997,  
26 Reclamation 2005b, Reclamation 2012).

27 Surface soils of the Central Valley include alluvial and Aeolian soils. The alluvial  
28 soils include calcic brown and noncalcic brown alluvial soils on deep alluvial fans  
29 and floodplains. The calcic brown soil is primarily made of calcium carbonate  
30 and alkaline (also known as “calcerous” soils). The noncalcic brown soils do not  
31 contain calcium carbonate and are either slightly acidic or neutral in chemical  
32 properties. In the western San Joaquin Valley, light colored calcerous soils occur  
33 with less organic matter than the brown soils (Reclamation 1997).

34 Basin soils occur in the San Joaquin Valley and portions of the Delta. These soils  
35 include organic soils, imperfectly drained soils, and saline alkali soils. The  
36 organic soils are typically dark, acidic, high in organic matter, and generally  
37 include peat. The organic soils occur in the Delta, as discussed below, and along  
38 the lower San Joaquin River adjacent to the Delta. The poorly drained soils  
39 contain dark clays and occur in areas with high groundwater in the San Joaquin  
40 Valley trough and as lake bed deposits (Reclamation et al. 2011). One of the  
41 most substantial stratigraphic features of the San Joaquin Valley and a major  
42 aquitard is the Corcoran Clay, located in the western and central valley  
43 (Galloway et al. 1999). The western boundary of the Corcoran Clay is generally  
44 located along the Delta-Mendota Canal and California Aqueduct (as described in  
45 Chapter 5, Surface Water Resources and Water Supply). The Corcoran Clay

1 generally extends from Mendota Pool area through the center of the valley to the  
 2 Tehachapi Mountains. The depth to the Corcoran Clay varies from 160 feet under  
 3 the Tulare Lake bed to less than a foot near the western edge of the Central  
 4 Valley. The Corcoran Clay comprised of numerous aquitards and coarser  
 5 interbeds.

6 Selenium salts and other salts occur naturally in the western and central San  
 7 Joaquin Valley soils that are derived from marine sedimentary rocks of the Coast  
 8 Ranges. Salts are leached from the soils by applied pre-irrigation and irrigation  
 9 water and collected by a series of drains. The drains also reduce high  
 10 groundwater elevations in areas with shallow clay soils. Reclamation and other  
 11 agencies are implementing programs to reduce salinity issues in the San Joaquin  
 12 Valley that will convey and dispose of drainage water in a manner that would  
 13 protect the surface water and groundwater resources (Reclamation et al. 2011).  
 14 As described in Chapter 12, Agricultural Resources, many portions of the western  
 15 and central San Joaquin Valley are no longer supporting irrigated crops or are  
 16 experiencing low crop yields due to the saline soils.

17 Soils in the eastern San Joaquin Valley come from the Sierra Nevada and contain  
 18 low levels of salt and selenium. Most soils in the western and southern San  
 19 Joaquin Valley are formed from Coast Range marine sediments, and contain  
 20 higher concentrations of salts as well as selenium and molybdenum. Soluble  
 21 selenium moves from soils into drainage water and groundwater, especially  
 22 during agricultural operations to leach salts from the soils. As described in  
 23 Chapter 3, Description of Alternatives, Reclamation and other agencies are  
 24 implementing programs to reduce the discharge of selenium from the San Joaquin  
 25 Valley into receiving waters (Reclamation 2005d, Reclamation et al. 2011,  
 26 Reclamation 2009). Additional information related to concerns with salinity and  
 27 selenium in the San Joaquin Valley is presented in Chapter 6, Surface Water  
 28 Quality, and Chapter 12, Agricultural Resources.

29 Soil wind erosion is related to soil erodibility, wind speeds, soil moisture, surface  
 30 roughness, and vegetative cover. Aeolian soils are more susceptible to wind  
 31 erosion than alluvial soils. Non-irrigated soils that have been disturbed by  
 32 cultivation or other activities throughout the Central Valley are more susceptible  
 33 to wind erosion and subsequent blowing dust than soils with more soil moisture.  
 34 Dust from eroding soils can create hazards due to soil composition (such as  
 35 naturally-occurring asbestos), allergic reactions to dust, adverse impacts to plants  
 36 due to dust, and increased risk of valley fever (as discussed in Chapter 18, Public  
 37 Health) (Reclamation 2005d).

#### 38 **11.3.2.4.2 Delta Soil Characteristics**

39 Soils in the Delta include organic and/or highly organic mineral soils; deltaic soils  
 40 along the Sacramento and San Joaquin rivers; basin rim soils; floodplain and  
 41 stream terrace soils; valley alluvial and low terrace soils; and upland and high  
 42 terrace soils (Reclamation 1997). Basin, deltaic, and organic soils occupy the  
 43 lowest elevation ranges and are often protected by levees. In many areas of the

1 western Delta, the soils contain substantial organic matter and are classified as  
2 peat or muck.

3 Basin rim soils are found along the eastern edges (rims) of the Delta, and are  
4 generally moderately deep or deep mineral soils that are poorly drained to well-  
5 drained and have fine textures in surface horizons. Some areas contain soils with  
6 a hardpan layer in the subsurface (SCS 1992, 1993). Floodplain and stream  
7 terrace soils are mineral soils adjacent to the Sacramento and San Joaquin rivers  
8 and other major tributaries. These soils are typically deep and stratified, with  
9 relatively poor drainage and fine textures. Valley fill, alluvial fan, and low terrace  
10 soils are typically very deep with variable texture and ability to transmit water  
11 ranging from somewhat poorly drained fine sandy loams and silty clay loams to  
12 well-drained silt loams and silty clay loams. Upland and high terrace soils are  
13 generally well-drained ranging in texture from loams to clays and are primarily  
14 formed in material weathered from sandstone, shale, and siltstone, and can occur  
15 on dissected terraces or on mountainous uplands.

16 Soils within the Yolo Bypass area range from clays to silty clay loams and  
17 alluvial soils (CALFED 2001, DFG et al. 2008). The higher clay content soils  
18 occur in the western portion of the basin north of Interstate 80 and in the eastern  
19 portion of the basin south of Interstate 80. The silty clay loams and alluvial soils  
20 occur in the western portion of the basin south of Interstate 80, including soils  
21 within the Yolo Bypass Wildlife Area.

22 Soil erosion by rainfall or flowing water occurs when raindrops detach soil  
23 particles or when flowing water erodes and transports soil material. Sandy  
24 alluvial soils, silty lacustrine soil, and highly organic soil are erodible. Organic  
25 soil (peat) in the Delta is also susceptible to wind erosion (deflation). Clay soils  
26 are erosion resistant.

#### 27 **11.3.2.4.3 Suisun Marsh Soil Characteristics**

28 Soil within the Suisun Bay include the Joice muck, Suisun peaty muck, and  
29 Tamba mucky clay; Reyes silty clay; and Valdez loam (SCS 1977a, Reclamation  
30 et al. 2010). The Joice muck generally is poorly drained organic soils in saline  
31 water areas interspersed with fine-grain sediment. Suisun peaty muck is formed  
32 from dark colored organic soils and plant materials with high permeability. These  
33 soils are generally located in areas with shallow surface water and groundwater;  
34 therefore, surface water tends to accumulate on the surface. Tamba mucky clay  
35 also are poorly drained organic soils formed from alluvial soils and plant  
36 materials that overlays mucky clays. Reyes silty clays are poorly drained soils  
37 formed from alluvium. The upper layers of the silty clays are acidic and saline.  
38 The lower layers are alkaline that become acidic when exposed to air, especially  
39 under wetting-drying conditions in tidal areas. Valdez loam soils are poorly  
40 drained soils formed on alluvial fans.

41 Suisun Marsh soils have a low susceptibility to water and wind erosion  
42 (SCS 1977a, Reclamation et al. 2010).

### 1 **11.3.2.5 Subsidence**

2 Land subsidence occurs for different reasons throughout the Central Valley as  
3 described in the following sections.

#### 4 **11.3.2.5.1 Sacramento and San Joaquin Valley Subsidence**

5 Land subsidence in the Sacramento Valley primarily occurs due to aquifer-system  
6 compaction as groundwater elevations decline; weathering of underlying of some-  
7 types of bedrock, such as limestone; decomposition of organic matter; and natural  
8 compaction of soils (Reclamation 2013a). Historic subsidence of the Sacramento  
9 Valley has been far less than that observed in the San Joaquin Valley. For  
10 example, the range of recent historic subsidence in the Sacramento Valley is  
11 generally less than 10 feet. Historical subsidence in the San Joaquin Valley has  
12 caused changes in land elevations of more than 30 feet.

13 In the 1970s, land subsidence exceeded 1 foot near Zamora; however, additional  
14 subsidence has not been reported since 1973 (Reclamation 2013a). Subsidence  
15 has been reported of two feet near Davis and three to four feet over the last  
16 several decades in the areas north of Woodland and east of Davis and Woodland  
17 (Davis 2007).

18 San Joaquin Valley subsidence primarily occurs when groundwater elevations  
19 decline which reduces water pressure in the soils and results in compressed clay  
20 lenses and subsided land elevations. Other factors that may influence the rate of  
21 subsidence in the San Joaquin Valley is the Sierran uplift, sediment loading and  
22 compressional down-warping or thrust loading from the Coast Ranges, and near  
23 surface compaction (Reclamation et al. 2011). Some of the first reports of land  
24 subsidence in the San Joaquin Valley occurred in 1935 in the area near Delano  
25 (Galloway et al. 1999). By the late 1960s, San Joaquin Valley subsidence had  
26 occurred over 5,212 square miles, or almost 50 percent of the San Joaquin Valley  
27 (Reclamation 2005d). During that period, some areas subsided over 33 vertical  
28 feet since the late 1880s. The rate of subsidence reduced initially following  
29 implementation of CVP and SWP water supplies in the San Joaquin Valley during  
30 the 1970s and 1980s. The rate of subsidence for the next twenty years appeared  
31 to continue at a rate of 0.008 to 0.016 inches/year in recent years (Reclamation et  
32 al. 2011). However, the amount of water available for irrigation from the CVP  
33 and SWP has declined more than 20 to 30 percent since the early 1980s due to  
34 hydrologic, regulatory, and operational concerns, as described in Chapter 1,  
35 Introduction. Due to the reduction in the availability of CVP and SWP water  
36 supplies, many water users have increased groundwater withdrawal. A recent  
37 study by the USGS of subsidence along the CVP Delta-Mendota Canal  
38 (USGS 2013b) reported that in areas where groundwater levels fluctuated  
39 consistently on a seasonal basis but were stable on a long-term basis, the land  
40 elevations also were relatively stable. Subsidence occurred in portions of the  
41 San Joaquin Valley where groundwater elevations below the Corcoran clay and in  
42 the shallow groundwater declined on a long-term basis between 2003 and 2010.  
43 The highest subsidence rates occurred along the Delta Mendota Canal between  
44 Merced and Mendota with subsidence of 0.8 inches to 21 inches between 2003  
45 and 2010.



1 Shallow subsidence, or hydrocompaction, occurs when low density, relatively  
2 dry, fine-grained sediments soften and collapse upon wetting. Historically,  
3 hydrocompaction has been most common along the western margin of the San  
4 Joaquin Valley (Reclamation 2005c). In the southern San Joaquin Valley,  
5 extraction of oil also can result in compaction. Changes in elevation, both  
6 subsidence and uplift, occurred near Coalinga following the 1983 Coalinga  
7 earthquake with uplift up to 1.6 feet and subsidence of 2 inches.

#### 8 **11.3.2.5.2 Delta and Suisun Marsh Subsidence**

9 Land subsidence on the islands in the central and western Delta and Suisun Marsh  
10 may be caused by the elimination of tidal inundation that formed the islands  
11 through sediment deposition and transport, and the oxidation and decay of plant  
12 materials that would compact to form soils. Following construction of levees,  
13 subsidence initially occurred through the mechanical settling of peat as the soil  
14 dried; and then, the dried peat and other soils shrunk (Reclamation et al. 2013,  
15 Drexler et al. 2009). Agricultural burning of peat (which has been discontinued),  
16 wind erosion, oxidation, and leaching of organic material. The rate of subsidence  
17 has declined from a maximum of 1.1 to 4.6 inches/year in the 1950s to less than  
18 0.2 to 1.2 inches/year in the western Delta (Drexler et al. 2009, Rojstaczer et al.  
19 1991). Many of the islands in the western and central Delta have subsided to  
20 elevations that are 10 to nearly 55 feet below sea level (USGS 2000b, Deverel and  
21 Leighton 2010).

22 Recently, the California Department of Water Resources has implemented several  
23 projects to reverse subsidence. The 274-acre Mayberry Farms Duck Club  
24 Subsidence Reversal Project on Sherman Island includes creation of emergent  
25 wetlands ponds and channels through excavation of peat soils, improving of water  
26 movement, and waterfowl habitat. The facility was constructed in 2010 and is  
27 being monitored to determine the effectiveness of subsidence reversal, methyl  
28 mercury management, and carbon sequestration (DWR 2013). The Department of  
29 Water Resources and USGS implemented wetlands restoration for about 15 acres  
30 on Twitchell Island in 1997 (DWR et al. 2013b) to encourage tule and cattail  
31 growth. After the growing season, the decomposed plant material accumulates  
32 and increases the land elevation. Since 1997, elevations have increased at a rate  
33 of 1.3 to 2.2 inches/year.

#### 34 **11.3.3 San Francisco Bay Area Region**

35 The San Francisco Bay Area Region includes portions of Contra Costa, Alameda,  
36 Santa Clara, San Benito, and Napa counties that are within the CVP and SWP  
37 service areas. Portions of Napa County are within the SWP service area that use  
38 water diverted from Barker Slough in the Sacramento River watershed for  
39 portions of Solano and Napa counties. Solano County was discussed under the  
40 Delta area of the Central Valley Region. Napa County is described under the  
41 San Francisco Bay Area Region.

### 1 **11.3.3.1 Geologic Setting**

2 The San Francisco Bay Area Region primarily is located within the Coast Ranges  
3 Geomorphic Province. Eastern Contra Costa and Alameda counties are located in  
4 the Great Valley Geomorphic Province. The Coast Ranges and Great Valley  
5 geomorphic provinces were described in Section 11.3.2, Central Valley Region.  
6 San Francisco Bay is a structural trough formed as a gap in the Coast Range  
7 down-dropped to allow the Sacramento, San Joaquin, Napa, Guadalupe, and  
8 Coyote Rivers to flow into the Pacific Ocean. When the polar ice caps melted  
9 10,000 to 25,000 years ago the ocean filled the inland valleys of the trough and  
10 formed San Francisco Bay, San Pablo Bay, and Suisun Bay (CALFED 2000).  
11 Initially, alluvial sands, silts, and clays filled the bays to form Bay Mud along the  
12 shoreline areas. Sedimentation patterns have changed over the past 150 years due  
13 to development of upstream areas of the watersheds which changed sedimentation  
14 and hydraulic flow patterns, hydraulic mining, and formation of levees and dams.

15 The San Francisco Bay Area is formed from the Salinian block located west of the  
16 San Andreas Fault; Mesozoic Franciscan complex located between the San  
17 Andreas and Hayward faults; and the Great Valley sequence located to the east of  
18 Hayward Fault (WTA 2003). The Salinian block generally is composed of  
19 granitic plutonic rocks probably from the Sierra Nevada Batholith that was  
20 displaced due to movement along the San Andreas Fault. The Franciscan  
21 complex includes deep marine sandstone and shale formed from oceanic crust  
22 with chert and limestone. The Great Valley sequence primarily includes marine  
23 sedimentary rocks.

### 24 **11.3.3.2 Regional Seismicity**

25 Large earthquakes have occurred in the San Francisco Bay Area Region along the  
26 San Andreas, Hayward, Calaveras, Greenville, Antioch, Concord-Green Valley,  
27 Midway, Midland, and Black Butte fault zones over the past 10,000 years. The  
28 San Francisco earthquake of 1906 took place as the result of movement along the  
29 San Andreas Fault. The San Andreas Fault remains active, as does the Hayward  
30 Fault, based on evidence of slippage along both (CALFED 2000).

### 31 **11.3.3.3 Soil Characteristics**

32 The San Francisco Bay Area Region soils include basin floor/basin rim,  
33 floodplain/valley land, terrace, foothill, and mountain soils (CALFED 2000).  
34 Basin floor/basin rim soils are organic-rich saline soils and poorly drained clays,  
35 clay loams, silty clay loams, and muck along the San Francisco Bay shoreline  
36 (SCS 1977b, 1981a; CALFED 2000). Well-drained sands and loamy sands and  
37 poorly-drained silty loams, clay loams, and clays occur on gently sloping alluvial  
38 fans of the San Francisco Bay Area Region that surround the floodplain and  
39 valley lands. Drained loams, silty loams, silty clay loams, and clay loams  
40 interbedded with sedimentary rock and some igneous rock occur in the foothills.  
41 Terrace loams are located along the southeastern edge of the San Francisco Bay  
42 Area Region above the valley land.

1     **11.3.3.4 Subsidence**

2 Subsidence in the San Francisco Bay Area Region primarily occurs in the Santa  
3 Clara Valley of Santa Clara County. The Santa Clara Valley is characterized by a  
4 groundwater aquifer with layers of non-consolidated porous soils interspersed  
5 with clay lenses. Historically, when the groundwater aquifer was in overdraft, the  
6 water pressure in the soils declined which resulted in compressed clay lenses and  
7 subsided land elevations. Between 1940 and 1970, soils near San Francisco Bay  
8 declined to elevations below sea level (SCVWD 2000). Under these conditions,  
9 salt water intrusion and tidal flooding occurred in the tributary streams of  
10 Guadalupe River and Coyote Creek. As of 2000, the land elevation in downtown  
11 San Jose subsided 13 feet since 1915. In 1951, water deliveries from San  
12 Francisco Water Department were initiated (Ingebritsen et al. 1999). In 1965,  
13 SWP deliveries were initiated in Santa Clara County. CVP water deliveries were  
14 initiated in 1987. The CVP and SWP water supplies are used to reduce  
15 groundwater withdrawals when groundwater elevations are low to allow natural  
16 recharge from local surface waters. The CVP and SWP also are used to directly  
17 recharge the groundwater through spreading basins in Santa Clara Valley.

18     **11.3.3.5 Central Coast and Southern California Regions**

19 The Central Coast Region includes portions of San Luis Obispo and Santa  
20 Barbara counties served by the SWP. The Southern California Region includes  
21 portions of Ventura, Los Angeles, Orange, San Diego, Riverside, and San  
22 Bernardino counties served by the SWP.

23 As described in Chapter 4, Approach to Environmental Analysis, the Southern  
24 California Region includes areas affected by operations of the SWP, including the  
25 Coachella Valley in Riverside County. The Coachella Valley Water District  
26 receives water under a SWP entitlement contract; however, SWP water cannot be  
27 conveyed directly to the Coachella Valley due to lack of conveyance facilities.  
28 Therefore, Coachella Valley Water District receives water from the Colorado  
29 River through an exchange agreement with the Metropolitan Water District of  
30 Southern California, as described in Chapter 5, Surface Water Resources and  
31 Water Supplies. The Imperial Valley, located to the southeast of the Southern  
32 California Region, receives irrigation water from the Colorado River through  
33 Reclamation canals; and does not use CVP or SWP water.

34     **11.3.3.6 Geologic Setting**

35 The Central Coast and Southern California Regions are located in the Coast  
36 Ranges, Transverse Ranges, Peninsular Ranges, Colorado Desert, and Mojave  
37 Desert geomorphic provinces (CGS 2002a).

38 The Central Coast Region includes portions of San Luis Obispo and Santa  
39 Barbara counties that use SWP water supplies. These areas are located within the  
40 Coast Ranges and Transverse Ranges geomorphic provinces. The Coast Ranges  
41 Geomorphic Province was described in Section 11.3.2, Central Valley Region.  
42 The Transverse Ranges Geomorphic Province consists of deeply folded and  
43 faulted sedimentary rocks (CGS 2002a, SBCAG 2013). Bedrock along the stream  
44 channels, coastal terraces, and coastal lowlands is overlain by alluvial and terrace

1 deposits; and, in some area, ancient sand dunes. The geomorphic province is  
2 being uplifted at the southern border along San Andreas Fault and compressed at  
3 the northern border along the Coast Ranges Geomorphic Province. Therefore, the  
4 geologic structure of the ridges and valleys are oriented along an east-west  
5 orientation, or in a “transverse” orientation, as compared to the north-south  
6 orientation of the Coast Range.

7 The Southern California Region includes portions of Ventura, Los Angeles,  
8 Orange, San Diego, Riverside, and San Bernardino counties that use SWP water  
9 supplies. These areas are located within the Transverse Ranges, Peninsular  
10 Ranges, Mojave Desert, and Colorado Desert geomorphic provinces. The  
11 Transverse Ranges Geomorphic Province includes Ventura County and portions  
12 of Los Angeles, San Bernardino, and Riverside counties. The Colorado Desert  
13 Geomorphic Province is also known as the Salton Trough where the Pacific and  
14 North American plants are separating.

15 The Peninsular Ranges Geomorphic Province is composed of granitic rock with  
16 metamorphic rocks (CGS 2002a, SCAG 2011, San Diego County 2011). The  
17 geologic structure is similar to the geology of the Sierra Nevada Geomorphic  
18 Province. The faulting of this geomorphic province has resulted in northwest  
19 trending valleys and ridges that extend into the Pacific Ocean to form the Santa  
20 Catalina, Santa Barbara, San Clemente, and San Nicolas islands. The Peninsular  
21 Ranges Geomorphic Province includes Orange County and portions of southern  
22 Los Angeles County, western San Diego County, northwestern San Bernardino  
23 County, and northern Riverside County (including the northern portion of the  
24 Coachella Valley).

25 The Mojave Desert Geomorphic Province is located between the Garlock Fault  
26 along the southern boundary of the Sierra Nevada Geomorphic Province and the  
27 San Andreas Fault (CGS 2002a, SCAG 2011, RCIP 2000). This geomorphic  
28 province includes extensive alluvial basins with non-marine sediments from the  
29 surrounding mountains and foothills; and many isolated ephemeral lakebeds (also  
30 known as “playas”) occur within this region with tributary streams from isolated  
31 mountain ranges. The Mojave Desert Geomorphic Province includes portions of  
32 Kern, Los Angeles, Riverside, and San Bernardino counties.

33 The Colorado Desert Geomorphic Province, or Salton Trough, is characterized by  
34 a geographically-depressed desert that extends northward from the Gulf of  
35 California (located at the mouth of the Colorado River) towards the Mojave  
36 Desert Geomorphic Province where the Pacific and North American plants are  
37 separating (CGS 2002a, SCAG 2011, RCIP 2000, San Diego County 2011).  
38 Large portions of this geomorphic province were formed by the inundation of the  
39 ancient Lake Cahuilla and are filled with sediments several miles thick from the  
40 historic Colorado River overflows and erosion of the Peninsular Ranges uplands.  
41 The Salton Trough is separated from the Gulf of California by a large ridge of  
42 sediment. The Salton Sea occurs within the trough along an ancient playa. The  
43 Colorado Desert Geomorphic Province includes portions of Riverside County in  
44 the Coachella Valley; and portions of San Diego and Imperial counties that are  
45 located outside of the study area.

1     **11.3.3.7 Regional Seismicity**

2     Most of the areas in the Central Coast and Southern California regions are  
3     characterized by active faults that are capable of producing major earthquakes  
4     with substantial ground displacement. The San Andreas Fault Zone extends from  
5     the Gulf of California and extends in a northwest direction throughout the Central  
6     Coast and Southern California regions (CGS 2006).

7     Within portions of San Luis Obispo County that use SWP water supplies, the  
8     Nacimiento Fault also can result in major seismic events (CGS 2006, San Luis  
9     Obispo County 2010a).

10    The northern portions of Santa Barbara County that use SWP water supplies  
11    include Lion’s Head Fault along the Pacific Ocean shoreline to the southwest of  
12    Santa Maria and along the northern boundary of Vandenberg Air Force Base  
13    (CGS 2006, SBCAG 2013). The Big Pine Fault may extend into the Vandenberg  
14    Air Force Base area. Areas near the mouth of the Santa Ynez River and Point  
15    Arguello could be affected by Lompoc Terrace Fault and Santa Ynez-Pacifico  
16    Fault Zone. The Santa Ynez Fault extends across this county and could affect  
17    communities near Santa Ynez. Along the southern coast of Santa Barbara County  
18    from Goleta to Carpinteria, the area includes many active faults, including More  
19    Ranch, Mission Ridge, Arroyo Parida, and Red Mountain faults; and potentially  
20    active faults, including Goleta, Mesa-Rincon, and Carpinteria faults.

21    Portions of Ventura County that use SWP water supplies are located in the  
22    southern portion of the county adjacent to Los Angeles County. Major faults in  
23    this area include the Oak Ridge Fault that extends into the Oxnard Plain along the  
24    south side of the Santa Clara River Valley and may extend into San Fernando  
25    Valley in Los Angeles County; Bailey Fault that extends from the Pacific Ocean  
26    to the Camarillo Fault; Simi-Santa Rosa, Camarillo, and Springville faults in Simi  
27    and Tierra Rejada valleys and near Camarillo; Sycamore Canyon and Boney  
28    Mountain faults that extend from the Pacific Ocean towards Thousand Oaks  
29    (CGS 2006, Ventura County 2011).

30    Los Angeles County major fault zones include Northridge Hills, San Gabriel,  
31    San Fernando, Verduga, Sierra Madre, Raymond, Hollywood, Santa Monica, and  
32    Malibu Coast fault zones; Elysian Park Fold and Thrust Belt in Los Angeles  
33    County; and Newport, Inglewood, Whittier, and Palos Verdes fault zones that  
34    extend into Los Angeles and Orange counties (CGS 2006, Los Angeles 2005).  
35    Recent major seismic events that have occurred in Southern California along  
36    faults in Los Angeles include the 1971 San Fernando, 1987 Whittier Narrows,  
37    1991 Sierra Madre, and 1994 Northridge earthquakes.

38    Riverside and San Bernardino counties are characterized by the San Andreas  
39    Fault Zone that extends from the eastern boundaries of these counties and crosses  
40    to the western side of San Bernardino County (CGS 2006, RCIP 2000, Riverside  
41    County 2000, SCAG 2011, DWR 2009). The San Jacinto Fault Zone also extends  
42    through the center of Riverside County and along the western side of San  
43    Bernardino County. The Elsinore Fault Zone extends along the western sides of  
44    both counties. In San Bernardino County, the Cucamonga Fault extends into

1 Los Angeles County where it intersects with the Sierra Madre and Raymond  
 2 faults. The Garlock and Lockhart fault zones extend into both San Bernardino  
 3 and Kern counties. San Bernardino County also includes several other major fault  
 4 zones, including North Frontal, and Helendale faults.

5 Portions of San Diego County that use SWP water supplies include the Rose  
 6 Canyon Fault Zone located along the Pacific Ocean shoreline and extends into the  
 7 City of San Diego (San Diego County 2011).

#### 8 **11.3.3.8 Soil Characteristics**

9 In the Central Coast Region, areas within San Luis Obispo and Santa Barbara  
 10 counties that use SWP water supplies are located within coastal valleys or along  
 11 the Pacific Ocean shoreline. In San Luis Obispo County, Morro Bay, Pismo  
 12 Beach, and Oceano areas are located along the coast with soils that range from  
 13 sands and loamy sands in areas near the shoreline to shaly loams, clay loams, and  
 14 clays in the terraces and foothills located along the eastern boundaries of these  
 15 communities (SBCAG 2010b, NRCS 2014a, NRCS 2014b). In Santa Barbara  
 16 County, the Santa Maria, Vandenberg Air Force Base, Santa Ynez, Goleta, Santa  
 17 Barbara, and Carpinteria areas are located in alluvial plains, along stream  
 18 channels with alluvium deposits, along the shoreline, or along marine terrace  
 19 deposits above the Pacific Ocean. The soils range from sands, sandy loams,  
 20 loams, shaly loams, and clay loams in the alluvial soils and along the shoreline.  
 21 The terrace deposits include silty clays, clay loams, and clays (NRCS 2014c,  
 22 NRCS 2014d, NRCS 2014e, SCS 1972, SCS 1981b).

23 Southern California Region soils include gravelly loams and gravelly sands,  
 24 sands, sandy loams and loamy sands, and silty loams along the Pacific Coast  
 25 shorelines and on alluvial plains. The mountains and foothills of the region  
 26 include silty loams, cobbly silty loam, gravelly loam, sandy clay loams, clay  
 27 loams, silty clays, and clays (SCAG 2011, UCCE 2014, SCS 1978, SCS 1986,  
 28 SCS 1973). The inland region in Riverside and San Bernardino counties include  
 29 sand to silty clays to cobbles and boulders on the alluvial fans, valley floor,  
 30 terraces, and mountains, and dry lake beds (CVWD 2011).

#### 31 **11.3.3.9 Subsidence**

32 Subsidence in the Central Coast and Southern California regions occur due to soil  
 33 compaction following groundwater withdrawals at rates greater than groundwater  
 34 recharge rates, oil and gas withdrawal, seismic activity, and hydroconsolidation of  
 35 soils along alluvial fans (Los Angeles 2005). The USGS described areas with  
 36 subsidence related to groundwater overdraft in the Central Coast and Southern  
 37 California regions in San Luis Obispo, Santa Barbara, Los Angeles, Riverside,  
 38 and Santa Bernardino counties (USGS 1999, Ventura County 2011, Los Angeles  
 39 2005, RCIP 2000). Many of the areas with subsidence have alluvial  
 40 unconsolidated sands and silty sands with lenses of silt and clayey silt.

41 A recent study by the USGS in the southern Coachella Valley portion of  
 42 Riverside described land subsidence of about 0.5 feet between 1930 and 1996  
 43 (USGS 2013c). Groundwater elevations in this area had declined since the early

1 1920s until 1949 when water from the Colorado River was provided to the area.  
2 This area is served by Coachella Valley Water District; and as described in  
3 Chapter 5, Surface Water Resources and Water Supply, the availability of surface  
4 water has not always been available to this area in recent years. The recent USGS  
5 study indicated that land subsidence of up to approximately 0.4 feet have occurred  
6 at some locations between 1996 and 2005; and possibly greater subsidence at  
7 other locations. A Coachella Valley Water District study indicated that up to  
8 13 inches have occurred in parts of the valley between 1996 and 2005  
9 (CVWD 2011).

## 10 **11.4 Impact Analysis**

11 This section describes the potential mechanisms and analytical methods for  
12 change in soils resources, results of the impact analysis, potential mitigation  
13 measures, and cumulative effects.

### 14 **11.4.1 Potential Mechanisms for Change in Soils Resources**

15 As described in Chapter 4, Approach to Environmental Analysis, the impact  
16 analysis considers changes in soils resources conditions related to changes in CVP  
17 and SWP operations under the alternatives as compared to the No Action  
18 Alternative and Second Basis of Comparison.

19 Changes in CVP and SWP operations under the alternatives as compared to the  
20 No Action Alternative and Second Basis of Comparison could change soil erosion  
21 potential due to crop idling on lands irrigated with CVP and SWP water supplies  
22 and along rivers downstream of CVP and SWP reservoirs, and potential changes  
23 in soils as lands are converted to seasonal floodplain or tidal-influenced wetlands.

#### 24 **11.4.1.1 Changes in Soil Erosion**

25 Changes in CVP and SWP operations under the alternatives could change the  
26 extent of irrigated acreage and the potential for soil erosion on crop idled lands  
27 over the long-term average condition and in dry and critical dry years as  
28 compared to the No Action Alternative and the Second Basis of Comparison.

29 Changes in CVP and SWP operations under the alternatives also could change  
30 peak flows in rivers downstream of CVP and SWP reservoirs in the Trinity River  
31 and Central Valley regions as compared to historical conditions which could lead  
32 to soil erosion during high peak flow events during storms in wet years along the  
33 river banks as compared to the No Action Alternative and the Second Basis of  
34 Comparison. However, as described in Chapter 5, Surface Water Resources and  
35 Water Supplies, the results of the analysis indicate that peak flows would be  
36 within historical range of peak flows in these rivers and would be similar under  
37 Alternatives 1 through 5, No Action Alternative, and Second Basis of  
38 Comparison. Therefore, changes in CVP and SWP operations would not result in  
39 changes to peak flow events that could result in soil erosion along these rivers.  
40 Therefore, these changes are not analyzed in this EIS.

1     **11.4.1.2 Changes in Soils at Restored Wetlands**

2 Restoration of seasonal floodplains and tidally-influenced wetlands would affect  
3 soils resources at the restoration locations. However, these actions would occur in  
4 a similar manner under the No Action Alternative, Alternatives 1 through 5, and  
5 Second Basis of Comparison, as described in Chapter 3, Description of  
6 Alternatives; in addition, the conditions of the soils would be the same under all  
7 of the alternatives and the Second Basis of Comparison. Therefore, these changes  
8 are not analyzed in this EIS.

9     **11.4.1.3 Effects Related to Water Transfers**

10 Historically water transfer programs have been developed on an annual basis.

11 The demand for water transfers is dependent upon the availability of water  
12 supplies to meet water demands. Water transfer transactions have increased over  
13 time as CVP and SWP water supply availability has decreased, especially during  
14 drier water years.

15 Parties seeking water transfers generally acquire water from sellers who have  
16 available surface water who can make the water available through releasing  
17 previously stored water, pump groundwater instead of using surface water  
18 (groundwater substitution), idle crops, or substitute crops that use less water in  
19 order to reduce normal consumptive use of surface water.

20 Water transfers using CVP and SWP Delta pumping plants and south of Delta  
21 canals generally occur when there is unused capacity in these facilities. These  
22 conditions generally occur during drier water year types when the flows from  
23 upstream reservoirs plus unregulated flows are adequate to meet the Sacramento  
24 Valley water demands and the CVP and SWP export allocations. In non-wet  
25 years, the CVP and SWP water allocations would be less than full contract  
26 amounts; therefore, capacity may be available in the CVP and SWP conveyance  
27 facilities to move water from other sources.

28 Projecting future soil conditions related to water transfer activities is difficult  
29 because specific water transfer actions required to make the water available,  
30 convey the water, and/or use the water would change each year due to changing  
31 hydrological conditions, CVP and SWP water availability, specific local agency  
32 operations, and local cropping patterns. Reclamation recently prepared a long-  
33 term regional water transfer environmental document which evaluated potential  
34 changes in surface water conditions related to water transfer actions (Reclamation  
35 2014c). Results from this analysis were used to inform the impact assessment of  
36 potential effects of water transfers under the alternatives as compared to the  
37 No Action Alternative and the Second Basis of Comparison.

38     **11.4.2 Conditions in Year 2030 without Implementation of**  
39     **Alternatives 1 through 5**

40 This EIS includes two bases of comparison, as described in Chapter 3,  
41 Description of Alternatives: the No Action Alternative and the Second Basis of  
42 Comparison. Both of these bases are evaluated at 2030 conditions. Changes that  
43 would occur over the next 15 years without implementation of the alternatives are



1 not analyzed in this EIS. However, the changes to soils resources that are  
2 assumed to occur by 2030 under the No Action Alternative and the Second Basis  
3 of Comparison are summarized in this section. Many of the changed conditions  
4 would occur in the same manner under both the No Action Alternative and the  
5 Second Basis of Comparison.

6 **11.4.2.1 Common Changes in Conditions under the No Action Alternative**  
7 **and Second Basis of Comparison**

8 Conditions in 2030 would be different than existing conditions due to:

- 9
- 10 • Climate change and sea-level rise
  - 11 • General plan development throughout California, including increased water  
12 demands in portions of Sacramento Valley
  - 13 • Implementation of reasonable and foreseeable water resources management  
14 projects to provide water supplies

14 It is anticipated that climate change would result in more short-duration high-  
15 rainfall events and less snowpack in the winter and early spring months. The  
16 reservoirs would be full more frequently by the end of April or May by 2030 than  
17 in recent historical conditions. However, as the water is released in the spring,  
18 there would be less snowpack to refill the reservoirs. This condition would  
19 reduce reservoir storage and available water supplies to downstream uses in the  
20 summer. The reduced end-of-September storage would also reduce the ability to  
21 release stored water to downstream regional reservoirs. These conditions would  
22 occur for all reservoirs in the California foothills and mountains, including non-  
23 CVP and SWP reservoirs.

24 These changes would result in a decline of the long-term average CVP and SWP  
25 water supply deliveries by 2030 as compared to recent historical long-term  
26 average deliveries under the No Action Alternative and the Second Basis of  
27 Comparison. However, the CVP and SWP water deliveries would be less under  
28 the No Action Alternative as compared to the Second Basis of Comparison, as  
29 described in Chapter 5, Surface Water Resources and Water Supplies, which  
30 could result in more crop idling that could be subject to erosion.

31 Under the No Action Alternative and the Second Basis of Comparison, land uses  
32 in 2030 would occur in accordance with adopted general plans. Development  
33 under the general plans would result in disruption of soils resources; however, the  
34 development of general plans includes preparation of environmental  
35 documentation that would identify methods to minimize adverse impacts to soils  
36 resources.

37 Under the No Action Alternative and the Second Basis of Comparison,  
38 development of future water resources management projects by 2030 which  
39 would result in disruption of soils resources. However, the development of these  
40 future programs would include preparation of environmental documentation that  
41 would identify methods to minimize adverse impacts to soils resources.

1 By 2030 under the No Action Alternative and the Second Basis of Comparison, it  
 2 is assumed that ongoing programs would result in restoration of more than  
 3 10,000 acres of intertidal and associated subtidal wetlands in Suisun Marsh and  
 4 Cache Slough; and 17,000 to 20,000 acres of seasonal floodplain restoration in the  
 5 Yolo Bypass.

### 6 **11.4.3 Evaluation of Alternatives**

7 Alternatives 1 through 5 have been compared to the No Action Alternative; and  
 8 the No Action Alternative and Alternatives 1 through 5 have been compared to  
 9 the Second Basis of Comparison. The evaluation of alternatives is focused on  
 10 portions of the Central Valley, San Francisco Bay Area, Central Coast, and  
 11 Southern California regions that use CVP and SWP water for irrigation.

12 During review of the numerical modeling analyses used in this EIS, an error was  
 13 determined in the CalSim II model assumptions related to the Stanislaus River  
 14 operations for the Second Basis of Comparison, Alternative 1, and Alternative 4  
 15 model runs. Appendix 5C includes a comparison of the CalSim II model run  
 16 results presented in this chapter and CalSim II model run results with the error  
 17 corrected. Appendix 5C also includes a discussion of changes in the comparison  
 18 of groundwater conditions for the following alternative analyses.

- 19 • No Action Alternative compared to the Second Basis of Comparison
- 20 • Alternative 1 compared to the No Action Alternative
- 21 • Alternative 3 compared to the Second Basis of Comparison
- 22 • Alternative 5 compared to the Second Basis of Comparison

#### 23 **11.4.3.1 No Action Alternative**

24 The No Action Alternative is compared to the Second Basis of Comparison.

##### 25 **11.4.3.1.1 Central Valley Region**

###### 26 *Potential Changes in Soil Erosion*

27 As described in Chapter 12, Agricultural Resources, the extent of irrigated  
 28 acreage under the No Action Alternative would be similar (within 5 percent) to  
 29 the conditions under the Second Basis of Comparison over long-term conditions  
 30 (throughout the 81-year model simulation period) and during dry and critical dry  
 31 years due to the increased use of groundwater.

###### 32 *Effects Related to Cross Delta Water Transfers*

33 Potential effects to soils resources could be similar to those identified in a recent  
 34 environmental analysis conducted by Reclamation for long-term water transfers  
 35 from the Sacramento to San Joaquin valleys (Reclamation 2014c). Potential  
 36 effects to soils resources were identified as increased erosion and shrinking of  
 37 expansive soils in the seller's service areas if crop idling is used to provide water  
 38 for transfers; and increased potential for shrinking of expansive soils and soil  
 39 movement in areas that use the transferred water. The analysis indicated that  
 40 these potential impacts would not be substantial because farmers manage idle  
 41 fields as part of normal agricultural operations and they would continue to use the  
 42 same practices to avoid erosion impacts. The analysis also indicated that

1 shrinking and soil movement occur as part of normal planting and harvesting  
2 practices and the changes with the water transfer programs would not result in  
3 substantial changes.

4 Under the No Action Alternative, the timing of cross Delta water transfers would  
5 be limited to July through September and include annual volumetric limits, in  
6 accordance with the 2008 U.S. Fish and Wildlife Service (USFWS) Biological  
7 Opinion (BO) and the 2009 National Marine Fisheries Service (NMFS) BO.  
8 Under the Second Basis of Comparison, water could be transferred throughout the  
9 year without an annual volumetric limit. Overall, the potential for cross Delta  
10 water transfers would be less under the No Action Alternative than under the  
11 Second Basis of Comparison.

#### 12 **11.4.3.1.2 San Francisco Bay Area, Central Coast, and Southern California** 13 **Regions**

##### 14 *Potential Changes in Soil Erosion*

15 As described in Chapter 12, Agricultural Resources, the extent of irrigated  
16 acreage under the No Action Alternative is anticipated to be similar as conditions  
17 under the Second Basis of Comparison due to the increased use of groundwater.

#### 18 **11.4.3.2 Alternative 1**

19 Alternative 1 is identical to the Second Basis of Comparison. Alternative 1 is  
20 compared to the No Action Alternative and the Second Basis of Comparison.  
21 However, because CVP and SWP operations conditions under Alternative 1 are  
22 identical to conditions under the Second Basis of Comparison; Alternative 1 is  
23 only compared to the No Action Alternative.

#### 24 **11.4.3.2.1 Alternative 1 Compared to the No Action Alternative**

##### 25 *Central Valley Region*

##### 26 *Potential Changes in Soil Erosion*

27 As described in Chapter 12, Agricultural Resources, the extent of irrigated  
28 acreage under Alternative 1 would be similar to conditions under the No Action  
29 Alternative over long-term conditions and during dry and critical dry years due to  
30 the increased availability of CVP and SWP water supplies.

##### 31 *Effects Related to Cross Delta Water Transfers*

32 Potential effects to soils resources could be similar to those identified in a recent  
33 environmental analysis conducted by Reclamation for long-term water transfers  
34 from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described  
35 above under the No Action Alternative compared to the Second Basis of  
36 Comparison. For the purposes of this EIS, it is anticipated that similar conditions  
37 would occur during implementation of cross Delta water transfers under  
38 Alternative 1 and the No Action Alternative, and that impacts on soils resources  
39 would not be substantial in the seller's service area due to implementation  
40 requirements of the transfer programs.

1 Under Alternative 1, water could be transferred throughout the year without an  
 2 annual volumetric limit. Under the No Action Alternative, the timing of cross  
 3 Delta water transfers would be limited to July through September and include  
 4 annual volumetric limits, in accordance with the 2008 USFWS BO and 2009  
 5 NMFS BO. Overall, the potential for cross Delta water transfers would be  
 6 increased under Alternative 1 as compared to the No Action Alternative.

7 *San Francisco Bay Area, Central Coast, and Southern California Regions*  
 8 *Potential Changes in Soil Erosion*

9 As described in Chapter 12, Agricultural Resources, the extent of irrigated  
 10 acreage under Alternative 1 is anticipated to be similar as conditions under the  
 11 No Action Alternative due to increased availability of CVP and SWP water  
 12 supplies.

13 **11.4.3.2 Alternative 1 Compared to the Second Basis of Comparison**

14 Alternative 1 is identical to the Second Basis of Comparison.

15 **11.4.3.3 Alternative 2**

16 The CVP and SWP operations under Alternative 2 are identical to the CVP and  
 17 SWP operations under the No Action Alternative; therefore, the soils resources  
 18 conditions under Alternative 2 are only compared to the Second Basis of  
 19 Comparison.

20 **11.4.3.3.1 Alternative 2 Compared to the Second Basis of Comparison**

21 Changes to soils resources under Alternative 2 as compared to the Second Basis  
 22 of Comparison would be the same as the impacts described in Section 11.4.3.1,  
 23 No Action Alternative.

24 **11.4.3.4 Alternative 3**

25 The CVP and SWP operations under Alternative 3 are similar to the Second Basis  
 26 of Comparison and Alternative 1 with modified Old and Middle River flow  
 27 criteria.

28 **11.4.3.4.1 Alternative 3 Compared to the No Action Alternative**

29 *Central Valley Region*

30 *Potential Changes in Soil Erosion*

31 As described in Chapter 12, Agricultural Resources, the extent of irrigated  
 32 acreage under Alternative 3 would be similar to the conditions under the No  
 33 Action Alternative over long-term conditions and during dry and critical dry years  
 34 due to the increased availability of CVP and SWP water supplies.

35 *Effects Related to Cross Delta Water Transfers*

36 Potential effects to soils resources could be similar to those identified in a recent  
 37 environmental analysis conducted by Reclamation for long-term water transfers  
 38 from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described  
 39 above under the No Action Alternative compared to the Second Basis of  
 40 Comparison. For the purposes of this EIS, it is anticipated that similar conditions

1 would occur during implementation of cross Delta water transfers under  
2 Alternative 3 and the No Action Alternative, and that impacts on soils resources  
3 would not be substantial in the seller's service area due to implementation  
4 requirements of the transfer programs.

5 Under Alternative 3, water could be transferred throughout the year without an  
6 annual volumetric limit. Under the No Action Alternative, the timing of cross  
7 Delta water transfers would be limited to July through September and include  
8 annual volumetric limits, in accordance with the 2008 USFWS BO and 2009  
9 NMFS BO. Overall, the potential for cross Delta water transfers would be  
10 increased under Alternative 3 as compared to the No Action Alternative.

11 *San Francisco Bay Area, Central Coast, and Southern California Regions*  
12 *Potential Changes in Soil Erosion*

13 As described in Chapter 12, Agricultural Resources, the extent of irrigated  
14 acreage under Alternative 3 is anticipated to be similar to conditions under the  
15 No Action Alternative due to increased availability of CVP and SWP water  
16 supplies.

17 **11.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison**  
18 *Central Valley Region*

19 *Potential Changes in Soil Erosion*

20 As described in Chapter 12, Agricultural Resources, the extent of irrigated  
21 acreage under Alternative 3 would be similar to the conditions under the Second  
22 Basis of Comparison over long-term conditions and during dry and critical dry  
23 years due to the increased use of groundwater.

24 *Effects Related to Cross Delta Water Transfers*

25 Potential effects to soils resources could be similar to those identified in a recent  
26 environmental analysis conducted by Reclamation for long-term water transfers  
27 from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described  
28 above under the No Action Alternative compared to the Second Basis of  
29 Comparison. For the purposes of this EIS, it is anticipated that similar conditions  
30 would occur during implementation of cross Delta water transfers under  
31 Alternative 3 and the Second Basis of Comparison, and that impacts on soils  
32 resources would not be substantial in the seller's service area due to  
33 implementation requirements of the transfer programs.

34 Under Alternative 3 and the Second Basis of Comparison, water could be  
35 transferred throughout the year without an annual volumetric limit. Overall, the  
36 potential for cross Delta water transfers would be similar under Alternative 3 and  
37 the Second Basis of Comparison.

38 *San Francisco Bay Area, Central Coast, and Southern California Regions*  
39 *Potential Changes in Soil Erosion*

40 As described in Chapter 12, Agricultural Resources, the extent of irrigated  
41 acreage under Alternative 3 is anticipated to be similar to conditions under the  
42 Second Basis of Comparison due to the increased use of groundwater.

1 **11.4.3.5 Alternative 4**

2 Soil resources conditions under Alternative 4 would be identical to the conditions  
3 under the Second Basis of Comparison; therefore, Alternative 4 is only compared  
4 to the No Action Alternative.

5 **11.4.3.5.1 Alternative 4 Compared to the No Action Alternative**

6 The CVP and SWP operations under Alternative 4 are identical to the CVP and  
7 SWP operations under the Second Basis of Comparison and Alternative 1.  
8 Therefore, changes in soil resources conditions under Alternative 4 as compared  
9 to the No Action Alternative would be the same as the impacts described in  
10 Section 11.4.3.2.1, Alternative 1 Compared to the No Action Alternative.

11 **11.4.3.6 Alternative 5**

12 The CVP and SWP operations under Alternative 5 are similar to the No Action  
13 Alternative with modified Old and Middle River flow criteria and New Melones  
14 Reservoir operations.

15 **11.4.3.6.1 Alternative 5 Compared to the No Action Alternative**

16 *Central Valley Region*

17 *Potential Changes in Soil Erosion*

18 As described in Chapter 12, Agricultural Resources, the extent of irrigated  
19 acreage under Alternative 5 would be similar to conditions under the No Action  
20 Alternative over long-term conditions and during dry and critical dry years  
21 because the availability of CVP and SWP water supplies would be similar.

22 *Effects Related to Cross Delta Water Transfers*

23 Potential effects to soils resources could be similar to those identified in a recent  
24 environmental analysis conducted by Reclamation for long-term water transfers  
25 from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described  
26 above under the No Action Alternative compared to the Second Basis of  
27 Comparison. For the purposes of this EIS, it is anticipated that similar conditions  
28 would occur during implementation of cross Delta water transfers under  
29 Alternative 5 and the No Action Alternative, and that impacts on soils resources  
30 would not be substantial in the seller's service area due to implementation  
31 requirements of the transfer programs.

32 Under Alternative 5 and the No Action Alternative, the timing of cross Delta  
33 water transfers would be limited to July through September and include annual  
34 volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO.  
35 Overall, the potential for cross Delta water transfers would be similar under  
36 Alternative 5 and the No Action Alternative.

37 *San Francisco Bay Area, Central Coast, and Southern California Regions*

38 *Potential Changes in Soil Erosion*

39 As described in Chapter 12, Agricultural Resources, the extent of irrigated  
40 acreage under Alternative 5 is anticipated to be similar as conditions under the  
41 No Action Alternative because CVP and SWP water deliveries would be similar.

1 **11.4.3.6.2 Alternative 5 Compared to the Second Basis of Comparison**

2 *Central Valley Region*

3 *Potential Changes in Soil Erosion*

4 As described in Chapter 12, Agricultural Resources, the extent of irrigated  
 5 acreage under Alternative 5 would be similar to the conditions under the Second  
 6 Basis of Comparison over long-term conditions and during dry and critical dry  
 7 years due to increased use of groundwater.

8 *Effects Related to Cross Delta Water Transfers*

9 Potential effects to soils resources could be similar to those identified in a recent  
 10 environmental analysis conducted by Reclamation for long-term water transfers  
 11 from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described  
 12 above under the No Action Alternative compared to the Second Basis of  
 13 Comparison. For the purposes of this EIS, it is anticipated that similar conditions  
 14 would occur during implementation of cross Delta water transfers under  
 15 Alternative 5 and the Second Basis of Comparison, and that impacts on soils  
 16 resources would not be substantial in the seller’s service area due to  
 17 implementation requirements of the transfer programs.

18 Under Alternative 5, the timing of cross Delta water transfers would be limited to  
 19 July through September and include annual volumetric limits, in accordance with  
 20 the 2008 USFWS BO and 2009 NMFS BO. Under Second Basis of Comparison,  
 21 water could be transferred throughout the year without an annual volumetric limit.  
 22 Overall, the potential for cross Delta water transfers would be less under  
 23 Alternative 5 as compared to the Second Basis of Comparison.

24 *San Francisco Bay Area, Central Coast, and Southern California Regions*

25 *Potential Changes in Soil Erosion*

26 As described in Chapter 12, Agricultural Resources, the extent of irrigated  
 27 acreage under Alternative 5 is anticipated to be similar to conditions under the  
 28 Second Basis of Comparison due to the increased use of groundwater.

29 **11.4.3.7 Summary of Impact Analysis**

30 The results of the environmental consequences of implementation of Alternatives  
 31 1 through 5 as compared to the No Action Alternative and the Second Basis of  
 32 Comparison are presented in Tables 11.1 and 11.2, respectively.

33 **Table 11.1 Comparison of Alternatives 1 through 5 to No Action Alternative**

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	No effects on soils resources	None needed
Alternative 2	No effects on soils resources	None needed
Alternative 3	No effects on soils resources	None needed
Alternative 4	No effects on soils resources	None needed
Alternative 5	No effects on soils resources	None needed

1 **Table 11.2 Comparison of No Action Alternative and Alternatives 1 through 5 to**  
 2 **Second Basis of Comparison**

Alternative	Potential Change	Consideration for Mitigation Measures
No Action Alternative	No effects on soils resources	Not considered for this comparison
Alternative 1	No effects on soils resources	Not considered for this comparison
Alternative 2	No effects on soils resources	Not considered for this comparison
Alternative 3	No effects on soils resources	Not considered for this comparison
Alternative 4	No effects on soils resources	Not considered for this comparison
Alternative 5	No effects on soils resources	Not considered for this comparison

3 **11.4.3.8 Potential Mitigation Measures**

4 Mitigation measures are presented in this section to avoid, minimize, rectify,  
 5 reduce, eliminate, or compensate for adverse environmental effects of  
 6 Alternatives 1 through 5 as compared to the No Action Alternative. Mitigation  
 7 measures were not included to address adverse impacts under the alternatives as  
 8 compared to the Second Basis of Comparison because this analysis was included  
 9 in this EIS for information purposes only.

10 Changes in CVP and SWP operations under Alternatives 1 through 5 as compared  
 11 to the No Action Alternative would not result in changes in soils resources.  
 12 Therefore, there would be no adverse impacts to soils resources as compared to  
 13 the No Action Alternative; and no mitigation measures are required.

14 **11.4.3.9 Cumulative Effects Analysis**

15 As described in Chapter 3, the cumulative effects analysis considers projects,  
 16 programs, and policies that are not speculative; and are based upon known or  
 17 reasonably foreseeable long-range plans, regulations, operating agreements, or  
 18 other information that establishes them as reasonably foreseeable.

19 The cumulative effects analysis for Alternatives 1 through 5 for Geology and  
 20 Soils Resources are summarized in Table 11.3.

21 **Table 11.3 Summary of Cumulative Effects on Geology and Soils Resources with**  
 22 **Implementation of Alternatives 1 through 5 as Compared to the No Action**  
 23 **Alternative**

Scenarios	Actions	Cumulative Effects of Actions
Past & Present, and Future Actions	Consistent with Affected Environment conditions plus:	These effects would be the same under all alternatives.



<b>Scenarios</b>	<b>Actions</b>	<b>Cumulative Effects of Actions</b>
<p>included in the No Action Alternative and in All Alternatives in Year 2030</p>	<p>Actions in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives) including climate change and sea level rise</p> <p>Actions not included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives):</p> <ul style="list-style-type: none"> <li>- Climate Change and Sea Level Rise</li> <li>- Implementation of Federal and state policies and programs, including Clean Water Act (e.g., Total Maximum Daily Loads); Safe Drinking Water Act; Clean Air Act; and flood management programs</li> <li>- General plans for 2030.</li> <li>- Trinity River Restoration Program.</li> <li>- Central Valley Project Improvement Act programs</li> <li>- Folsom Dam Water Control Manual Update</li> <li>- Dutch Slough Tidal Marsh Restoration</li> <li>- Suisun Marsh Habitat Management, Preservation, and Restoration Plan Implementation</li> <li>- Tidal Wetland Restoration: Yolo Ranch, Northern Liberty Island Fish Restoration Project, Prospect Island Restoration Project, and Calhoun Cut/Lindsey Slough Tidal Habitat Restoration Project</li> <li>- San Joaquin River Restoration Program</li> <li>- Grasslands Bypass Project</li> <li>- Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS)</li> <li>- Future water supply projects, including water recycling, desalination, groundwater banks</li> </ul>	<p>Developments under the general plans and future water supply, water quality improvement, and restoration projects could affect soils resources. However, development of these future programs would include preparation of environmental documentation that would identify methods to minimize adverse impacts to soils resources.</p> <p>Some of the future actions would reduce the effects of agricultural drainage and/or reduce salinity in the San Joaquin River and the Delta. These programs would result in a beneficial impact to soils resources.</p>

Scenarios	Actions	Cumulative Effects of Actions
	and wellfields, and conveyance facilities (projects with completed environmental documents)	
<p>Future Actions considered as Cumulative Effects Actions in All Alternatives in Year 2030</p>	<p>Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives):</p> <ul style="list-style-type: none"> <li>- Bay-Delta Water Quality Control Plan Update</li> <li>- FERC Relicensing Projects</li> <li>- Bay Delta Conservation Plan and California WaterFix</li> <li>- Shasta Lake Water Resources, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations</li> <li>- El Dorado Water and Power Authority Supplemental Water Rights Project</li> <li>- Semitropic Water Storage District Delta Wetlands</li> <li>- North Bay Aqueduct Alternative Intake</li> <li>- Irrigated Lands Regulatory Program</li> <li>- San Luis Reservoir Low Point Improvement Project</li> <li>- Westlands Water District v. United States Settlement</li> <li>- Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects that did not have completed environmental documents during preparation of the EIS)</li> </ul>	<p>These effects would be the same in all alternatives.</p> <p>Developments under the future projects are anticipated to potentially effect soils resources. However, development of these future programs would include preparation of environmental documentation that would identify methods to minimize adverse impacts to soils resources.</p> <p>Some of the future cumulative effects actions would reduce the effects of agricultural drainage and/or reduce salinity in the San Joaquin River and the Delta. These programs would result in a beneficial impact to soils resources.</p>
<p>No Action Alternative with Associated Cumulative Effects Actions in Year 2030</p>	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO</p>	<p>Implementation of the No Action Alternative with reasonably foreseeable actions would include developments under general plans and future water supply, water quality improvement, and restoration projects are anticipated to potentially affect soils resources. However,</p>

Scenarios	Actions	Cumulative Effects of Actions
		development of these future programs would include preparation of environmental documentation that would identify methods to minimize adverse impacts to soils resources.
Alternative 1 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternative 1 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
2 with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions No implementation of structural improvements or other actions that require further study to develop a more detailed action description.	Implementation of Alternative 2 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 3 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant) Slight increase in positive Old and Middle River flows in the winter and spring months	Implementation of Alternative 3 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 4 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternative 4 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 5 with Associated Cumulative Effects Actions in Year 20530	Full implementation of the 2008 USFWS BO and 2009 NMFS BO Positive Old and Middle River flows and increased Delta outflow in spring months	Implementation of Alternative 5 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.

1

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Figure 11.1 Geomorphic Provinces in California

**Chapter 12**

1 **Agricultural Resources**

2 **12.1 Introduction**

3 This chapter describes agricultural resources in the study area, and potential  
4 changes that could occur as a result of implementing the alternatives evaluated in  
5 this Environmental Impact Statement (EIS). Implementation of the alternatives  
6 could affect land use through potential changes in operation of the Central Valley  
7 Project (CVP) and State Water Project (SWP) and ecosystem restoration.  
8 Changes in non-agricultural land use and resources are described in Chapter 13,  
9 Land Use.

10 **12.2 Regulatory Environment and Compliance**  
11 **Requirements**

12 Potential actions that could be implemented under the alternatives evaluated in  
13 this EIS could affect agricultural resources served by CVP and SWP water  
14 supplies. Actions located on public agency lands; or implemented, funded, or  
15 approved by Federal and state agencies would need to be compliant with  
16 appropriate Federal and state agency policies and regulations, as summarized in  
17 Chapter 4, Approach to Environmental Analyses.

18 **12.3 Affected Environment**

19 This section describes agricultural resources that could be potentially affected by  
20 the implementation of the alternatives considered in this EIS. Changes in  
21 agricultural resources due to changes in CVP and SWP operations may occur in  
22 the Trinity River, Central Valley, San Francisco Bay Area, Central Coast, and  
23 Southern California regions. Direct or indirect agricultural resource effects due to  
24 implementation of the alternatives analyzed in this EIS are related to changes in  
25 agricultural land uses due to the availability and reliability of CVP and SWP  
26 water supplies.

27 Changes in agricultural resources can affect agriculture throughout the state. An  
28 overview of California agriculture is presented prior to discussions of agricultural  
29 resources in each of the regions.

30 **12.3.1 Overview of California Agriculture**

31 California agriculture is an important resource that produces over 400 types of  
32 crops. California is the nation’s leading producer of nearly 80 commodities; and  
33 produces more than 99 percent of the nation’s almonds, artichokes, dates, figs,  
34 raisins, kiwifruit, olives, clingstone peaches, pistachios, prunes, pomegranates,

1 and walnuts (USDA-NASS 2012). In 2011, cultivation of 25.4 million acres of  
2 agricultural land contributed about \$43.5 billion to California's economy and  
3 11.6 percent of total agricultural revenues in the United States. This section  
4 provides:

- 5 • Recent trends in California agricultural resources
- 6 • Crop production practices
- 7 • Cropping pattern changes in response to water supply availability
- 8 • Water supply and crop acreage relationships in the San Joaquin Valley

9 **12.3.1.1 Recent Trends in Agricultural Production**

10 The United States Department of Agriculture (USDA) National Agricultural  
11 Statistics Service (NASS) California Field Office publishes annual reports  
12 containing data from County Agricultural Commissioners and periodic statewide  
13 census of agricultural producers. County Agricultural Commissioners' data  
14 covers acres planted, total production, prices, yield per acre, and value of  
15 production across crop groups and counties.

16 From 1960 to 2012, total acreage in production fluctuated between eight and nine  
17 million acres, as summarized in Figure 12.1. Over the last fifteen years, total  
18 acreage has trended down. Most of the variability over time, and the more recent  
19 downward trend, are largely attributable to changes in field and forage crop  
20 acreage. The percentage of field and forage acreage decreased from 77 percent of  
21 total acreage in 1960 to 48 percent in 2012. The proportion of acreage of  
22 permanent crops (e.g. orchards and vine) has steadily increased from 1960 to  
23 2012. Orchard and vine acreage rose from 14 percent of total acreage in 1960 to  
24 38 percent in 2012.

25 From 1960 to 2012, statewide annual value of production rose from \$20 billion  
26 (all values are in 2012 US dollars) to \$45 billion, as summarized in Figure 12.2.  
27 Of the crop categories, orchard and vine values grew the fastest over this period,  
28 from around \$3 billion in annual value of production in 1960 to over \$17 billion  
29 in 2012. This increase may be attributable to both the expansion of acreage  
30 planted, as shown in Figure 12.1, as well as price and yield increases. Orchard  
31 and vine values of production rose from 17 percent of the total statewide value of  
32 production in 1960 to 38 percent in 2012. Other crop categories that have also  
33 experienced an increase in value of production over this time period are:  
34 vegetable, livestock, dairy and poultry, and nursery. Field crops have shown a  
35 downward trend. The percentage from field and forage crops decreased from the  
36 peak of 28 percent of state value of production in 1980 to 11 percent in 2012.  
37 Total value of production is influenced by both the acreage planted each year as  
38 well as market prices and yields.

39 **12.3.1.2 Crop Production Practices**

40 Crop production practices vary by crop and locational differences such as soil,  
41 slope, local climate, and water source and reliability. Production practices  
42 discussed in this subsection include:

- 43 • Crop rotation and fallowing.

- 1 • Crop water use.
- 2 • Crop irrigation methods.
- 3 • Crop responses to water quality.
- 4 • Crop drainage methods.
- 5 • Crop adaptation to changes in water supply availability.

#### 6 **12.3.1.2.1 Crop Rotation and Fallowing**

7 Crop rotation is the planned variation in the crop grown on a given field. Growers  
8 rotate annual crops and some forage crops in order to control plant pests, diseases,  
9 and weeds, and to improve soil structure, microbial diversity, and nutrient and  
10 mineral availability. Growers select a series of crops that are compatible for  
11 rotation that are planned to be grown in a field in a succession of years and plan  
12 their operations schedule and build their on-farm infrastructure (e.g., equipment,  
13 facilities and staffing) to a scale that meets the production needs of those crop  
14 acreage mixes (Baldwin 2006).

15 Field fallowing is the practice of not planting a crop in a field for one or more  
16 growing seasons. Fallowing can be a planned part of the rotation, or may be a  
17 consequence of another event like water supply shortage, flooding, land  
18 improvement, or poor crop prices. Rotations are not fixed, so changes in market  
19 conditions or Federal farm programs can affect crop mix and the pattern and  
20 magnitude of fallowing.

21 Fallowed fields without cover crops can lose topsoil to surface drainage and wind  
22 erosion. Loss of topsoil to erosion reduces land productivity, and can reduce  
23 nearby crop yields and marketability.

#### 24 **12.3.1.2.2 Crop Water Use**

25 Crop irrigation water use depends on crop type, stage of crop growth, soil  
26 moisture profile from winter rains, soil moisture holding capacity (total amount of  
27 water in the soil potentially available to plants), management of plant pests and  
28 diseases, weather conditions (solar radiation, temperature and humidity) and  
29 irrigation water use efficiency. Irrigation water use efficiency can be defined in  
30 different ways. The California Department of Water Resources (DWR) defines  
31 the agronomic water use fraction as the irrigation water beneficially used for  
32 necessary agronomic functions (e.g., transpiration, leaching, frost protection,  
33 germination) divided by the total applied water (DWR 2012). Applied irrigation  
34 water is transpired by plants (crops and weeds), percolates into the groundwater  
35 below the root zone (necessary salt leaching component or over-irrigation loss to  
36 groundwater), evaporates directly from water or soil surfaces, or runs off the field  
37 as surface drainage (Edinger-Marshall and Letey 1997).

38 Reuse of water from fields to irrigate other fields, often multiple times, occurs  
39 throughout California. As a result, relatively low field-level efficiency  
40 (agronomic water use fraction) can result in relatively high efficiency from a  
41 regional or basin perspective (DWR 2013a).

1 **12.3.1.2.3 Crop Irrigation**

2 Agricultural irrigation needs vary by season. In the winter, rainfall refills the soil  
3 moisture profile that was depleted from the crop root zone the previous summer  
4 and fall. If soil moisture is not adequate for planting of annual crops,  
5 pre-irrigation water is applied. Pre-irrigation and early growing season irrigations  
6 generally occur in the time period from March through May. Peak agricultural  
7 irrigation water supply demand generally occurs from the late spring through late  
8 summer. Permanent crops are irrigated post-harvest to refill the root zone. Post-  
9 harvest irrigation of annual crop land is sometimes used to help break down crop  
10 residue and suppress some pests and diseases, especially in rice fields.

11 Irrigation methods vary by area, soil, crop type, and existing facilities. Annual  
12 row crops are often sprinkler irrigated for crop germination and furrow irrigated  
13 for the rest of the season. Permanent crops are typically irrigated with drip,  
14 sprinkler, furrow, border, or flood irrigation methods. Irrigated pasture and  
15 alfalfa are typically irrigated with sprinkler or flood irrigation methods. Rice is  
16 generally irrigated with flood irrigation. Irrigation methods utilized in the Central  
17 Valley include:

- 18 • **Flood and Border Irrigation:** Water is released into a leveled field or block  
19 that is segmented into “checks” with a small berm to contain the water. Water  
20 applied to the check until it is flooded and the water seeps into the ground or  
21 some is allowed to drain off the lower elevation end of the field.
- 22 • **Furrow Irrigation:** Water is released into furrows at the higher side of the  
23 field and flows down to the lower end of the field. To provide adequate water  
24 to the low end of the field, surface irrigation requires that a certain amount of  
25 water be spilled or drained off as tailwater. Recycling the tailwater to the  
26 head of the field or to an adjacent field can significantly increase overall  
27 efficiency. Furrow irrigation is used on annual row crops and on some  
28 vineyards.
- 29 • **Sprinkler Irrigation:** Sprinkler irrigation uses pressurized water through  
30 movable or solid set pipe to a sprinkler. Sprinklers lose some irrigation water  
31 to evaporation in the air before the water reaches the ground. Sprinklers also  
32 apply water to ground that does not have crop roots, and this applied water  
33 goes to surface evaporation, weed transpiration, or percolation to groundwater  
34 leaching. Sprinklers are often used during the germination stage of  
35 vegetables, and can also be used for frost control on orchards, especially  
36 citrus. Sprinkler irrigation can be used on most crops except those for which  
37 direct contact with the water drops could cause fruit cracking, fungal growth,  
38 or other issues.
- 39 • **Surface Drip and Micro-sprinkler Irrigation:** Surface drip and micro-  
40 sprinkler irrigation also use pressurized water that is delivered through  
41 flexible tubes to drip emitters or micro-sprinkler heads. Surface drip irrigation  
42 generally applies water only to the crop root areas. Drip irrigation and  
43 micro-sprinklers are used on most orchards and vineyards.

- 1 • **Subsurface Drip Irrigation:** Subsurface drip irrigation is similar to the drip  
 2 irrigation described above, but the tubing or drip tape is buried a few inches to  
 3 several feet, depending on the crop. Subsurface drip irrigation generally  
 4 applies water only to crop root areas and reduces surface evaporation.  
 5 Subsurface drip is used on some row crops and vineyards.
- 6 Flood and furrow irrigated acreage has declined over time, especially for trees and  
 7 vines by drip and micro-sprinkler irrigation (NCWA 2011). Crops that continue  
 8 to rely upon flood irrigation, such as rice, have improved irrigation efficiency  
 9 through the use of laser leveling of the fields. The use of furrow and flood  
 10 irrigation has declined in California from 67 percent of the total irrigated acreage  
 11 in 1991 to 43 percent in 2010 (DWR 2013a). During this same time period, the  
 12 use of drip, micro-sprinkler, and subsurface drip irrigation increased from  
 13 16 percent of total irrigated acreage in 1991 to 42 percent in 2010.

#### 14 **12.3.1.2.4 Crop Response to Water Quality**

15 Water quality of the surface water streams in the Central Valley is generally very  
 16 suitable for agricultural production with low salinity, neutral acidity/alkalinity  
 17 (i.e., pH), minerals, nutrients, and dissolved metal concentrations that are  
 18 appropriate for agricultural uses. However, groundwater quality varies  
 19 substantially across California, as described in Chapter 7, Groundwater Resources  
 20 and Groundwater Quality.

21 Agricultural production can be affected by high salinity, minerals, and boron in  
 22 the irrigation water and the soils. In the Sacramento Valley, water temperature  
 23 can reduce crop yields; cold water is a particular concern for rice production  
 24 (Roel et al., 2005). Irrigation water can carry debris and biological contaminants  
 25 that affect agricultural operations and the value of crop production (USDA 2006).

26 High salinity concerns occur on agricultural lands receiving CVP and SWP water  
 27 from the Delta. As described in Chapter 6, Surface Water Quality, surface waters  
 28 in the Delta and lower San Joaquin River water frequently are characterized by  
 29 high salinity. These waters are used by agricultural water users in the Delta and  
 30 CVP and SWP water users located within and to the south of the Delta.

31 Evaporation and transpiration of irrigation water cause salts to accumulate in soils  
 32 unless adequate leaching and drainage are provided (Reclamation 2005). High  
 33 water tables with elevated concentrations of salts can draw the salinity vertically  
 34 through the soil by capillary action into the plant root zone and cause damage to  
 35 the plant. Excessive irrigation water salinity and accumulated soil salinity can  
 36 adversely affect soil structure, reduce water infiltration rates, reduce seed  
 37 germination, increase seedling mortality, impede root growth, impede water  
 38 uptake by the plant (from increased osmotic pressure), reduce plant growth rate,  
 39 and reduce yields.

40 All irrigation water adds soluble salts to the soil, including sodium, calcium,  
 41 magnesium, potassium, sulfate, and chlorides (Grattan 2002). Salinity is usually  
 42 measured either in parts per million of total dissolved solids or by electrical  
 43 conductivity (EC). Water salinity of irrigation water is measured as “EC<sub>w</sub>.”



1 Accumulated salts in the soil are measured as “EC<sub>e</sub>.” The strength of the  
 2 electrical conductivity depends upon the water temperature, types of salts, and salt  
 3 concentrations.

4 High salinity can affect the amount of irrigation water applied for crop irrigation  
 5 and necessary soil leaching component (washing soil salts out of the plant root  
 6 zone) compared to the total quantity of irrigation water applied (Reclamation  
 7 2005). Irrigation in the San Joaquin Valley typically includes a salt leaching  
 8 component. The leaching water generally conveys the salts into installed drains  
 9 in the fields or into the groundwater. Therefore, in locations where adequate  
 10 drainage does not exist, continued irrigation with high salinity water has increased  
 11 groundwater salinity, as described in Chapter 7, Groundwater Resources and  
 12 Groundwater Quality.

13 Table 12.1 presents EC<sub>e</sub> and EC<sub>w</sub> values for salinity tolerances of a range of crops  
 14 grown in the Central Valley.

15 **Table 12.1 Salinity Tolerance of Selected Crops (as percent of maximum yield)**

Crops <sup>a, b</sup>	Crop Tolerance based on Soil Salinity (measured as EC <sub>e</sub> )			Crop Tolerance based on Water Salinity (measured as EC <sub>w</sub> )		
	100%	50%	0% <sup>c</sup>	100%	50%	0% <sup>c</sup>
Alfalfa	2.0	8.8	16	1.3	5.9	10
Almond <sup>d</sup>	1.5	4.1	6.8	1.0	2.8	4.5
Apricot <sup>d</sup>	1.6	3.7	5.8	1.1	2.5	3.8
Bean	1.0	3.6	6.3	0.7	2.4	4.2
Corn, sweet	1.7	5.9	10	1.1	3.9	6.7
Cucumber	2.5	6.3	10	1.7	4.2	6.8
Grape <sup>e</sup>	1.5	6.7	12	1.0	4.5	7.9
Peach	1.7	4.1	6.5	1.1	2.7	4.3
Rice (paddy)	3.0	7.2	11	2.0	4.8	7.6
Squash, Zucchini	4.7	10	15	3.1	6.7	10
Sudan Grass	2.8	14	26	1.9	9.6	17
Sugar Beet <sup>e</sup>	7.0	15	24	4.7	10	16
Tomato	2.5	7.6	13	1.7	5.0	8.4

16 Sources: Ayers and Westcot 1994; Grattan 2002; Maas and Hoffman 1977

17 Notes:

18 a. These data should be used as a guide to relative tolerances among crops. Absolute  
 19 tolerances will change based upon climate, soil conditions, and cultural practices.  
 20 Plants will tolerate about 2 deciSiemens per meter (dS/m) higher soil salinity (EC<sub>e</sub>)  
 21 than indicated if soils have high gypsum, however the water salinity (EC<sub>w</sub>) tolerances  
 22 do not change.

23 b. EC<sub>e</sub> is average root zone salinity as measured by electrical conductivity of the  
 24 saturation extract of the soil, and EC<sub>w</sub> is electrical conductivity of the irrigation water,

- 1 both reported in dS/m) at 25°C. The data is based upon a relationship between soil  
 2 salinity and water salinity of  $EC_e = 1.5 EC_w$  with a 15 to 20 percent leaching fraction  
 3 and a 40-30-20-10 percent water use pattern for the upper to lower quarters of the  
 4 root zone.
- 5 c. The zero yield potential or maximum  $EC_e$  indicates the theoretical soil salinity ( $EC_e$ ) at  
 6 which crop growth ceases.
- 7 d. Tolerance evaluations are based on tree growth and not on yield.
- 8 e. For beets, which are more sensitive during germination, the  $EC_e$  should not exceed  
 9 3 dS/m in the seeding area for garden beets and sugar beets.

10 The most sensitive crops are affected when  $EC_e$  values exceed 1 dS/m, and  
 11 include the following crops with threshold values: beans (1.0 dS/m); walnuts  
 12 1.1 dS/m), bulb onions (1.2 dS/m); grapes, peppers and almonds (1.5 dS/m);  
 13 apricots (1.6 dS/m); corn and peaches (1.7 dS/m); alfalfa (2.0 dS/m); and  
 14 cucumbers and tomatoes (2.5 dS/m).

15 In addition to salinity, boron is also a concern in some areas. Dry beans are one  
 16 of the more boron sensitive crops with a threshold value of 0.75 to 1.0 mg/l in the  
 17 soil water within the crop root zone.

#### 18 **12.3.1.2.5 Crop Drainage Methods**

19 Agricultural crop surface and subsurface drainage is important for the suitability  
 20 of agricultural production (DWR 2013a; Reclamation 2005; SJVDIP 1998).  
 21 Drainage of most agricultural fields occurs by a combination of surface drainage  
 22 and subsurface drainage. Poor drainage can lead to crop loss or damage from lack  
 23 of soil oxygen availability for plant roots, pest infestations (e.g., pathogenic root  
 24 fungi, such as *phytothora*), and salt accumulation in the root zone. High water  
 25 tables, high salinity, and poor drainage can limit crop selection and limit the  
 26 ability of farmers to use irrigation water to leach excess salts out of the crop root  
 27 zone.

28 Surface water drainage from agricultural fields is collected in on-farm drainage  
 29 ditches which are typically connected to larger drainage facilities. The drainage  
 30 water either flows by gravity or is pumped into adjacent water bodies. Water  
 31 quality issues related to disposal of surface water drainage can include high  
 32 concentrations of sediment; nutrients from fertilizers; or residual organic carbon  
 33 constituents from herbicides, pesticides, or nematicides. On-farm surface  
 34 drainage systems sometimes include local methods to remove sediment or  
 35 nutrients, such as the inclusion of vegetative strips to remove sediment and  
 36 improve drain water quality (CALFED 2000). During the irrigation season,  
 37 surface drainage water collected from irrigation can be recirculated for subsequent  
 38 irrigation; however, this can lead to a long-term increase in soil salinity  
 39 (DWR 2013a; SJVDIP 1998).

40 Subsurface drainage is used to control groundwater depth to avoid or limit its  
 41 encroachment into the root zone of crops (Panuska 2011). For example in the  
 42 Delta, subsurface and surface drainage is used not only to control groundwater  
 43 depths related to irrigation practices, but also to control groundwater that seeps

1 into the soils from the surface water that surrounds the islands and tracts. Areas  
2 in the western and southern San Joaquin Valley are affected by shallow, saline  
3 groundwater that accumulates due to irrigation; and the shallow groundwater is  
4 underlain by soils with poor drainage (CALFED 2000; DWR 2013a; SJVDP  
5 1990; SJVDIP 1998; WWD 2013a, 2013b). Some areas of northern San Joaquin,  
6 Valley collect and discharge subsurface drainage to the San Joaquin River  
7 (Reclamation, 2013). Areas in the central and southern San Joaquin Valley  
8 manage poor drainage conditions by careful and integrated management of crop  
9 patterns, land retirement, irrigation methods and application rates, and/or drainage  
10 water reuse and blending, (USGS 2008; WRCD 2004).

#### 11 **12.3.1.2.6 Crop Adaptation in Response to Changes in Water Supply** 12 **Availability**

13 Farmers and water suppliers can react to changes in water supply in a range of  
14 ways. Some farmers adapt to variability by maintaining a mix of crops that can  
15 be shifted or fallowed in response to water supply changes. Some farmers have  
16 groundwater wells that can be used to replace surface water in times of shortage.  
17 Short term responses can also include reducing irrigation water application below  
18 what is needed to maintain full crop yield (water stressing). Over the long term,  
19 irrigation systems and management can be changed to apply less water.  
20 Decisions that farmers make in response to changes in water supply affect other  
21 aspects of their operations, and affect the economy of the surrounding  
22 community. For example, crop mix and irrigation methods affect the kinds of  
23 tractors and other equipment used on the farm.

24 Some types of on-farm infrastructure also are specialized for the crops grown  
25 including: grain driers and storage, hullers, fruit sorting and packing, fruit driers,  
26 cotton gins and cold storage plants. Crop-specific equipment, infrastructure, and  
27 marketing agreements may prevent a grower from change crops quickly due to  
28 changes in water supply availability.

29 Input suppliers, equipment dealers, labor force, and processing facilities are also  
30 dependent on, and affected by, cropping decisions. As crop types change, the mix  
31 of these related economic activities also change. This can happen over a period of  
32 time, but is difficult to achieve in the short term.

#### 33 *Response to Variability in CVP and SWP Water Supplies*

34 Water availability provided by the CVP and SWP varies each year based upon  
35 hydrologic conditions and regulatory requirements, as described in Chapter 5,  
36 Surface Water Resources and Water Supplies. The CVP and SWP water supply  
37 allocations are initially announced in the late winter. The allocations can be  
38 revised throughout the spring months as the hydrologic conditions become more  
39 certain. Growers often delay finalizing some of their crop decisions until water  
40 supply allocations are announced as late as April or May. Delays in finalizing  
41 crop decisions also can result in delays in finalizing crop financing and orders to  
42 suppliers (e.g., seed, fertilizer), and contracting with labor suppliers and crop  
43 processors. Responses to variations in water allocations depend on many factors,  
44 including but not limited to: feasibility of alternative water supplies (availability,

1 suitability of water quality, cost); types of crops grown and need for changes in  
 2 equipment, processing, and labor; and long-term crop supply contracts and  
 3 obligations, (WWD 2013a, 2013b). A study of changes that occurred during the  
 4 1986 through 1992 drought indicated that implementation of the changes will  
 5 probably occur over a longer period of time and not necessarily during the water  
 6 supply shortage, especially if groundwater or other surface water supplies can be  
 7 obtained within the growing season (Dale et al. 1998).

8 The effects on the surrounding communities of the variability of CVP and SWP  
 9 water supplies are discussed in Chapter 19, Socioeconomics, and Chapter 21,  
 10 Environmental Justice.

11 Typical responses of a farmer or water supplier to increasing shortage of water  
 12 supplies include the following actions.

- 13 • **Increase the use of groundwater:** Reduction in surface water supplies can  
 14 induce substitution with groundwater using new or existing wells. Water  
 15 supplies are used conjunctively in some areas with groundwater storage so  
 16 that during surface water shortages, water historically used to recharge  
 17 groundwater can be used for applied irrigation uses.
- 18 • **Use alternative/supplemental surface water supplies:** Alternative water  
 19 supplies may include local exchanges or transfers of surface water, water  
 20 transfers/purchases from more distant areas, and/or use of water stored in  
 21 surface water reservoirs or groundwater banks. These all depend on the  
 22 infrastructure to convey the water and the financial ability to pay for the  
 23 alternatives water supplies.
- 24 • **Increased water use efficiency:** Reduced use of irrigation water may be  
 25 achieved by on-farm system and irrigation management improvements, water  
 26 reuse, water source blending, and delivery system improvements. Specific  
 27 on-farm and delivery system improvements can include irrigation scheduling,  
 28 field leveling, application system changes, and conveyance system loss  
 29 reduction such as canal lining, spill reduction, and automation. Some of the  
 30 changes require only management changes, such as irrigation scheduling, and  
 31 can occur within the growing season. Other changes, such as conveyance  
 32 system modifications, require capital investments and generally require  
 33 several years to implement.
- 34 • **Field fallowing or changing to lower-water-use crops:** Fallowing, or  
 35 temporary idling, reduces gross water use by the entire applied water amount,  
 36 and reduces net water use by at least the evapotranspiration of the crop not  
 37 planted. Typically fields with higher water use crops or lower value rotation  
 38 crops would be the first fields to be fallowed. Farmers generally would avoid  
 39 or minimize fallowing permanent crops or crops with long-term obligations  
 40 (e.g., cannery contracts). A farmer receiving a partial allocation of water  
 41 could decide to reduce irrigated acreage and transfer that acreage's water  
 42 allocation to the remaining fields in production or sell the water to other water  
 43 users. A smaller reduction in water use can be achieved by switching from a  
 44 crop using more water to one using less water (Dale et al. 1998). Permanent

- 1 crops, such as trees and vines, that are the least economically viable or that are  
2 approaching the end of their lifespan can be removed or abandoned, and the  
3 land fallowed until adequate water is available. In extreme dry periods, such  
4 as 2014 when there were no deliveries of CVP water to San Joaquin Valley  
5 water supply agencies with CVP water service contracts, permanent crops  
6 were removed because the plants would not survive the stress of no water or  
7 saline groundwater (Fresno Bee 2014).
- 8 • **Stress Irrigation:** Farmers generally try to irrigate to achieve maximum  
9 economic yield. For some permanent crops, severe pruning could reduce  
10 water use, but could reduce yield over multiple years (AgAlert 2010).

11 **12.3.1.3 Cropping Pattern Changes in Response to Water Supply**  
12 **Availability**

13 Conversion of farm lands to other land uses has occurred historically and  
14 continues to occur. Agricultural lands have been converted to different crop  
15 patterns, urban areas, habitat restoration, off-farm infrastructure (e.g., utilities and  
16 transportation), and on-farm infrastructure (e.g., storage, maintenance, and  
17 processing facilities). Crop conversions occur in response to changes in water  
18 supply reliability, changes in market demand for specific crops, and decisions to  
19 convert lands to urban or infrastructure land uses.

20 One method used to indicate changes in California agricultural acreage is related  
21 to a loss of the value of production on “Important Farmland” and “Grazing Land”  
22 acreages, as reported by the California Department of Conservation since 1988  
23 (CDOC 2004). The comparison of the acreage of lands within each category can  
24 be used to identify trends in agricultural land conversions. This information is  
25 provided in the following subsections for the years 2000 and 2010 for counties  
26 within the study area.

27 Another factor to be considered prior to crop conversion is the costs related to  
28 crop establishment. Costs of irrigated crop production include labor, purchased  
29 inputs (e.g., seed, fertilizer, chemicals), custom services, investment in growing  
30 stock, other capital (including machinery and structures), and other overhead  
31 costs.

32 Reliability of water supply can be especially important for maintaining substantial  
33 investments in growing stock of perennial and multi-year crops. Perennial crops  
34 include orchards and vineyards that may have useful lives of 25 years or more.  
35 Multiyear forage crops, such as alfalfa and irrigated pasture, also may be in  
36 production for years. Investment in growing stock may be expressed as the  
37 accumulated costs incurred during the period when the crop is planted and  
38 brought to bearing age, called the establishment period. Establishment costs for  
39 perennial crops can range up to \$15,000 per acre in total costs (including cash  
40 outlays plus noncash and allocated overhead costs). The example establishment  
41 costs provided in Table 12.2 are for the Central Valley, but are generally  
42 representative of establishment costs in other regions.

1 **Table 12.2 Typical Establishment Costs for Some Perennial Crops in the Central**  
 2 **Valley**

Example Crop	Establishment Period (years)	Assumed Life of Stand (years)	Accumulated Total Cost during Establishment (\$ per acre)	University of California Cooperative Extension Cost of Production Study
Alfalfa Hay	1	4	534	Sacramento Valley, 2013
Almonds	4	25	10,117	San Joaquin Valley North, 2011
Irrigated Pasture	1	20	408	Sacramento Valley, 2003
Walnuts	5	25	14,133	San Joaquin Valley North, 2013
Wine Grapes	3	25	18,495	Cabernet Sauvignon, SJ Valley North, 2012

3 Sources: UCCE 2003, 2011, 2012a, 2013a

4 Notes: All costs are converted to 2012 dollar equivalent values using the Gross Domestic  
 5 Product Implicit Price Deflator (USDOC 2014). Assumed stand life is the financial life  
 6 used for the cost and budget analysis. Individual growers may decide to keep stands in  
 7 production longer or to remove them sooner.

8 Farm expenditures are largely spent in the surrounding community in the form of  
 9 input purchases, hired labor, rents paid to landlords, well drilling, and custom  
 10 consulting services. Total labor in the agricultural production sector is discussed  
 11 in relation to the regional economy in Chapter 19, Socioeconomics. Labor hours  
 12 and input purchases vary substantially among crops, as shown in Table 12.3.

13 **Table 12.3 Land Rent, Labor Hours, and Custom Services for Example Crops in the**  
 14 **Central Valley**

Example Crop	Typical Rent (\$ per acre)	Typical Annual Labor (hours per acre)	Custom Services Purchased (\$ per acre)	University of California Cooperative Extension Cost of Production Study
Alfalfa Hay	284	2	368	Sacramento Valley, 2013
Almonds	763	31	828	San Joaquin Valley North, 2011
Corn, Grain	147	3	324	San Joaquin Valley South, 2012
Irrigated Pasture	63	3	159	Sacramento Valley, 2003
Rice	280	5	329	Sacramento Valley, 2012
Walnuts	690	8	1,203	San Joaquin Valley North, 2013
Wheat	246	2	57	San Joaquin Valley South, 2013
Wine Grapes	633	68	505	Cabernet Sauvignon, SJ Valley North, 2012

15 Sources: UCCE 2003, 2011, 2012a, 2012b, 2012c, 2013a, 2013b, 2013c

16 Notes: All costs are converted to 2012 dollar equivalent values using the Gross Domestic  
 17 Product Implicit Price Deflator (USDOC 2014).

1     **12.3.1.4    Water Supply and Crop Acreage Relationships in the San**  
2                    **Joaquin Valley**

3     Most publically-available information on irrigated acreage and crop types is  
4     compiled at the county level, not the water district level. Water availability for  
5     CVP and SWP water is provided at a smaller geographic level, such as a water  
6     supply entity or several adjacent entities. Therefore, it is difficult to analyze the  
7     correlation of water supply availability, irrigated acreage, and crop types.  
8     However, the Westlands Water District does provide more detailed information  
9     related to water availability, irrigated acreage, and crop types in their publically-  
10    available reports, as summarized in this sub-section of Chapter 12. The purpose  
11    of this summary is to describe the relationships between cropping patterns,  
12    irrigation methods, and water supply availability. Due to the increased frequency  
13    of water supply reductions, especially in drier years (as described in Chapter 5,  
14    Surface Water Resources and Water Supplies), the amount of fallowed and  
15    non-harvested lands has increased as a percentage of total lands within Westlands  
16    Water District. The trend observed in Westlands Water District of using  
17    additional groundwater and crop idling land when CVP and SWP water supplies  
18    are reduced; and reducing groundwater use and increasing irrigated acreage when  
19    CVP and SWP become more available occurs throughout the San Joaquin Valley.

20    **12.3.1.4.1      Water Supplies in Westlands Water District**

21    Formed in 1952, Westlands Water District currently serves over 700 farmers  
22    across 604,000 acres located on the west side of Fresno and Kings Counties, as  
23    described in Chapter 5, Surface Water Resources and Water Supplies  
24    (WWD 2013a, 2013b). There are approximately 568,000 irrigable acres in the  
25    district.

26    Westlands Water District began receiving CVP water in 1968. In the first  
27    10 years of operations, irrigation water conveyance facilities were completed and  
28    cropping patterns became established. The CVP water supplies were reduced  
29    during the 1976 to 1977 drought. Crop acreage and water supply information are  
30    available for Westlands Water District from 1978 through 2013 (WWD 2013a,  
31    2014b, 2014c).

32    This time period includes several major happenings and/or changes in the CVP  
33    water supplies, as described in Chapter 5, Surface Water Resources and Water  
34    Supplies, and Chapter 6, Surface Water Quality.

- 35    • In 1978, the CVP water supplies were recovering from the 1976 to  
36      1977 drought.
- 37    • In the late 1980s, high selenium concentrations were detected in subsurface  
38      drainage flows from areas on the west side of the San Joaquin Valley where  
39      naturally occurring selenium deposits are located. Subsequently, farmers in  
40      these areas changed irrigation practices and in some cases, eliminated  
41      irrigation of some lands.
- 42    • Between 1987 and 1992, another drought occurred.

- 1 • In mid-1990s, the CVP water supplies recovered from a six year drought;  
2 however, CVP water supplies available to the district were limited due to  
3 initial restrictions on CVP operations to protect winter-run Chinook salmon  
4 and delta smelt and to provide refuge water supplies in accordance with the  
5 federal Central Valley Project Improvement Act (Public Law 102-575).
- 6 • By 2000, the CVP was initially operated under the requirements of State  
7 Water Resources Control Board Decision 1641 and the federal Central Valley  
8 Project Improvement Act which reduced the long-term availability of CVP  
9 water as compared to the 1980s.
- 10 • In 2007, the CVP operations were modified in accordance with the Interim  
11 Remedial Order issued by the U.S. District Court for the Eastern District of  
12 California in *Natural Resources Defense Council, et al. v. Kempthorne*.
- 13 • In 2009, the CVP operations were modified in accordance with the 2008  
14 U.S. Fish and Wildlife Service and 2009 National Marine Fisheries Services  
15 biological opinions.
- 16 • Between 2007 and 2013, six of the seven years were designated as Below  
17 Normal, Dry, or Critical Dry water years, which reduced CVP water supplies.

18 As CVP water supplies have declined over the past 35 years, Westland Water  
19 District has needed to implement major conservation programs and purchase  
20 water from other CVP and SWP water users and water rights holders.  
21 Concurrently, growers have increased groundwater pumping, as illustrated in  
22 Figure 12.3. Total supply over this time period ranges from a low of  
23 787,554 acre-feet in 2010 to a high of 1,546,883 acre-feet in 1984  
24 (WWD 2013a, 2014a).

#### 25 **12.3.1.4.2 Cropping Patterns in Westlands Water District**

26 In response to varying water supplies and market factors, farmers in Westlands  
27 Water District have changed cropping patterns. In 1978, the predominant crops  
28 were cotton and grain crops, including wheat and barley, with some vegetables,  
29 including tomatoes and cantaloupe, as summarized in Figure 12.4 (WWD 2013a).  
30 Between 1980 and 1996, grain crops were replaced by vegetable crops because  
31 other areas in California that traditionally grew crops were experiencing  
32 urbanization and groundwater shortages, including southern Santa Clara County  
33 and Monterey County (WWD 2008). Planting of permanent crops, including  
34 orchards and grapevines, increased between 1978 and 2013 as the markets factors  
35 became favorable (WWD 2013a, 2014b, 2014c). Total cotton acreage remained  
36 stable between 1978 and 2000, with Acala cotton as the primary crop (WWD No  
37 Date-a, No Date-b). After 2000, the total acreage of cotton declined and the  
38 primary crop was Pima cotton due to higher market price for this crop; however,  
39 cotton prices declined in the early 2000s.

#### 40 **12.3.1.4.3 Irrigation Methods in Westlands Water District**

41 Conversion of the major crops from annual grains to more orchards and vines  
42 resulted in Westlands Water District modifying water conveyance facilities



1 because the water demand patterns changed both in quantities and seasonal timing  
 2 (WWD No Date-c). The change in cropping patterns and the concurrent emphasis  
 3 on water conservation also resulted in changes in irrigation methods within the  
 4 district, as summarized in Table 12.4.

5 **Table 12.4 Irrigation Methods Used in Westlands Water District, as a percentage of**  
 6 **total irrigation methods**

Years	Furrow or Border Strip Irrigation	Sprinkler Irrigation	Drip or Trickle Irrigation	Sprinkler and Furrow Irrigation
1985	63%	21%	1%	15%
1990	43%	16%	3%	38%
1995	36%	15%	6%	43%
2000	30%	13%	13%	44%
2005	23%	10%	33%	34%
2010	11%	11%	67%	22%
2011	13%	12%	65%	22%

7 Source: WWD 2013a

8 These changes represent a major investment by the farmers and are considered in  
 9 the cost of crop establishment costs, a consideration described in above in  
 10 subsection 12.32.3.1, Crop Establishment Costs. The lower-valued grain and  
 11 forage crops generally use furrow or border strip irrigation (WWD 2013a).  
 12 Shallow-rooted vegetables frequently are irrigated with sprinklers or a  
 13 combination of sprinklers and furrow irrigation. Recently, tomatoes for  
 14 fresh-pack have been grown with drip irrigation. New orchard and vines have  
 15 been planted with pressurized drip or trickle irrigation. Other methods, including  
 16 leveling lands with lasers guided by global positioning satellites and aerated  
 17 irrigation to introduce air to plant roots, are used to increase irrigation efficiency  
 18 and improve crop yield (WWD No Date-a).

19 **12.3.1.4.4 Response to Reduced Water Supplies in Westlands Water**  
 20 **District**

21 Westlands Water District acquired over 95,000 acres of land with inadequate  
 22 drainage and the water supplies allocated to these lands are now available for  
 23 other lands in the district (WWD 2008, 2013a, No Date-c). Much of the  
 24 purchased land is leased to farmers for non-irrigated crops, or made available for  
 25 buildings or other economic development, including about 600 acres to the  
 26 U.S. Bureau of Prisons and about 1,250 acres to Pacific Gas & Electric Company  
 27 for solar projects.

28 Frequently, the amount of available surface water is not adequate to meet the  
 29 irrigation water demand. For example in the drier years of 1991, 1992, 2009, and  
 30 2013, groundwater provided more than 50 percent of the irrigation water supply.  
 31 This extensive reliance on groundwater can substantially reduce groundwater

1 elevations, as described in Chapter 7, Groundwater Resources and Groundwater  
2 Quality.

3 The Westlands Water District *Water Management Handbook* discusses that  
4 during droughts, water supplies are reduced and the cost of available water  
5 supplies are generally high due to costs of water transfers and/or implementing  
6 new or expanded groundwater facilities (WWD 2013b). At the farm level,  
7 Westlands' growers use a mix of methods to respond to reduced water supplies:  
8 groundwater pumping, land fallowing, and stress irrigation. The decision to  
9 fallow land or stress crops by applying less than full irrigation depends upon the  
10 crop. Some crops require full irrigation in order to produce a profitable yield, so  
11 stress irrigation is not practical – if water is short, acreage of these crops is  
12 reduced. Other crops may be able to withstand some stress and produce profitable  
13 yield. In the most severe shortage years, such as 2014, even some orchards and  
14 vineyards may be stressed or removed from production. From 1978 through the  
15 late 1990s when the primary crops were grains and cotton, those crops continued  
16 to be grown under stressed conditions and the fallowed and non-harvested land  
17 ranged from 3 to 16 percent of the total land in the district, as summarized in  
18 Figure 12.5 (WWD 2013a, 2014b, 2014c). However, since 2000, over 40 to  
19 55 percent of the total land in the district is planted in high value orchards, vine,  
20 and vegetable crops which cannot sustain stress. Therefore, farmers have  
21 increased the amount of fallowed and non-harvested acres to 10 to 34 percent of  
22 the total land in the district. When permanent orchards and vines are removed  
23 from production, the overall value of production in the district declines for  
24 number of years as the permanent crops require several years to become  
25 established.

### 26 **12.3.2 Trinity River Region**

27 The Trinity River Region includes the area in Trinity County along the Trinity  
28 River from Trinity Lake to the confluence with the Klamath River; and in  
29 Humboldt and Del Norte counties along the Klamath River from the confluence  
30 with the Trinity River to the Pacific Ocean.

31 Agriculture in the Trinity River Region is primarily related to timber products and  
32 cattle ranching which generally do not rely upon irrigation. Small farms and  
33 vineyards are located adjacent to or near the Trinity River rely primarily upon  
34 groundwater that is recharged by precipitation and infiltration from local streams,  
35 as described in Chapter 7, Groundwater Resources and Groundwater Quality. No  
36 lands in Trinity River Region are irrigated with water supplies delivered through  
37 the CVP or SWP.

38 Total value of production and acreage by crop category in the counties that  
39 include portions of the Trinity River Region are listed in Table 12.5.

1 **Table 12.5 Average Annual Agricultural Acreage and Value of Production in Trinity,**  
 2 **Humboldt, and Del Norte Counties from 2007 through 2012**

	<b>Orchards, Vineyards, and Berries</b>	<b>Field and Forage</b>	<b>Livestock, Dairy, Poultry</b>	<b>Nursery, Other</b>	<b>Vegetable</b>	<b>Total</b>
Acreage <sup>a</sup>	114	30,846	N/A	231	–	31,191
Value <sup>b</sup>	\$1.8	\$8.1	\$108.2	\$64.5	\$1.7	\$184

3 Sources: USDA-NASS2008, 2009, 2010, 2011a, 2012a, 2013a

4 Notes:

- 5 a. Not all acreages and/or production values are reported for every crop in every county.  
 6 Therefore the implied value of production per acre may be misleading for some crop  
 7 categories.  
 8 b. Values in million dollars, 2012 basis.

### 9 **12.3.3 Central Valley Region**

10 The Central Valley Region extends from above Shasta Lake to the Tehachapi  
 11 Mountains, and includes the Sacramento Valley and San Joaquin Valley. In this  
 12 chapter, the counties within the Delta and Suisun Marsh area are included in the  
 13 description of the Sacramento and San Joaquin valleys or the San Francisco Bay  
 14 Area Region. The Delta counties of Sacramento, Yolo, and Solano counties are  
 15 included within the Sacramento Valley discussion. Solano County also includes  
 16 the Suisun Marsh. San Joaquin County is included within the San Joaquin Valley  
 17 discussion. Contra Costa County is included within the San Francisco Bay Area  
 18 Region discussion.

19 Central Valley agriculture is highly productive due to favorable climate, adequate  
 20 supplies of good quality irrigation water, and deep, fertile soils. Most of the  
 21 Central Valley receives rainfall in the late fall through the winter months. Very  
 22 little of the annual rainfall occurs during the peak agricultural irrigation season  
 23 which extends from early spring through fall. The seasonality of rainfall in the  
 24 Central Valley is important for agricultural resources, as the timing of  
 25 precipitation does not reliably support dryland (non-irrigated) farming. Lower  
 26 value over-winter non-irrigated crops (e.g., winter wheat) can be grown  
 27 economically in many years but higher value row crops and permanent crops  
 28 require substantial supplemental irrigation (DWR 2009). Irrigation water  
 29 provided by the CVP and SWP, local surface water, and groundwater have  
 30 transformed lands in the Central Valley into some of the most productive and  
 31 diverse agricultural lands in the United States.

#### 32 **12.3.3.1 Sacramento Valley Crop Patterns**

33 The Sacramento Valley includes the counties of Shasta, Plumas, Tehama, Glenn,  
 34 Colusa, Butte, Sutter, Yuba, Nevada, Placer, El Dorado, Sacramento, Yolo, and  
 35 Solano counties. Other counties in Sacramento Valley are not anticipated to be  
 36 affected by changes in CVP and SWP operations, and are not discussed here,  
 37 including: Alpine, Sierra, Lassen, and Amador counties.

1 Field and forage crops dominate the irrigated acreage in Sacramento Valley with  
 2 over 1.4 million acres irrigated and about 38 percent of crop value produced, as  
 3 summarized in Table 12.6. Rice, irrigated pasture, and hay are the largest  
 4 acreages. Second to field and forage are orchard and vine crops, making up  
 5 roughly 21 percent of total acreage, but providing more than 38 percent crop  
 6 value produced. Almonds and walnuts are the largest acreages in this category.  
 7 Crop establishment and production costs are as summarized in Tables 12.2 and  
 8 12.3. In total, the Sacramento Valley contains nearly two million agricultural  
 9 acres generating over four billion dollars per year in value of production.

10 **Table 12.6 Sacramento Valley Average Annual Agricultural Acreage and Value of**  
 11 **Production from 2007 through 2012**

	Orchards, Vineyards, and Berries	Field and Forage	Livestock, Dairy, Poultry	Nursery, Other	Vegetable	Total
Acreage <sup>a</sup>	419,263	1,435,923	N/A	1,658	91,684	1,948,527
Value <sup>b</sup>	\$1,569	\$1,581	\$506	\$135	\$322	\$4,113

12 Sources: USDA-NASS 2008, 2009, 2010, 2011a, 2012a, 2013a

13 Notes:

- 14 a. Not all acreages and/or production values are reported for every crop in every county.  
 15 Therefore the implied value of production per acre may be misleading for some crop  
 16 categories.  
 17 b. Values in million dollars, 2012 basis

18 Most of the counties within the Sacramento Valley have experienced losses in  
 19 Important Farmland between 2000 and 2010, as summarized in Table 12.7.

20 **Table 12.7 Farmland Mapping and Monitoring Program Acreages in the**  
 21 **Sacramento Valley in 2000 and 2010**

County	Total <sup>a</sup>	Important Farmland <sup>b</sup>			Grazing Land		
		2000	2010	Change	2000	2010	Change
Butte	1.08	257,316	237,351	-19,965	264,982	402,999	138,017
Colusa	0.72	565,890	554,695	-11,195	7,526	9,161	1,635
El Dorado	1.1	68,292	64,259	-4,033	203,798	193,883	-9,915
Glenn	0.84	407,906	348,147	-59,759	176,072	226,837	50,765
Nevada	0.64	21,973	25,934	3,961	129,758	116,808	-12,950
Placer	0.96	156,701	132,741	-23,960	23,708	24,193	485
Sacramento	1.1	227,931	211,744	-16,187	168,144	155,822	-12,322
Shasta	2.4	35,349	19,716	-15,633	409,479	414,052	4,573
Solano	0.58	169,934	147,464	-22,470	201,813	209,195	7,382
Sutter	0.39	301,176	285,820	-15,356	50,958	53,538	2,580
Tehama	1.7	244,782	231,592	-13,190	706,027	1,547,951	841,924
Yolo	0.65	409,796	374,534	-35,262	143,365	160,450	17,085
Yuba	0.41	90,173	82,538	-7,635	144,519	141,509	-3,010

1 Sources: Butte County 2010; CDOC 2013; Colusa County 2011; El Dorado County 2003;  
2 Glenn County 1993; Nevada County 1995; Placer County 2011; Sacramento County  
3 2010; Shasta County 2004; Solano County 2008; Sutter County 2010; Tehama County  
4 2008; Yolo County 2009; Yuba County 2011

5 Notes:

6 a. Total acreage of county in million acres

7 b. Includes Prime Farmland, Farmland of Statewide Importance, and Unique Farmland.

8 No data was reported by California Department of Conservation for Plumas County.

9 **12.3.3.2 San Joaquin Valley**

10 The San Joaquin Valley includes the counties of Stanislaus, Merced, Madera,  
11 San Joaquin, Fresno, Kings, Tulare, and Kern counties. Other counties in the San  
12 Joaquin Valley are not anticipated to be affected by changes in CVP and SWP  
13 operations, and are not discussed here, including: Calaveras, Mariposa, and  
14 Tuolumne counties.

15 Field and forage crops are also the largest category in by acreage in this region, as  
16 summarized in Table 12.8. Hay, cotton, and silage have the largest acreage in this  
17 category. Second to field and forage is orchard and vine crops with almost two  
18 million acres, but providing more than three times the value of production.

19 Almonds and grapes are the two largest acreages of orchard and vine crops in the  
20 San Joaquin Valley. Crop establishment and production costs are as summarized  
21 in Tables 12.2 and 12.3. In total, the San Joaquin Valley contains over 5.5 million  
22 irrigated acres, generating over twenty-six billion dollars in value of production.

23 Important differences exist in water supply mix and reliability within the San  
24 Joaquin Valley. The CVP water users that are located on the west side of the  
25 valley and the SWP water users in Kings and Kern counties rely primarily on  
26 surface water conveyed through the Delta and groundwater, as discussed in  
27 Chapter 5, Surface Water Resources and Water Supplies. Agricultural producers  
28 within these CVP water service contractors and SWP entitlement holders are  
29 especially susceptible to large variation in available surface water supplies. The  
30 San Joaquin River Exchange Contractors receive CVP water supplies in exchange  
31 for their water rights on the San Joaquin River; and therefore, have much higher  
32 water supply reliability than CVP water service contractors or SWP entitlement  
33 holders, as described in Chapter 5, Surface Water Resources and Water Supplies.

34 On the east side of the San Joaquin Valley at the base of the Sierra Nevada,  
35 surface water is delivered under senior water rights on streams from the Sierra  
36 Nevada, or by the CVP from Millerton Lake at Friant Dam, as described in  
37 Chapter 5, Surface Water Resources and Water Supplies. The reliability of CVP  
38 water supplies from Friant Dam have generally been similar to or higher than that  
39 of CVP water supplies conveyed through the Delta. However, in 2014, the  
40 allocations were reduced to zero and available water from Friant Dam was  
41 provided to the water rights holders along the San Joaquin River (e.g., San  
42 Joaquin River Exchange Contractors).

1 A number of agricultural areas throughout the valley have no or very low priority  
 2 surface water rights. Growers in these areas rely on groundwater for irrigation  
 3 water.

4 **Table 12.8 San Joaquin Valley Average Annual Agricultural Acreage and Value of**  
 5 **Production from 2007 through 2012**

	Orchards, Vineyards, and Berries	Field and Forage	Livestock, Dairy, Poultry	Nursery, Other	Vegetable	Total
Acreage <sup>a</sup>	1,943,549	3,078,803	N/A	3,838	510,370	5,536,560
Value <sup>b</sup>	\$10,915	\$3,049	\$9,429	\$469	\$2,789	\$26,651

6 Sources: USDA-NASS 2008, 2009, 2010, 2011a, 2012a, 2013a

7 Notes:

8 a. Not all acreages and/or production values are reported for every crop in every county.  
 9 Therefore the implied value of production per acre may be misleading for some crop  
 10 categories.

11 b. Values in million dollars, 2012 basis.

12 Most counties within the San Joaquin Valley Region have experienced losses in  
 13 Important Farmland between 2000 and 2010, as summarized in Table 12.9. The  
 14 acreage of Important Farmland in Kern County grew substantially due to  
 15 reclassification of lands in the foothills of the county.

16 **Table 12.9 Farmland Mapping and Monitoring Program Acreages in the San**  
 17 **Joaquin Valley in 2000 and 2010**

County	Total <sup>a</sup>	Important Farmland <sup>b</sup>			Grazing Land		
		2000	2010	Change	2000	2010	Change
Fresno	3.8	1,400,535	1,370,273	-30,262	835,870	825,752	-10,118
Kern	5.3	990,422	914,084	-76,338	1,777,640	1,827,391	49,751
Kings	0.82	607,274	552,087	-55,187	238,485	271,831	33,346
Madera	1.4	60,617	39,812	-20,805	216,795	231,475	14,680
Merced	1.3	374,762	361,582	-13,180	401,592	400,604	-988
San Joaquin	0.91	630,990	614,994	-15,996	150,341	139,235	-11,106
Stanislaus	0.94	386,534	403,802	17,268	375,367	429,544	54,177
Tulare	3.1	880,604	859,991	-20,613	434,047	440,042	5,995

18 Sources: CDOC 2013; Fresno County 2000; Kern County 2004; Kings County 2009;  
 19 Madera County 1995; Merced County 2012; San Joaquin 2009; Stanislaus County 2010;  
 20 Tulare County 2010

21 Notes:

22 a. Total acreage of county in million acres

23 b. Includes Prime Farmland, Farmland of Statewide Importance, and Unique Farmland

1 **12.3.4 San Francisco Bay Area Region**

2 The San Francisco Bay Area Region includes portions of Napa, Contra Costa,  
3 Alameda, Santa Clara, and San Benito counties that are within the CVP and SWP  
4 service areas.

5 Crops grown in the San Francisco Bay Area Region include berries, vegetables,  
6 orchards, nursery plants, and irrigated and non-irrigated pasture. Permanent crops  
7 (orchards, vineyards, and berries) cover the largest acreage in this region with  
8 around 60,000 acres planted, as summarized in Table 12.10. Field and forage  
9 crops and vegetables also cover substantial acreage. Crop establishment and  
10 production costs are generally similar to those shown in Tables 12.2 and 12.3,  
11 except that land costs and rent may be substantially higher in this region. In total,  
12 the San Francisco Bay Area Region contains about 150,000 acres planted,  
13 creating over one billion dollars per year in value of production.

14 **Table 12.10 San Francisco Bay Area Average Annual Agricultural Acreage and**  
15 **Value from 2007 through 2012**

	<b>Orchards, Vineyards, Berries</b>	<b>Field and Forage</b>	<b>Livestock, Dairy, Poultry</b>	<b>Nursery, Other</b>	<b>Vegetable</b>	<b>Total</b>
Acreage <sup>a</sup>	60,239	50,715	N/A	942	41,564	153,460
Value <sup>b</sup>	\$589	\$22	\$62	\$145	\$329	\$1,148

16 Sources: USDA-NASS 2008, 2009, 2010, 2011a, 2012a, 2013a

17 Notes:

- 18 a. Not all acreages and/or production values are reported for every crop in every county.  
19 Therefore the implied value of production per acre may be misleading for some crop  
20 categories.  
21 b. Values in million dollars, 2012 basis

22 Changes in farmland in the San Francisco Bay Area Region counties are  
23 summarized in Table 12.11.

24 **Table 12.11 Farmland Mapping and Monitoring Program Acreages in the San**  
25 **Francisco Bay Area Region in 2000 and 2010**

<b>County</b>	<b>Total<sup>a</sup></b>	<b>Important Farmland<sup>b</sup></b>			<b>Grazing Land</b>		
		<b>2000</b>	<b>2010</b>	<b>Change</b>	<b>2000</b>	<b>2010</b>	<b>Change</b>
Alameda	0.47	10,346	7,566	-2,780	247,218	244,033	-3,185
Contra Costa	0.52	102,294	90,148	-12,146	172,053	168,646	-3,407
Napa	0.51	78,406	76,210	-2,196	180,920	179,029	-1,891
San Benito	0.89	81,701	57,460	-24,241	595,537	614,821	19,284
Santa Clara	0.84	44,025	27,751	-16,274	389,210	392,777	3,567

26 Sources: Alameda County 2000; CDOC 2013; Contra Costa County 2005; Napa County  
27 2007; San Benito County 2013; Santa Clara County 1994

- 28 a. Total acreage of county in million acres  
29 b. Includes Prime Farmland, Farmland of Statewide Importance, and Unique Farmland

**12.3.5 Central Coast Region**

The Central Coast Region includes portions of San Luis Obispo and Santa Barbara counties served by the SWP.

Crops grown in this region include orchards and vineyards, berries, vegetables, and irrigated pasture. Permanent crops and vegetables dominate the irrigated acreage in this region, accounting for about eighty percent of both the acres planted and the annual value of production, as summarized in Table 12.12. Crop establishment and production costs are generally similar to those shown in Tables 12.2 and 12.3, except that land costs and rent may be higher in this region. On average, the Central Coast Region contains almost 230,000 acres planted and almost two billion dollars per year in value of production.

**Table 12.12 Central Coast Region Average Annual Agricultural Acreage and Value from 2007 through 2012**

	Orchards, Vineyards, Berries	Field and Forage	Livestock, Dairy, Poultry	Nursery, Other	Vegetable	Total
Acreage <sup>a</sup>	86,394	43,078	N/A	1,749	97,17	228,397
Value <sup>b</sup>	\$874	\$22	\$98	\$268	\$641	\$1,904

Sources: USDA-NASS 2008, 2009, 2010, 2011a, 2012a, 2013a

Notes:

a. Not all acreages and/or production values are reported for every crop in every county. Therefore the implied value of production per acre may be misleading for some crop categories.

b. Values in million dollars, 2012 basis

Changes in farmland in the Central Coast Region between 2000 and 2010 are summarized in Table 12.13.

**Table 12.13 Farmland Mapping and Monitoring Program Acreages in the Central Coast and Southern California Regions in 2000 and 2010**

County	Total <sup>a</sup>	Important Farmland <sup>b</sup>			Grazing Land		
		2000	2010	Change	2000	2010	Change
San Luis Obispo	2.3	496,116	409,726	-86,390	1,105,169	1,181,015	75,846
Santa Barbara	1.8	139,810	125,292	-14,518	583,709	581,642	-2,067

Sources: CDOC 2013; San Luis Obispo County 2013; Santa Barbara County 2009

Notes:

a. Total acreage of county in million acres

b. Includes Prime Farmland, Farmland of Statewide Importance, and Unique Farmland

**12.3.6 Southern California Region**

The Southern California Region includes portions of Ventura, Los Angeles, Orange, San Diego, Riverside, and San Bernardino counties served by the SWP.



1 Two crop categories, orchards, vineyards, and berries; and field and forage,  
 2 account for more than three quarters of the irrigated acreage and about sixty  
 3 percent of the annual value of production in the Southern California Region, as  
 4 summarized in Table 12.14). Vegetables account for about one fifth of the  
 5 irrigated acreage and production value. Crop establishment and production costs  
 6 are generally similar to those shown in Tables 12.2 and 12.3, except that land  
 7 costs and rent may be higher in parts of this region. In total, the Southern  
 8 California Region contains almost 380,000 acres irrigated and generates over five  
 9 billion dollars per year in value of production.

10 **Table 12.14 Southern California Average Annual Agricultural Acreage and Value**  
 11 **from 2007 through 2012**

	Orchards, Vineyards, Berries	Field and Forage	Livestock, Dairy, Poultry	Nursery, Other	Vegetable	Total
Acreage <sup>a</sup>	141,447	143,747	N/A	10,143	81,306	376,642
Value <sup>b</sup>	\$1,693	\$161	\$809	\$1,851	\$925	\$5,439

12 Sources: USDA-NASS 2008, 2009, 2010, 2011a, 2012a, 2013a

13 Notes:

14 a. Not all acreages and/or production values are reported for every crop in every county.  
 15 Therefore the implied value of production per acre may be misleading for some crop  
 16 categories.

17 b. Values in million dollars, 2012 basis

18 Changes in farmland in the Southern California Region between 2000 and 2010  
 19 are summarized in Table 12.15.

20 **Table 12.15 Farmland Mapping and Monitoring Program Acreages in the Southern**  
 21 **California Region in 2000 and 2010**

		Important Farmland <sup>b</sup>			Grazing Land		
County	Total <sup>a</sup>	2000	2010	Change	2000	2010	Change
Los Angeles	2.6	60,617	39,812	-20,805	216,795	231,475	14,680
Orange	0.61	16,953	7,264	-9,689	37,963	37,639	-324
Riverside	4.7	484,821	428,989	-55,832	124,714	110,841	-13,873
San Bernardino	12.9	44,738	22,761	-21,977	936,090	902,590	-33,500
San Diego	2.9	193,103	218,921	25,818	137,619	126,496	-11,123
Ventura	1.2	131,512	119,683	-11,829	208,752	197,278	-11,474

22 Sources: CDOC 2013; Los Angeles County 2011; Orange County 2005; RCIP 2000; San  
 23 Bernardino County 2007; San Diego County 2011; Ventura County 2005

24 Notes:

25 a. Total acreage of county in million acres

26 b. Includes Prime Farmland, Farmland of Statewide Importance, and Unique Farmland

## 1 **12.4 Impact Analysis**

2 This section describes the potential mechanisms and analytical methods for  
3 change in agricultural resources; results of the impact analysis; potential  
4 mitigation measures; and cumulative effects.

### 5 **12.4.1 Potential Mechanisms for Change in Agricultural** 6 **Resources**

7 As described in Chapter 4, Approach to Environmental Analysis, the impact  
8 analysis considers changes in agricultural resources related to changes in CVP  
9 and SWP operations under the alternatives as compared to the No Action  
10 Alternative and Second Basis of Comparison.

11 Changes in CVP and SWP operations under the alternatives as compared to the  
12 No Action Alternative and Second Basis of Comparison could change irrigated  
13 acreage and total production value in areas that use CVP and SWP water supplies  
14 under long-term conditions (based upon the 81-year model simulation period) and  
15 dry and critical dry years.

16 This chapter only includes the analysis of economic changes in agricultural  
17 revenues. Chapter 19, Socioeconomics, includes economic changes related to  
18 municipal and industrial water supplies and changes in regional economics.

#### 19 **12.4.1.1 Changes in Irrigated Agricultural Acreage and Total Production** 20 **Value**

21 Changes in CVP and SWP operations under the alternatives could change the  
22 extent of irrigated acreage and total production value over the long-term average  
23 condition and in dry and critical dry years as compared to the No Action  
24 Alternative and Second Basis of Comparison.

25 The results of the impact analysis represents comparison of long-term changes  
26 that would occur between alternatives by 2030. The impact analysis does not  
27 represent short-term responses, especially during one to five years, in response to  
28 emergency flood or drought conditions.

29 Agricultural impacts were evaluated using a regional agricultural production  
30 model developed for large-scale analysis of irrigation water supply and cost  
31 changes. The Statewide Agricultural Production (SWAP) model is a regional  
32 model of irrigated agricultural production and economics that simulates the  
33 decisions of producers (farmers) in 27 agricultural subregions in the Central  
34 Valley Region, as described in Appendix 12A. The model selects the crops, water  
35 supplies, and other inputs that maximize profit subject to constraints on water and  
36 land, and subject to economic conditions regarding prices, yields, and costs.

37 The SWAP model incorporates CVP and SWP water supplies, other local water  
38 supplies represented in the CalSim II model, and groundwater. As conditions  
39 change within a SWAP subregion (e.g., the quantity of available project water  
40 supply declines), the model optimizes production by adjusting the crop mix, water

1 sources and quantities used, and other inputs. The model also follows land when  
2 that appears to be the most cost-effective response to resource conditions.

3 SWAP was used to compare the long-run agricultural economic responses to  
4 potential changes in CVP and SWP irrigation water delivery and to changes in  
5 groundwater conditions associated with the alternatives. Results from the surface  
6 water analysis that used the CalSim II model, as described in Chapter 5, Surface  
7 Water Resources and Water Supplies, were provided as inputs into SWAP  
8 through a standardized data linkage procedure. Results from the groundwater  
9 analysis that used the CVHM model, as described in Chapter 7, Groundwater  
10 Resources and Groundwater Quality, were used to develop changes in pumping  
11 lift in SWAP. SWAP produces estimates of the change in value and costs of  
12 agricultural production.

13 The analysis only reduces groundwater withdrawals based upon an optimization  
14 of agricultural production costs. The analysis does not restrict groundwater  
15 withdrawals based upon groundwater overdraft or groundwater quality conditions.  
16 As described in Chapter 7, Groundwater Resources and Groundwater Quality, the  
17 Sustainable Groundwater Management Act requires preparation of Groundwater  
18 Sustainability Plans (GSPs) by 2020 or 2022 for most of the groundwater basins  
19 in the Central Valley Region. The GSPs will identify methods to implement  
20 measures that will achieve sustainable groundwater operations by 2040 or 2042.  
21 The analysis in this chapter is focused on conditions that would occur in 2030. If  
22 local agencies fully implement GSPs prior to the regulatory deadline, increasing  
23 groundwater use would be less of an option for agricultural water users.  
24 However, to achieve sustainable conditions, some measures could require several  
25 years to design and construct new water supply facilities, and sustainable  
26 groundwater conditions are not required until the 2040s. Therefore, it was  
27 assumed that Central Valley agriculture water users would not reduce  
28 groundwater use by 2030, and that groundwater use would change in response to  
29 changes in CVP and SWP water supplies.

#### 30 **12.4.1.2 Effects Related to Water Transfers**

31 Historically water transfer programs have been developed on an annual basis.  
32 The demand for water transfers is dependent upon the availability of water  
33 supplies to meet water demands. Water transfer transactions have increased over  
34 time as CVP and SWP water supply availability has decreased, especially during  
35 drier water years.

36 Parties seeking water transfers generally acquire water from sellers who have  
37 available surface water who can make the water available through releasing  
38 previously stored water, pump groundwater instead of using surface water  
39 (groundwater substitution); idle crops; or substitute crops that uses less water in  
40 order to reduce normal consumptive use of surface water.

41 Water transfers using CVP and SWP Delta pumping plants and south of Delta  
42 canals generally occur when there is unused capacity in these facilities. These  
43 conditions generally occur in drier water year types when the flows from  
44 upstream reservoirs plus unregulated flows are adequate to meet the Sacramento

1 Valley water demands and the CVP and SWP export allocations. In non-wet  
 2 years, the CVP and SWP water allocations would be less than full contract  
 3 amounts; therefore, capacity may be available in the CVP and SWP conveyance  
 4 facilities to move water from other sources.

5 Projecting future agricultural resources conditions related to water transfer  
 6 activities is difficult because specific water transfer actions required to make the  
 7 water available, convey the water, and/or use the water would change each year  
 8 due to changing hydrological conditions, CVP and SWP water availability,  
 9 specific local agency operations, and local cropping patterns. Reclamation  
 10 recently prepared a long-term regional water transfer environmental document  
 11 which evaluated potential changes in agricultural resources conditions related to  
 12 water transfer actions (Reclamation 2014c). Results from this analysis were used  
 13 to inform the impact assessment of potential effects of water transfers under the  
 14 alternatives as compared to the No Action Alternative and the Second Basis of  
 15 Comparison.

#### 16 **12.4.2 Conditions in Year 2030 without Implementation of** 17 **Alternatives 1 through 5**

18 This EIS includes two bases of comparison, as described in Chapter 3,  
 19 Description of Alternatives: the No Action Alternative and the Second Basis of  
 20 Comparison. Both of these bases are evaluated at 2030 conditions. Changes that  
 21 would occur over the next 15 years without implementation of the alternatives are  
 22 not analyzed in this EIS. However, the changes to agricultural resources that are  
 23 assumed to occur by 2030 under the No Action Alternative and the Second Basis  
 24 of Comparison are summarized in this section. Many of the changed conditions  
 25 would occur in the same manner under both the No Action Alternative and the  
 26 Second Basis of Comparison.

##### 27 **12.4.2.1 Common Changes in Conditions under the No Action Alternative** 28 **and Second Basis of Comparison**

29 Conditions in 2030 would be different than existing conditions due to:

- 30 • Climate change and sea level rise
- 31 • General plan development throughout California, including increased water  
 32 demands in portions of Sacramento Valley
- 33 • Implementation of reasonable and foreseeable water resources management  
 34 projects to provide water supplies

35 It is anticipated that climate change would result in more short-duration  
 36 high-rainfall events and less snowpack in the winter and early spring months. The  
 37 reservoirs would be full more frequently by the end of April or May by 2030 than  
 38 in recent historical conditions. However, as the water is released in the spring,  
 39 there would be less snowpack to refill the reservoirs. These changes would result  
 40 in a decline of the long-term average CVP and SWP water supply deliveries by  
 41 2030 as compared to recent historical long-term average deliveries under the  
 42 No Action Alternative and the Second Basis of Comparison. However, the CVP

1 and SWP water deliveries would be less under the No Action Alternative as  
2 compared to the Second Basis of Comparison, as described in Chapter 5, Surface  
3 Water Resources and Water Supplies, which could result in more crop idling.

4 Under the No Action Alternative and the Second Basis of Comparison, land uses  
5 in 2030 would occur in accordance with adopted general plans. Development  
6 under the general plans would result in disruption of agricultural resources;  
7 however, the development of general plans includes preparation of environmental  
8 documentation that would identify methods to minimize adverse impacts to  
9 agricultural resources.

10 Under the No Action Alternative and the Second Basis of Comparison,  
11 development of future water resources management projects by 2030 which  
12 would result in improved water supply flexibility and availability, including water  
13 supplies for agricultural resources, as described in Chapter 3, Description of  
14 Alternatives.

15 By 2030 under the No Action Alternative and the Second Basis of Comparison, it  
16 is assumed that ongoing programs would result in restoration of more than  
17 10,000 acres of intertidal and associated subtidal wetlands in Suisun Marsh and  
18 Cache Slough; and 17,000 to 20,000 acres of seasonal floodplain restoration in the  
19 Yolo Bypass. The restoration programs could disrupt agricultural resources  
20 depending upon the location of the restoration.

### 21 **12.4.3 Evaluation of Alternatives**

22 Alternatives 1 through 5 have been compared to the No Action Alternative; and  
23 the No Action Alternative and Alternatives 1 through 5 have been compared to  
24 the Second Basis of Comparison.

25 During review of the numerical modeling analyses used in this EIS, an error was  
26 determined in the CalSim II model assumptions related to the Stanislaus River  
27 operations for the Second Basis of Comparison, Alternative 1, and Alternative 4  
28 model runs. Appendix 5C, Revised Second Basis of Comparison, includes a  
29 comparison of the CalSim II model run results presented in this chapter and  
30 CalSim II model run results with the error corrected.

31 Chapter 7, Groundwater Resources and Groundwater Quality, includes a  
32 discussion of changes in the comparison of groundwater conditions for the  
33 following alternative analyses.

- 34 • No Action Alternative compared to the Second Basis of Comparison
- 35 • Alternative 1 compared to the No Action Alternative
- 36 • Alternative 3 compared to the Second Basis of Comparison
- 37 • Alternative 5 compared to the Second Basis of Comparison.

38 The results of the impact analysis represents comparison of long-term changes  
39 that would occur between alternatives by 2030. The impact analysis does not  
40 represent short-term responses, especially during one to five years, in response to  
41 emergency flood or drought conditions.

1 **12.4.3.1 No Action Alternative**

2 The No Action Alternative is compared to the Second Basis of Comparison.

3 **12.4.3.1.1 Trinity River Region**

4 *Potential Changes in Irrigated Agricultural*

5 There are no agricultural lands irrigated with CVP and SWP water supplies in the  
6 Trinity River Region. Therefore, there would be no changes in irrigated lands  
7 under the No Action Alternative as compared to the Second Basis of Comparison.

8 **12.4.3.1.2 Central Valley Region**

9 *Potential Changes in Irrigated Agriculture.*

10 *Sacramento Valley*

11 Results of the SWAP analysis indicated that agricultural crop patterns in the  
12 Sacramento Valley would be similar (less than 5 percent change) under the  
13 No Action Alternative and the Second Basis of Comparison over long-term  
14 average conditions and in dry and critical dry years, as summarized in  
15 Tables 12.16 and 12.17.

16 **Table 12.16 Changes in Sacramento Valley Irrigated Acreage over the Long-term**  
17 **Average Conditions under the No Action Alternative as Compared to the Second**  
18 **Basis of Comparison**

Crops	No Action Alternative (1000s acres)	Second Basis of Comparison (1000s acres)	Changes (1000s acres)
Grain Crops	155	154	1
Rice	548	548	0
Field Crops	59	59	0
Forage Crops	199	200	-1
Vegetables and Truck Crops	119	119	0
Orchards and Vineyards	456	457	0
<b>Total</b>	<b>1,537</b>	<b>1,537</b>	<b>0</b>

19 Notes:

20 Grain crops include corn, dry beans, and grain.

21 Field crops include cotton, grass, hay, safflower, and sugar beets.

22 Forage crops include alfalfa and pasture.

23 **Table 12.17 Changes in Sacramento Valley Irrigated Acreage in Dry and Critical Dry**  
24 **Years under the No Action Alternative as Compared to the Second Basis of**  
25 **Comparison**

Crops	No Action Alternative (1000s acres)	Second Basis of Comparison (1000s acres)	Changes (1000s acres)
Grain Crops	155	155	0
Rice	544	548	-4
Field Crops	59	59	0
Forage Crops	197	198	-1

Crops	No Action Alternative (1000s acres)	Second Basis of Comparison (1000s acres)	Changes (1000s acres)
Vegetables and Truck Crops	119	119	0
Orchards and Vineyards	456	457	-1
<b>Total</b>	<b>1,529</b>	<b>1,536</b>	<b>-7</b>

- 1 Notes:  
 2 Grain crops include corn, dry beans, and grain.  
 3 Field crops include cotton, grass, hay, safflower, and sugar beets.  
 4 Forage crops include alfalfa and pasture.

5 Agricultural production in the Sacramento Valley would be similar (less than  
 6 5 percent change) under the No Action Alternative and the Second Basis of  
 7 Comparison over long-term average conditions and in dry and critical dry years  
 8 due to increased use of groundwater, as summarized in Tables 12.18 and 12.19.

9 **Table 12.18 Changes in Sacramento Valley Agricultural Production over the**  
 10 **Long-term Average Conditions under the No Action Alternative as Compared to the**  
 11 **Second Basis of Comparison**

Crops	No Action Alternative (\$ millions)	Second Basis of Comparison (\$ millions)	Changes (\$ millions)
Grain Crops	150	149	0.8
Rice	1,114	1,115	-0.9
Field Crops	77	77	0.1
Forage Crops	246	246	-0.7
Vegetables and Truck Crops	967	967	0.0
Orchards and Vineyards	3,192	3,193	-0.9
<b>Total</b>	<b>5,745</b>	<b>5,747</b>	<b>-1.6</b>

- 12 Notes:  
 13 Grain crops include corn, dry beans, and grain.  
 14 Field crops include cotton, grass, hay, safflower, and sugar beets.  
 15 Forage crops include alfalfa and pasture.  
 16 All values of production are in 2012 dollar equivalent values.

17 **Table 12.19 Changes in Sacramento Valley Agricultural Production in Dry and**  
 18 **Critical Dry Years under the No Action Alternative as Compared to the Second**  
 19 **Basis of Comparison**

Crops	No Action Alternative (\$ millions)	Second Basis of Comparison (\$ millions)	Changes (\$ millions)
Grain Crops	150	150	-0.5
Rice	1,107	1,114	-7.3

Crops	No Action Alternative (\$ millions)	Second Basis of Comparison (\$ millions)	Changes (\$ millions)
Field Crops	77	77	-0.1
Forage Crops	243	245	-1.4
Vegetables and Truck Crops	967	967	-0.2
Orchards and Vineyards	3,191	3,193	-1.7
<b>Total</b>	<b>5,735</b>	<b>5,746</b>	<b>-11.3</b>

- 1 Notes:
- 2 Grain crops include corn, dry beans, and grain.
- 3 Field crops include cotton, grass, hay, safflower, and sugar beets.
- 4 Forage crops include alfalfa and pasture.
- 5 All values of production are in 2012 dollar equivalent values.

6 *San Joaquin Valley*

7 Results of the SWAP analysis indicated that irrigated acreage in the San Joaquin  
 8 Valley, including the Tulare Lake area, would be similar under the No Action  
 9 Alternative as compared to the Second Basis of Comparison over long-term  
 10 average conditions and in dry and critical dry years, as summarized in  
 11 Tables 12.20 and 12.21.

12 **Table 12.20 Changes in San Joaquin Valley Irrigated Acreage over the Long-term**  
 13 **Average Conditions under the No Action Alternative as Compared to the Second**  
 14 **Basis of Comparison**

Crops	No Action Alternative (1000s acres)	Second Basis of Comparison (1000s acres)	Changes (1000s acres)
Grain Crops	1,024	1,024	0
Rice	17	17	0
Field Crops	828	828	0
Forage Crops	735	735	0
Vegetables and Truck Crops	633	633	0
Orchards and Vineyards	2,156	2,156	0
<b>Total</b>	<b>5,392</b>	<b>5,392</b>	<b>0</b>

- 15 Notes:
- 16 Grain crops include corn, dry beans, and grain.
- 17 Field crops include cotton, grass, hay, safflower, and sugar beets.
- 18 Forage crops include alfalfa and pasture.



1 **Table 12.21 Changes in San Joaquin Valley Irrigated Acreage in Dry and Critical**  
 2 **Dry Years under the No Action Alternative as Compared to the Second Basis of**  
 3 **Comparison**

Crops	No Action Alternative (1000s acres)	Second Basis of Comparison (1000s acres)	Changes (1000s acres)
<b>Grain Crops</b>	1,010	1,024	-14
<b>Rice</b>	17	17	0
<b>Field Crops</b>	827	828	0
<b>Forage Crops</b>	735	735	-1
<b>Vegetables and Truck Crops</b>	633	633	0
<b>Orchards and Vineyards</b>	2,154	2,156	-2
<b>Total</b>	5,375	5,392	-17

4 Notes:

- 5 Grain crops include corn, dry beans, and grain.  
 6 Field crops include cotton, grass, hay, safflower, and sugar beets.  
 7 Forage crops include alfalfa and pasture.

8 Agricultural production in the Sacramento Valley would be similar under the  
 9 No Action Alternative and the Second Basis of Comparison over long-term  
 10 average conditions and in dry and critical dry years due to increased use of  
 11 groundwater, as summarized in Tables 12.22 and 12.23.

12 **Table 12.22 Changes in San Joaquin Valley Agricultural Production over the Long-**  
 13 **term Average Conditions under the No Action Alternative as Compared to the**  
 14 **Second Basis of Comparison**

Crops	No Action Alternative (\$ millions)	Second Basis of Comparison (\$ millions)	Changes (\$ millions)
<b>Grain Crops</b>	1,373	1,373	-0.2
<b>Rice</b>	31	31	0.0
<b>Field Crops</b>	1,436	1,437	-0.4
<b>Forage Crops</b>	1,426	1,426	-0.1
<b>Vegetables and Truck Crops</b>	4,623	4,623	0.1
<b>Orchards and Vineyards</b>	16,547	16,547	0.0
<b>Total</b>	25,437	25,438	-0.5

15 Notes:

- 16 Grain crops include corn, dry beans, and grain.  
 17 Field crops include cotton, grass, hay, safflower, and sugar beets.  
 18 Forage crops include alfalfa and pasture.  
 19 All values of production are in 2012 dollar equivalent values.

1 **Table 12.23 Changes in San Joaquin Valley Agricultural Production in Dry and**  
 2 **Critical Dry Years under the No Action Alternative as Compared to the Second**  
 3 **Basis of Comparison**

Crops	No Action Alternative (\$ millions)	Second Basis of Comparison (\$ millions)	Changes (\$ millions)
<b>Grain Crops</b>	1,359	1,373	-14.4
<b>Rice</b>	31	31	0.0
<b>Field Crops</b>	1,436	1,437	-0.9
<b>Forage Crops</b>	1,426	1,426	-0.4
<b>Vegetables and Truck Crops</b>	4,623	4,623	-0.2
<b>Orchards and Vineyards</b>	16,542	16,547	-4.4
<b>Total</b>	25,417	25,437	-20.3

- 4 Notes:  
 5 Grain crops include corn, dry beans, and grain.  
 6 Field crops include cotton, grass, hay, safflower, and sugar beets.  
 7 Forage crops include alfalfa and pasture.  
 8 All values of production are in 2012 dollar equivalent values.

9 *Effects Related to Cross Delta Water Transfers*

10 Potential effects to agricultural resources could be similar to those identified in a  
 11 recent environmental analysis conducted by Reclamation for long-term water  
 12 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c).  
 13 Potential effects to agricultural resources were identified as reduced cultivation of  
 14 agricultural lands over the term of the transfer in the seller’s service area.  
 15 However, the amount of land effected by the water transfers would be relatively  
 16 small as compared to the total cultivated acreage within a region. Beneficial  
 17 changes would occur related to agricultural resources in the purchaser’s service  
 18 areas. The analysis indicated that these potential impacts would not be  
 19 substantial.

20 Under the No Action Alternative, the timing of cross Delta water transfers would  
 21 be limited to July through September and include annual volumetric limits, in  
 22 accordance with the 2008 USFWS BO and 2009 NMFS BO. Under the Second  
 23 Basis of Comparison, water could be transferred throughout the year without an  
 24 annual volumetric limit. Overall, the potential for cross Delta water transfers  
 25 would be less under the No Action Alternative than under the Second Basis of  
 26 Comparison.

27 **12.4.3.1.3 San Francisco Bay Area, Central Coast, and Southern California**  
 28 **Regions**

29 *Potential Changes in Irrigated Agricultural*

30 It is anticipated that reductions in CVP and SWP water supplies within the  
 31 San Francisco Bay Area, Central Coast, and Southern California regions would

1 not result in reductions in irrigated acreage or land use changes due to the use of  
 2 other water supplies in the same manner that is projected to occur in the Central  
 3 Valley Region.

4 **12.4.3.2 Alternative 1**

5 Alternative 1 is identical to the Second Basis of Comparison. Alternative 1 is  
 6 compared to the No Action Alternative and the Second Basis of Comparison.  
 7 However, because agricultural resource conditions under Alternative 1 are  
 8 identical to agricultural resource conditions under the Second Basis of  
 9 Comparison; Alternative 1 is only compared to the No Action Alternative.

10 **12.4.3.2.1 Alternative 1 Compared to the No Action Alternative**

11 *Trinity River Region*

12 *Potential Changes in Irrigated Agricultural*

13 There are no agricultural lands irrigated with CVP and SWP water supplies in the  
 14 Trinity River Region. Therefore, there would be no changes in irrigated lands  
 15 under Alternative 1 as compared to the No Action Alternative.

16 *Central Valley Region*

17 *Potential Changes in Irrigated Agricultural*

18 *Sacramento Valley*

19 Results of the SWAP analysis indicated that agricultural crop patterns in the  
 20 Sacramento Valley would be similar under Alternative 1 as compared to the No  
 21 Action Alternative over long-term average conditions and in dry and critical dry  
 22 years, as summarized in Tables 12.24 and 12.25.

23 **Table 12.24 Changes in Sacramento Valley Irrigated Acreage over the Long-term**  
 24 **Average Conditions under Alternative 1 as Compared to the No Action Alternative**

Crops	Alternative 1 (1000s acres)	No Action Alternative (1000s acres)	Changes (1000s acres)
<b>Grain Crops</b>	154	155	-1
<b>Rice</b>	549	548	0
<b>Field Crops</b>	59	59	0
<b>Forage Crops</b>	200	199	1
<b>Vegetables and Truck Crops</b>	119	119	0
<b>Orchards and Vineyards</b>	457	456	0
<b>Total</b>	1,537	1,537	0

25 Notes:

26 Grain crops include corn, dry beans, and grain.

27 Field crops include cotton, grass, hay, safflower, and sugar beets.

28 Forage crops include alfalfa and pasture.

1 **Table 12.25 Changes in Sacramento Valley Irrigated Acreage in Dry and Critical Dry**  
 2 **Years under Alternative 1 as Compared to the No Action Alternative**

Crops	Alternative 1 (1000s acres)	No Action Alternative (1000s acres)	Changes (1000s acres)
Grain Crops	155	155	0
Rice	548	544	4
Field Crops	59	59	0
Forage Crops	198	197	1
Vegetables and Truck Crops	119	119	0
Orchards and Vineyards	457	456	1
<b>Total</b>	<b>1,536</b>	<b>1,529</b>	<b>7</b>

- 3 Notes:  
 4 Grain crops include corn, dry beans, and grain.  
 5 Field crops include cotton, grass, hay, safflower, and sugar beets.  
 6 Forage crops include alfalfa and pasture.

7 Agricultural production in the Sacramento Valley would be similar (less than  
 8 5 percent change) under Alternative 1 as compared to the No Action Alternative  
 9 over long-term average conditions and in dry and critical dry years due to reduced  
 10 use of groundwater, as summarized in Tables 12.26 and 12.27.

11 **Table 12.26 Changes in Sacramento Valley Agricultural Production over the**  
 12 **Long-term Average Conditions under Alternative 1 as Compared to the No Action**  
 13 **Alternative**

Crops	Alternative 1 (\$ millions)	No Action Alternative (\$ millions)	Changes (\$ millions)
Grain Crops	149	150	-0.8
Rice	1,115	1,114	0.9
Field Crops	77	77	-0.1
Forage Crops	246	246	0.7
Vegetables and Truck Crops	967	967	0.0
Orchards and Vineyards	3,193	3,192	0.9
<b>Total</b>	<b>5,747</b>	<b>5,745</b>	<b>1.6</b>

- 14 Notes:  
 15 Grain crops include corn, dry beans, and grain.  
 16 Field crops include cotton, grass, hay, safflower, and sugar beets.  
 17 Forage crops include alfalfa and pasture.  
 18 All values of production are in 2012 dollar equivalent values.

1 **Table 12.27 Changes in Sacramento Valley Agricultural Production in Dry and**  
 2 **Critical Dry Years under Alternative 1 as Compared to the No Action Alternative**

Crops	Alternative 1 (\$ millions)	No Action Alternative (\$ millions)	Changes (\$ millions)
<b>Grain Crops</b>	150	150	0.5
<b>Rice</b>	1,114	1,107	7.3
<b>Field Crops</b>	77	77	0.1
<b>Forage Crops</b>	245	243	1.4
<b>Vegetables and Truck Crops</b>	967	967	0.2
<b>Orchards and Vineyards</b>	3,193	3,191	1.7
<b>Total</b>	5,746	5,735	11.3

- 3 Notes:  
 4 Grain crops include corn, dry beans, and grain.  
 5 Field crops include cotton, grass, hay, safflower, and sugar beets.  
 6 Forage crops include alfalfa and pasture.  
 7 All values of production are in 2012 dollar equivalent values.

8 *San Joaquin Valley*

9 Results of the SWAP analysis indicated that irrigated acreage in the San Joaquin  
 10 Valley, including the Tulare Lake area, would be similar under Alternative 1 as  
 11 compared to the No Action Alternative over long-term average conditions and in  
 12 dry and critical dry years, as summarized in Tables 12.28 and 12.29.

13 **Table 12.28 Changes in San Joaquin Valley Irrigated Acreage over the Long-term**  
 14 **Average Conditions under Alternative 1 as Compared to the No Action Alternative**

Crops	Alternative 1 (1000s acres)	No Action Alternative (1000s acres)	Changes (1000s acres)
<b>Grain Crops</b>	1,024	1,024	0
<b>Rice</b>	17	17	0
<b>Field Crops</b>	828	828	0
<b>Forage Crops</b>	735	735	0
<b>Vegetables and Truck Crops</b>	633	633	0
<b>Orchards and Vineyards</b>	2,156	2,156	0
<b>Total</b>	5,392	5,392	0

- 15 Notes:  
 16 Grain crops include corn, dry beans, and grain.  
 17 Field crops include cotton, grass, hay, safflower, and sugar beets.  
 18 Forage crops include alfalfa and pasture.

1 **Table 12.29 Changes in San Joaquin Valley Irrigated Acreage in Dry and Critical**  
 2 **Dry Years under Alternative 1 as Compared to the No Action Alternative**

Crops	Alternative 1 (1000s acres)	No Action Alternative (1000s acres)	Changes (1000s acres)
<b>Grain Crops</b>	1,024	1,010	14
<b>Rice</b>	17	17	0
<b>Field Crops</b>	828	827	0
<b>Forage Crops</b>	735	735	1
<b>Vegetables and Truck Crops</b>	633	633	0
<b>Orchards and Vineyards</b>	2,156	2,154	2
<b>Total</b>	5,392	5,375	17

3 Notes:

4 Grain crops include corn, dry beans, and grain.

5 Field crops include cotton, grass, hay, safflower, and sugar beets.

6 Forage crops include alfalfa and pasture.

7 Agricultural production in the San Joaquin Valley would be similar under  
 8 Alternative 1 as compared to the No Action Alternative over long-term average  
 9 conditions and in dry and critical dry years due to reduced use of groundwater, as  
 10 summarized in Tables 12.30 and 12.31.

11 **Table 12.30 Changes in San Joaquin Valley Agricultural Production over the**  
 12 **Long-term Average Conditions under Alternative 1 as Compared to the No Action**  
 13 **Alternative**

Crops	Alternative 1 (\$ millions)	No Action Alternative (\$ millions)	Changes (\$ millions)
<b>Grain Crops</b>	1,373	1,373	0.2
<b>Rice</b>	31	31	0.0
<b>Field Crops</b>	1,437	1,436	0.4
<b>Forage Crops</b>	1,426	1,426	0.1
<b>Vegetables and Truck Crops</b>	4,623	4,623	-0.1
<b>Orchards and Vineyards</b>	16,547	16,547	0.0
<b>Total</b>	25,438	25,437	0.5

14 Notes:

15 Grain crops include corn, dry beans, and grain.

16 Field crops include cotton, grass, hay, safflower, and sugar beets.

17 Forage crops include alfalfa and pasture.

18 All values of production are in 2012 dollar equivalent values.

1 **Table 12.31 Changes in San Joaquin Valley Agricultural Production in Dry and**  
 2 **Critical Dry Years under Alternative 1 as Compared to the No Action Alternative**

Crops	Alternative 1 (\$ millions)	No Action Alternative (\$ millions)	Changes (\$ millions)
<b>Grain Crops</b>	1,373	1,359	14.4
<b>Rice</b>	31	31	0.0
<b>Field Crops</b>	1,437	1,436	0.9
<b>Forage Crops</b>	1,426	1,426	0.4
<b>Vegetables and Truck Crops</b>	4,623	4,623	0.2
<b>Orchards and Vineyards</b>	16,547	16,542	4.4
<b>Total</b>	25,437	25,417	20.3

- 3 Notes:  
 4 Grain crops include corn, dry beans, and grain.  
 5 Field crops include cotton, grass, hay, safflower, and sugar beets.  
 6 Forage crops include alfalfa and pasture.  
 7 All values of production are in 2012 dollar equivalent values.

8 *Effects Related to Water Transfers*

9 Potential effects to agricultural resources could be similar to those identified in a  
 10 recent environmental analysis conducted by Reclamation for long-term water  
 11 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as  
 12 described above under the No Action Alternative compared to the Second Basis  
 13 of Comparison. For the purposes of this EIS, it is anticipated that similar  
 14 conditions would occur during implementation of cross Delta water transfers  
 15 under Alternative 1 and the No Action Alternative, and that impacts on  
 16 agricultural resources would not be substantial in the seller’s service area due to  
 17 implementation requirements of the transfer programs.

18 Under Alternative 1, water could be transferred throughout the year without an  
 19 annual volumetric limit. Under the No Action Alternative, the timing of cross  
 20 Delta water transfers would be limited to July through September and include  
 21 annual volumetric limits, in accordance with the 2008 USFWS BO and  
 22 2009 NMFS BO. Overall, the potential for cross Delta water transfers would be  
 23 increased under Alternative 1 as compared to the No Action Alternative.

24 *San Francisco Bay Area, Central Coast, and Southern California Regions*

25 *Potential Changes in Irrigated Agricultural*

26 It is anticipated that reductions in CVP and SWP water supplies within the San  
 27 Francisco Bay Area, Central Coast, and Southern California regions would not  
 28 result in reductions in irrigated acreage or land use changes due to the use of other  
 29 water supplies in the same manner that is projected to occur in the Central Valley  
 30 Region.

1 **12.4.3.2.2 Alternative 1 Compared to the Second Basis of Comparison**

2 Alternative 1 is identical to the Second Basis of Comparison.

3 **12.4.3.3 Alternative 2**

4 The agricultural resources under Alternative 2 would be identical to the conditions  
5 under the No Action Alternative; therefore, Alternative 2 is only compared to the  
6 Second Basis of Comparison.

7 **12.4.3.3.1 Alternative 2 Compared to the Second Basis of Comparison**

8 Changes to agricultural resources under Alternative 2 as compared to the Second  
9 Basis of Comparison would be the same as the impacts described in Section  
10 12.4.3.1, No Action Alternative.

11 **12.4.3.4 Alternative 3**

12 The CVP and SWP operations under Alternative 3 are similar to the Second Basis  
13 of Comparison with modified Old and Middle River flow criteria and New  
14 Melones Reservoir operations.

15 **12.4.3.4.1 Alternative 3 Compared to the No Action Alternative**

16 *Trinity River Region*

17 *Potential Changes in Irrigated Agricultural*

18 There are no agricultural lands irrigated with CVP and SWP water supplies in the  
19 Trinity River Region. Therefore, there would be no changes in irrigated lands  
20 under Alternative 3 as compared to the No Action Alternative.

21 *Central Valley Region*

22 *Potential Changes in Irrigated Agricultural*

23 *Sacramento Valley*

24 Results of the SWAP analysis indicated that agricultural crop patterns in the  
25 Sacramento Valley would be similar under Alternative 3 as compared to the No  
26 Action Alternative over long-term average conditions and in dry and critical dry  
27 years, as summarized in Tables 12.32 and 12.33.

28 **Table 12.32 Changes in Sacramento Valley Irrigated Acreage over the Long-term**  
29 **Average Conditions under Alternative 3 as Compared to the No Action Alternative**

<b>Crops</b>	<b>Alternative 3 (1000s acres)</b>	<b>No Action Alternative (1000s acres)</b>	<b>Changes (1000s acres)</b>
<b>Grain Crops</b>	154	155	-1
<b>Rice</b>	548	548	0
<b>Field Crops</b>	59	59	0
<b>Forage Crops</b>	200	199	1
<b>Vegetables and Truck Crops</b>	119	119	0



Crops	Alternative 3 (1000s acres)	No Action Alternative (1000s acres)	Changes (1000s acres)
Orchards and Vineyards	457	456	0
<b>Total</b>	<b>1,537</b>	<b>1,537</b>	<b>0</b>

- 1 Notes:
- 2 Grain crops include corn, dry beans, and grain.
- 3 Field crops include cotton, grass, hay, safflower, and sugar beets.
- 4 Forage crops include alfalfa and pasture.

5 **Table 12.33 Changes in Sacramento Valley Irrigated Acreage in Dry and Critical Dry**  
 6 **Years under Alternative 3 as Compared to the No Action Alternative**

Crops	Alternative 3 (1000s acres)	No Action Alternative (1000s acres)	Changes (1000s acres)
Grain Crops	155	155	0
Rice	547	544	3
Field Crops	59	59	0
Forage Crops	197	197	1
Vegetables and Truck Crops	119	119	0
Orchards and Vineyards	456	456	1
<b>Total</b>	<b>1,533</b>	<b>1,529</b>	<b>4</b>

- 7 Notes:
- 8 Grain crops include corn, dry beans, and grain.
- 9 Field crops include cotton, grass, hay, safflower, and sugar beets.
- 10 Forage crops include alfalfa and pasture.

11 Agricultural production in the Sacramento Valley would be similar under  
 12 Alternative 3 as compared to the No Action Alternative over long-term average  
 13 conditions and in dry and critical dry years due to reduced use of groundwater, as  
 14 summarized in Tables 12.34 and 12.35.

15 **Table 12.34 Changes in Sacramento Valley Agricultural Production over the**  
 16 **Long-term Average Conditions under Alternative 3 as Compared to the No Action**  
 17 **Alternative**

Crops	Alternative 3 (\$ millions)	No Action Alternative (\$ millions)	Changes (\$ millions)
Grain Crops	149	150	-0.7
Rice	1,115	1,114	0.6
Field Crops	77	77	-0.1

Crops	Alternative 3 (\$ millions)	No Action Alternative (\$ millions)	Changes (\$ millions)
Forage Crops	246	246	0.5
Vegetables and Truck Crops	967	967	0.0
Orchards and Vineyards	3,192	3,192	0.9
<b>Total</b>	<b>5,746</b>	<b>5,745</b>	<b>1.2</b>

- 1 Notes:
- 2 Grain crops include corn, dry beans, and grain.
- 3 Field crops include cotton, grass, hay, safflower, and sugar beets.
- 4 Forage crops include alfalfa and pasture.
- 5 All values of production are in 2012 dollar equivalent values.

6 **Table 12.35 Changes in Sacramento Valley Agricultural Production in Dry and**  
 7 **Critical Dry Years under Alternative 3 as Compared to the No Action Alternative**

Crops	Alternative 3 (\$ millions)	No Action Alternative (\$ millions)	Changes (\$ millions)
Grain Crops	150	150	0.2
Rice	1,112	1,107	5.8
Field Crops	77	77	0.1
Forage Crops	244	243	0.8
Vegetables and Truck Crops	967	967	0.1
Orchards and Vineyards	3,193	3,191	2.2
<b>Total</b>	<b>5,744</b>	<b>5,735</b>	<b>9.2</b>

- 8 Notes:
- 9 Grain crops include corn, dry beans, and grain.
- 10 Field crops include cotton, grass, hay, safflower, and sugar beets.
- 11 Forage crops include alfalfa and pasture.
- 12 All values of production are in 2012 dollar equivalent values.

13 *San Joaquin Valley*

14 Results of the SWAP analysis indicated that irrigated acreage in the San Joaquin  
 15 Valley, including the Tulare Lake area, would be similar under Alternative 3 as  
 16 compared to the No Action Alternative over long-term average conditions and in  
 17 dry and critical dry years, as summarized in Tables 12.36 and 12.37.

1 **Table 12.36 Changes in San Joaquin Valley Irrigated Acreage over the Long-term**  
 2 **Average Conditions under Alternative 3 as Compared to the No Action Alternative**

<b>Crops</b>	<b>Alternative 3 (1000s acres)</b>	<b>No Action Alternative (1000s acres)</b>	<b>Changes (1000s acres)</b>
<b>Grain Crops</b>	1,024	1,024	0
<b>Rice</b>	17	17	0
<b>Field Crops</b>	828	828	0
<b>Forage Crops</b>	735	735	0
<b>Vegetables and Truck Crops</b>	633	633	0
<b>Orchards and Vineyards</b>	2,156	2,156	0
<b>Total</b>	5,392	5,392	0

3 Notes:

4 Grain crops include corn, dry beans, and grain.

5 Field crops include cotton, grass, hay, safflower, and sugar beets.

6 Forage crops include alfalfa and pasture.

7 **Table 12.37 Changes in San Joaquin Valley Irrigated Acreage in Dry and Critical**  
 8 **Dry Years under Alternative 3 as Compared to the No Action Alternative**

<b>Crops</b>	<b>Alternative 3 (1000s acres)</b>	<b>No Action Alternative (1000s acres)</b>	<b>Changes (1000s acres)</b>
<b>Grain Crops</b>	1,021	1,010	11
<b>Rice</b>	17	17	0
<b>Field Crops</b>	828	827	0
<b>Forage Crops</b>	735	735	0
<b>Vegetables and Truck Crops</b>	633	633	0
<b>Orchards and Vineyards</b>	2,154	2,154	0
<b>Total</b>	5,387	5,375	12

9 Notes:

10 Grain crops include corn, dry beans, and grain.

11 Field crops include cotton, grass, hay, safflower, and sugar beets.

12 Forage crops include alfalfa and pasture.

13 Agricultural production in the San Joaquin Valley would be similar under  
 14 Alternative 3 as compared to the No Action Alternative over long-term average  
 15 conditions and in dry and critical dry years due to reduced use of groundwater, as  
 16 summarized in Tables 12.38 and 12.39.

1 **Table 12.38 Changes in San Joaquin Valley Agricultural Production over the**  
 2 **Long-term Average Conditions under Alternative 3 as Compared to the No Action**  
 3 **Alternative**

<b>Crops</b>	<b>Alternative 3 (\$ millions)</b>	<b>No Action Alternative (\$ millions)</b>	<b>Changes (\$ millions)</b>
<b>Grain Crops</b>	1,373	1,373	0.1
<b>Rice</b>	31	31	0.0
<b>Field Crops</b>	1,437	1,436	0.3
<b>Forage Crops</b>	1,426	1,426	0.1
<b>Vegetables and Truck Crops</b>	4,623	4,623	-0.1
<b>Orchards and Vineyards</b>	16,547	16,547	-0.1
<b>Total</b>	25,437	25,437	0.3

- 4 Notes:  
 5 Grain crops include corn, dry beans, and grain.  
 6 Field crops include cotton, grass, hay, safflower, and sugar beets.  
 7 Forage crops include alfalfa and pasture.  
 8 All values of production are in 2012 dollar equivalent values.

9 **Table 12.39 Changes in San Joaquin Valley Agricultural Production in Dry and**  
 10 **Critical Dry Years under Alternative 3 as Compared to the No Action Alternative**

<b>Crops</b>	<b>Alternative 3 (\$ millions)</b>	<b>No Action Alternative (\$ millions)</b>	<b>Changes (\$ millions)</b>
<b>Grain Crops</b>	1,370	1,359	11.5
<b>Rice</b>	31	31	0.0
<b>Field Crops</b>	1,436	1,436	0.4
<b>Forage Crops</b>	1,426	1,426	-0.1
<b>Vegetables and Truck Crops</b>	4,623	4,623	0.0
<b>Orchards and Vineyards</b>	16,542	16,542	-0.3
<b>Total</b>	25,428	25,417	11.4

- 11 Notes:  
 12 Grain crops include corn, dry beans, and grain.  
 13 Field crops include cotton, grass, hay, safflower, and sugar beets.  
 14 Forage crops include alfalfa and pasture.  
 15 All values of production are in 2012 dollar equivalent values.

1            *Effects Related to Water Transfers*

2 Potential effects to agricultural resources could be similar to those identified in a  
3 recent environmental analysis conducted by Reclamation for long-term water  
4 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as  
5 described above under the No Action Alternative compared to the Second Basis  
6 of Comparison. For the purposes of this EIS, it is anticipated that similar  
7 conditions would occur during implementation of cross Delta water transfers  
8 under Alternative 3 and the No Action Alternative, and that impacts on  
9 agricultural resources would not be substantial in the seller's service area due to  
10 implementation requirements of the transfer programs.

11 Under Alternative 3, water could be transferred throughout the year without an  
12 annual volumetric limit. Under the No Action Alternative, the timing of cross  
13 Delta water transfers would be limited to July through September and include  
14 annual volumetric limits, in accordance with the 2008 USFWS BO and  
15 2009 NMFS BO. Overall, the potential for cross Delta water transfers would be  
16 increased under Alternative 3 as compared to the No Action Alternative.

17 *San Francisco Bay Area, Central Coast, and Southern California Regions*

18            *Potential Changes in Irrigated Agricultural*

19 It is anticipated that reductions in CVP and SWP water supplies within the  
20 San Francisco Bay Area, Central Coast, and Southern California regions would  
21 not result in reductions in irrigated acreage or land use changes due to the use of  
22 other water supplies in the same manner that is projected to occur in the Central  
23 Valley Region.

24 **12.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison**

25 *Trinity River Region*

26            *Potential Changes in Irrigated Agricultural*

27 There are no agricultural lands irrigated with CVP and SWP water supplies in the  
28 Trinity River Region. Therefore, there would be no changes in irrigated lands  
29 under Alternative 3 as compared to the Second Basis of Comparison.

30 *Central Valley Region*

31            *Potential Changes in Irrigated Agricultural*

32                    *Sacramento Valley*

33 Results of the SWAP analysis indicated that agricultural crop patterns in the  
34 Sacramento Valley would be similar under Alternative 3 as compared to the  
35 Second Basis of Comparison over long-term average conditions and in dry and  
36 critical dry years, as summarized in Tables 12.40 and 12.41.

1 **Table 12.40 Changes in Sacramento Valley Irrigated Acreage over the Long-term**  
 2 **Average Conditions under Alternative 3 as Compared to the Second Basis of**  
 3 **Comparison**

Crops	Alternative 3 (1000s acres)	Second Basis of Comparison (1000s acres)	Changes (1000s acres)
Grain Crops	154	154	0
Rice	548	548	0
Field Crops	59	59	0
Forage Crops	200	200	0
Vegetables and Truck Crops	119	119	0
Orchards and Vineyards	457	457	0
<b>Total</b>	<b>1,537</b>	<b>1,537</b>	<b>0</b>

- 4 Notes:  
 5 Grain crops include corn, dry beans, and grain.  
 6 Field crops include cotton, grass, hay, safflower, and sugar beets.  
 7 Forage crops include alfalfa and pasture.

8 **Table 12.41 Changes in Sacramento Valley Irrigated Acreage in Dry and Critical Dry**  
 9 **Years under Alternative 3 as Compared to the Second Basis of Comparison**

Crops	Alternative 3 (1000s acres)	Second Basis of Comparison (1000s acres)	Changes (1000s acres)
Grain Crops	155	155	0
Rice	547	548	-1
Field Crops	59	59	0
Forage Crops	197	198	-1
Vegetables and Truck Crops	119	119	0
Orchards and Vineyards	456	457	-1
<b>Total</b>	<b>1,533</b>	<b>1,536</b>	<b>-3</b>

- 10 Notes:  
 11 Grain crops include corn, dry beans, and grain.  
 12 Field crops include cotton, grass, hay, safflower, and sugar beets.  
 13 Forage crops include alfalfa and pasture.

1 The agricultural production value under long-term average conditions and dry and  
 2 critical dry conditions would be similar under Alternative 3 and Second Basis of  
 3 Comparison, as summarized in Tables 12.42 and 12.43, primarily due to a  
 4 decrease in groundwater pumping.

5 **Table 12.42 Changes in Sacramento Valley Agricultural Production over the**  
 6 **Long-term Average Conditions under Alternative 3 as Compared to the Second**  
 7 **Basis of Comparison**

Crops	Alternative 3 (\$ millions)	Second Basis of Comparison (\$ millions)	Changes (\$ millions)
<b>Grain Crops</b>	149	149	0.1
<b>Rice</b>	1,115	1,115	-0.3
<b>Field Crops</b>	77	77	0.0
<b>Forage Crops</b>	246	246	-0.1
<b>Vegetables and Truck Crops</b>	967	967	0.0
<b>Orchards and Vineyards</b>	3,192	3,193	-0.1
<b>Total</b>	5,746	5,747	-0.3

8 Notes:  
 9 Grain crops include corn, dry beans, and grain.  
 10 Field crops include cotton, grass, hay, safflower, and sugar beets.  
 11 Forage crops include alfalfa and pasture.  
 12 All values of production are in 2012 dollar equivalent values.

13 **Table 12.43 Changes in Sacramento Valley Agricultural Production in Dry and**  
 14 **Critical Dry Years under Alternative 3 as Compared to the Second Basis of**  
 15 **Comparison**

Crops	Alternative 3 (\$ millions)	Second Basis of Comparison (\$ millions)	Changes (\$ millions)
<b>Grain Crops</b>	150	150	-0.3
<b>Rice</b>	1,112	1,114	-1.5
<b>Field Crops</b>	77	77	0.0
<b>Forage Crops</b>	244	245	-0.6
<b>Vegetables and Truck Crops</b>	967	967	-0.1
<b>Orchards and Vineyards</b>	3,193	3,193	0.4
<b>Total</b>	5,744	5,746	-2.1

16 Notes:  
 17 Grain crops include corn, dry beans, and grain.  
 18 Field crops include cotton, grass, hay, safflower, and sugar beets.  
 19 Forage crops include alfalfa and pasture.  
 20 All values of production are in 2012 dollar equivalent values.

*San Joaquin Valley*

Results of the SWAP analysis indicated that irrigated acreage in the San Joaquin Valley, including the Tulare Lake area, would be similar under Alternative 3 as compared to the Second Basis of Comparison over long-term average conditions and in dry and critical dry years, as summarized in Tables 12.44 and 12.45.

**Table 12.44 Changes in San Joaquin Valley Irrigated Acreage over the Long-term Average Conditions under Alternative 3 as Compared to the Second Basis of Comparison**

Crops	Alternative 3 (1000s acres)	Second Basis of Comparison (1000s acres)	Changes (1000s acres)
<b>Grain Crops</b>	1,024	1,024	0
Rice	17	17	0
<b>Field Crops</b>	828	828	0
<b>Forage Crops</b>	735	735	0
<b>Vegetables and Truck Crops</b>	633	633	0
<b>Orchards and Vineyards</b>	2,156	2,156	0
<b>Total</b>	5,392	5,392	0

Notes:

Grain crops include corn, dry beans, and grain.

Field crops include cotton, grass, hay, safflower, and sugar beets.

Forage crops include alfalfa and pasture.

**Table 12.45 Changes in San Joaquin Valley Irrigated Acreage in Dry and Critical Dry Years under Alternative 3 as Compared to the Second Basis of Comparison**

Crops	Alternative 3 (1000s acres)	Second Basis of Comparison (1000s acres)	Changes (1000s acres)
<b>Grain Crops</b>	1,021	1,024	-3
Rice	17	17	0
<b>Field Crops</b>	828	828	0
<b>Forage Crops</b>	735	735	-1
<b>Vegetables and Truck Crops</b>	633	633	0
<b>Orchards and Vineyards</b>	2,154	2,156	-2
<b>Total</b>	5,387	5,392	-5

Notes:

Grain crops include corn, dry beans, and grain.

Field crops include cotton, grass, hay, safflower, and sugar beets.

Forage crops include alfalfa and pasture.



1 The agricultural production value under long-term average conditions would be  
 2 similar under Alternative 3 and the Second Basis of Comparison, as summarized  
 3 in Tables 12.46 and 12.47, primarily due to an increase in groundwater pumping.

4 **Table 12.46 Changes in San Joaquin Valley Agricultural Production over the**  
 5 **Long-term Average Conditions under Alternative 3 as Compared to the Second**  
 6 **Basis of Comparison**

Crops	Alternative 3 (\$ millions)	Second Basis of Comparison (\$ millions)	Changes (\$ millions)
<b>Grain Crops</b>	1,373	1,373	-0.1
<b>Rice</b>	31	31	0.0
<b>Field Crops</b>	1,437	1,437	-0.1
<b>Forage Crops</b>	1,426	1,426	0.0
<b>Vegetables and Truck Crops</b>	4,623	4,623	0.0
<b>Orchards and Vineyards</b>	16,547	16,547	-0.1
<b>Total</b>	25,437	25,438	-0.3

7 Notes:  
 8 Grain crops include corn, dry beans, and grain.  
 9 Field crops include cotton, grass, hay, safflower, and sugar beets.  
 10 Forage crops include alfalfa and pasture.  
 11 All values of production are in 2012 dollar equivalent values.

12 **Table 12.47 Changes in San Joaquin Valley Agricultural Production in Dry and**  
 13 **Critical Dry Years under Alternative 3 as Compared to the Second Basis of**  
 14 **Comparison**

Crops	Alternative 3 (\$ millions)	Second Basis of Comparison (\$ millions)	Changes (\$ millions)
<b>Grain Crops</b>	1,370	1,373	-2.9
<b>Rice</b>	31	31	0.0
<b>Field Crops</b>	1,436	1,437	-0.6
<b>Forage Crops</b>	1,426	1,426	-0.5
<b>Vegetables and Truck Crops</b>	4,623	4,623	-0.2
<b>Orchards and Vineyards</b>	16,542	16,547	-4.7
<b>Total</b>	25,428	25,437	-8.9

15 Notes:  
 16 Grain crops include corn, dry beans, and grain.  
 17 Field crops include cotton, grass, hay, safflower, and sugar beets.  
 18 Forage crops include alfalfa and pasture.  
 19 All values of production are in 2012 dollar equivalent values.

1            *Effects Related to Water Transfers*

2 It is anticipated that water would be transferred between subbasins in the same  
3 manner under Alternative 3 as compared to the Second Basis of Comparison. If  
4 the water to be transferred is made available through crop idling, there would be a  
5 reduction in irrigated acreage. If the water is used to reduce crop idling in dry and  
6 critical dry years, there would be an increase in irrigated acreage. Therefore, the  
7 changes in agricultural resources would need to be determined for each water  
8 transfer program.

9 Potential effects to agricultural resources could be similar to those identified in a  
10 recent environmental analysis conducted by Reclamation for long-term water  
11 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as  
12 described above under the No Action Alternative compared to the Second Basis  
13 of Comparison. For the purposes of this EIS, it is anticipated that similar  
14 conditions would occur during implementation of cross Delta water transfers  
15 under Alternative 3 as compared to the Second Basis of Comparison, and that  
16 impacts on agricultural resources would not be substantial in the seller's service  
17 area due to implementation requirements of the transfer programs.

18 Under Alternative 3 and the Second Basis of Comparison, water could be  
19 transferred throughout the year without an annual volumetric limit. Overall, the  
20 potential for cross Delta water transfers would be similar under Alternative 3 as  
21 compared to the Second Basis of Comparison.

22 *San Francisco Bay Area, Central Coast, and Southern California Regions*

23            *Potential Changes in Irrigated Agricultural*

24 It is anticipated that reductions in CVP and SWP water supplies within the San  
25 Francisco Bay Area, Central Coast, and Southern California regions would not  
26 result in reductions in irrigated acreage or land use changes due to the use of other  
27 water supplies in the same manner that is projected to occur in the Central Valley  
28 Region.

29            **12.4.3.5 Alternative 4**

30 The agricultural resources under Alternative 4 would be identical to the  
31 conditions under the Second Basis of Comparison; therefore, Alternative 4 is only  
32 compared to the No Action Alternative.

33            **12.4.3.5.1 Alternative 4 Compared to the No Action Alternative**

34 The CVP and SWP operations under Alternative 4 are identical to the CVP and  
35 SWP operations under the Second Basis of Comparison and Alternative 1.  
36 Therefore, changes in agricultural resources under Alternative 4 as compared to  
37 the No Action Alternative would be the same as the impacts described in  
38 Section 12.4.3.2.1, Alternative 1 Compared to the No Action Alternative.

39            **12.4.3.6 Alternative 5**

40 The CVP and SWP operations under Alternative 5 are similar to the No Action  
41 Alternative with modified Old and Middle River flow criteria and New Melones  
42 Reservoir operations.

1 **12.4.3.6.1 Alternative 5 Compared to the No Action Alternative**

2 *Trinity River Region*

3 *Potential Changes in Irrigated Agricultural*

4 There are no agricultural lands irrigated with CVP and SWP water supplies in the  
 5 Trinity River Region. Therefore, there would be no changes in irrigated lands  
 6 under Alternative 5 as compared to the No Action Alternative.

7 *Central Valley Region*

8 *Potential Changes in Irrigated Agricultural*

9 *Sacramento Valley*

10 Results of the SWAP analysis indicated that agricultural crop patterns in the  
 11 Sacramento Valley would be similar under Alternative 5 as compared to the  
 12 No Action Alternative over long-term average conditions and in dry and critical  
 13 dry years, as summarized in Tables 12.48 and 12.49.

14 **Table 12.48 Changes in Sacramento Valley Irrigated Acreage over the Long-term**  
 15 **Average Conditions under Alternative 5 as Compared to the No Action Alternative**

Crops	Alternative 5 (1000s acres)	No Action Alternative (1000s acres)	Changes (1000s acres)
Grain Crops	155	155	0
Rice	548	548	0
Field Crops	59	59	0
Forage Crops	199	199	0
Vegetables and Truck Crops	119	119	0
Orchards and Vineyards	456	456	0
<b>Total</b>	<b>1,537</b>	<b>1,537</b>	<b>0</b>

16 Notes:

17 Grain crops include corn, dry beans, and grain.

18 Field crops include cotton, grass, hay, safflower, and sugar beets.

19 Forage crops include alfalfa and pasture.

20 **Table 12.49 Changes in Sacramento Valley Irrigated Acreage in Dry and Critical Dry**  
 21 **Years under Alternative 5 as Compared to the No Action Alternative**

Crops	Alternative 5 (1000s acres)	No Action Alternative (1000s acres)	Changes (1000s acres)
Grain Crops	155	155	0
Rice	544	544	0
Field Crops	59	59	0
Forage Crops	197	197	0

<b>Crops</b>	<b>Alternative 5 (1000s acres)</b>	<b>No Action Alternative (1000s acres)</b>	<b>Changes (1000s acres)</b>
<b>Vegetables and Truck Crops</b>	119	119	0
<b>Orchards and Vineyards</b>	456	456	0
<b>Total</b>	1,529	1,529	0

- 1 Notes:  
 2 Grain crops include corn, dry beans, and grain.  
 3 Field crops include cotton, grass, hay, safflower, and sugar beets.  
 4 Forage crops include alfalfa and pasture.

5 The agricultural production value under long-term average conditions and dry and  
 6 critical dry conditions would be similar under Alternative 5 and the No Action  
 7 Alternative, as summarized in Tables 12.50 and 12.51.

8 **Table 12.50 Changes in Sacramento Valley Agricultural Production over the**  
 9 **Long-term Average Conditions under Alternative 5 as Compared to the No Action**  
 10 **Alternative**

<b>Crops</b>	<b>Alternative 5 (\$ millions)</b>	<b>No Action Alternative (\$ millions)</b>	<b>Changes (\$ millions)</b>
<b>Grain Crops</b>	150	150	0.0
<b>Rice</b>	1,114	1,114	0.1
<b>Field Crops</b>	77	77	0.0
<b>Forage Crops</b>	246	246	0.0
<b>Vegetables and Truck Crops</b>	967	967	0.0
<b>Orchards and Vineyards</b>	3,192	3,192	0.1
<b>Total</b>	5,745	5,745	0.1

- 11 Notes:  
 12 Grain crops include corn, dry beans, and grain.  
 13 Field crops include cotton, grass, hay, safflower, and sugar beets.  
 14 Forage crops include alfalfa and pasture.  
 15 All values of production are in 2012 dollar equivalent values.

1 **Table 12.51 Changes in Sacramento Valley Agricultural Production in Dry and**  
 2 **Critical Dry Years under Alternative 5 as Compared to the No Action Alternative**

Crops	Alternative 5 (\$ millions)	No Action Alternative (\$ millions)	Changes (\$ millions)
<b>Grain Crops</b>	150	150	-0.1
<b>Rice</b>	1,107	1,107	0.2
<b>Field Crops</b>	77	77	0.0
<b>Forage Crops</b>	243	243	0.1
<b>Vegetables and Truck Crops</b>	967	967	0.0
<b>Orchards and Vineyards</b>	3,192	3,191	0.7
<b>Total</b>	5,736	5,735	0.8

3 Notes:

4 Grain crops include corn, dry beans, and grain.

5 Field crops include cotton, grass, hay, safflower, and sugar beets.

6 Forage crops include alfalfa and pasture.

7 All values of production are in 2012 dollar equivalent values.

8 *San Joaquin Valley*

9 Results of the SWAP analysis indicated that irrigated acreage in the San Joaquin  
 10 Valley, including the Tulare Lake area, would be similar under Alternative 5 as  
 11 compared to the No Action Alternative over long-term average conditions and dry  
 12 and critical dry years, as summarized in Tables 12.52 and 12.53.

13 **Table 12.52 Changes in San Joaquin Valley Irrigated Acreage over the Long-term**  
 14 **Average Conditions under Alternative 5 as Compared to the No Action Alternative**

Crops	Alternative 5 (1000s acres)	No Action Alternative (1000s acres)	Changes (1000s acres)
<b>Grain Crops</b>	1,024	1,024	0
<b>Rice</b>	17	17	0
<b>Field Crops</b>	828	828	0
<b>Forage Crops</b>	735	735	0
<b>Vegetables and Truck Crops</b>	633	633	0
<b>Orchards and Vineyards</b>	2,156	2,156	0
<b>Total</b>	5,392	5,392	0

15 Notes:

16 Grain crops include corn, dry beans, and grain.

17 Field crops include cotton, grass, hay, safflower, and sugar beets.

18 Forage crops include alfalfa and pasture.

1 **Table 12.53 Changes in San Joaquin Valley Irrigated Acreage in Dry and Critical**  
 2 **Dry Years under Alternative 5 as Compared to the No Action Alternative**

Crops	Alternative 5 (1000s acres)	No Action Alternative (1000s acres)	Changes (1000s acres)
Grain Crops	1,010	1,010	0
Rice	17	17	0
Field Crops	827	827	0
Forage Crops	734	735	0
Vegetables and Truck Crops	633	633	0
Orchards and Vineyards	2,153	2,154	-1
<b>Total</b>	<b>5,374</b>	<b>5,375</b>	<b>-1</b>

3 Notes:

4 Grain crops include corn, dry beans, and grain.

5 Field crops include cotton, grass, hay, safflower, and sugar beets.

6 Forage crops include alfalfa and pasture.

7 The agricultural production value under long-term average conditions and dry and  
 8 critical dry year conditions would be similar under Alternative 5 and the No  
 9 Action Alternative, as summarized in Tables 12.54 and 12.55.

10 **Table 12.54 Changes in San Joaquin Valley Agricultural Production over the**  
 11 **Long-term Average Conditions under Alternative 5 as Compared to the No Action**  
 12 **Alternative**

Crops	Alternative 5 (\$ millions)	No Action Alternative (\$ millions)	Changes (\$ millions)
Grain Crops	1,373	1,373	0.0
Rice	31	31	0.0
Field Crops	1,436	1,436	0.0
Forage Crops	1,426	1,426	0.0
Vegetables and Truck Crops	4,623	4,623	0.0
Orchards and Vineyards	16,547	16,547	-0.1
<b>Total</b>	<b>25,437</b>	<b>25,437</b>	<b>-0.1</b>

13 Notes:

14 Grain crops include corn, dry beans, and grain.

15 Field crops include cotton, grass, hay, safflower, and sugar beets.

16 Forage crops include alfalfa and pasture.

17 All values of production are in 2012 dollar equivalent values.

1 **Table 12.55 Changes in San Joaquin Valley Agricultural Production in Dry and**  
 2 **Critical Dry Years under Alternative 5 as Compared to the No Action Alternative**

Crops	Alternative 5 (\$ millions)	No Action Alternative (\$ millions)	Changes (\$ millions)
<b>Grain Crops</b>	1,359	1,359	-0.1
<b>Rice</b>	31	31	0.0
<b>Field Crops</b>	1,435	1,436	-0.2
<b>Forage Crops</b>	1,426	1,426	-0.1
<b>Vegetables and Truck Crops</b>	4,622	4,623	-0.2
<b>Orchards and Vineyards</b>	16,540	16,542	-2.0
<b>Total</b>	25,414	25,417	-2.7

3 Notes:

4 Grain crops include corn, dry beans, and grain.

5 Field crops include cotton, grass, hay, safflower, and sugar beets.

6 Forage crops include alfalfa and pasture.

7 All values of production are in 2012 dollar equivalent values.

#### 8 *Effects Related to Water Transfers*

9 Potential effects to agricultural resources could be similar to those identified in a  
 10 recent environmental analysis conducted by Reclamation for long-term water  
 11 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as  
 12 described above under the No Action Alternative compared to the Second Basis  
 13 of Comparison. For the purposes of this EIS, it is anticipated that similar  
 14 conditions would occur during implementation of cross Delta water transfers  
 15 under Alternative 5 and the No Action Alternative, and that impacts on  
 16 agricultural resources would not be substantial in the seller's service area due to  
 17 implementation requirements of the transfer programs.

18 Under Alternative 5 and the No Action Alternative, the timing of cross Delta  
 19 water transfers would be limited to July through September and include annual  
 20 volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO.  
 21 Overall, the potential for cross Delta water transfers would be similar under  
 22 Alternative 5 and the No Action Alternative.

#### 23 *San Francisco Bay Area, Central Coast, and Southern California Regions*

##### 24 *Potential Changes in Irrigated Agricultural*

25 It is anticipated that reductions in CVP and SWP water supplies within the San  
 26 Francisco Bay Area, Central Coast, and Southern California regions would not  
 27 result in reductions in irrigated acreage or land use changes due to the use of other  
 28 water supplies in the same manner that is projected to occur in the Central Valley  
 29 Region.

1 **12.4.3.6.2 Alternative 5 Compared to the Second Basis of Comparison**

2 *Trinity River Region*

3 *Potential Changes in Irrigated Agricultural*

4 There are no agricultural lands irrigated with CVP and SWP water supplies in the  
 5 Trinity River Region. Therefore, there would be no changes in irrigated lands  
 6 under Alternative 5 as compared to the Second Basis of Comparison.

7 *Central Valley Region*

8 *Potential Changes in Irrigated Agricultural*

9 *Sacramento Valley*

10 Results of the SWAP analysis indicated that agricultural crop patterns in the  
 11 Sacramento Valley would be similar under Alternative 5 as compared to the  
 12 Second Basis of Comparison over long-term average conditions and in dry and  
 13 critical dry years, as summarized in Tables 12.56 and 12.57.

14 **Table 12.56 Changes in Sacramento Valley Irrigated Acreage over the Long-term**  
 15 **Average Conditions under Alternative 5 as Compared to the Second Basis of**  
 16 **Comparison**

Crops	Alternative 5 (1000s acres)	Second Basis of Comparison (1000s acres)	Changes (1000s acres)
<b>Grain Crops</b>	155	154	1
<b>Rice</b>	548	549	0
<b>Field Crops</b>	59	59	0
<b>Forage Crops</b>	199	200	-1
<b>Vegetables and Truck Crops</b>	119	119	0
<b>Orchards and Vineyards</b>	456	457	0
<b>Total</b>	1,537	1,537	0

17 Notes:

18 Grain crops include corn, dry beans, and grain.

19 Field crops include cotton, grass, hay, safflower, and sugar beets.

20 Forage crops include alfalfa and pasture.

21 **Table 12.57 Changes in Sacramento Valley Irrigated Acreage in Dry and Critical Dry**  
 22 **Years under Alternative 5 as Compared to the Second Basis of Comparison**

Crops	Alternative 5 (1000s acres)	Second Basis of Comparison (1000s acres)	Changes (1000s acres)
<b>Grain Crops</b>	155	155	-1
<b>Rice</b>	544	548	-4
<b>Field Crops</b>	59	59	0



<b>Crops</b>	<b>Alternative 5 (1000s acres)</b>	<b>Second Basis of Comparison (1000s acres)</b>	<b>Changes (1000s acres)</b>
<b>Forage Crops</b>	197	198	-1
<b>Vegetables and Truck Crops</b>	119	119	0
<b>Orchards and Vineyards</b>	456	457	-1
<b>Total</b>	1,529	1,536	-7

1 Notes:

2 Grain crops include corn, dry beans, and grain.

3 Field crops include cotton, grass, hay, safflower, and sugar beets.

4 Forage crops include alfalfa and pasture.

5 The agricultural production value under long-term average conditions and in dry  
6 and critical dry conditions would be similar under Alternative 5 and Second Basis  
7 of Comparison, as summarized in Tables 12.58 and 12.59.

8 **Table 12.58 Changes in Sacramento Valley Agricultural Production over the**  
9 **Long-term Average Conditions under Alternative 5 as Compared to the Second**  
10 **Basis of Comparison**

<b>Crops</b>	<b>Alternative 5 (\$ millions)</b>	<b>Second Basis of Comparison (\$ millions)</b>	<b>Changes (\$ millions)</b>
<b>Grain Crops</b>	150	149	0.8
<b>Rice</b>	1,114	1,115	-0.8
<b>Field Crops</b>	77	77	0.1
<b>Forage Crops</b>	246	246	-0.6
<b>Vegetables and Truck Crops</b>	967	967	0.0
<b>Orchards and Vineyards</b>	3,192	3,193	-0.9
<b>Total</b>	5,745	5,747	-1.5

11 Notes:

12 Grain crops include corn, dry beans, and grain.

13 Field crops include cotton, grass, hay, safflower, and sugar beets.

14 Forage crops include alfalfa and pasture.

15 All values of production are in 2012 dollar equivalent values.

1 **Table 12.59 Changes in Sacramento Valley Agricultural Production in Dry and**  
 2 **Critical Dry Years under Alternative 5 as Compared to the Second Basis of**  
 3 **Comparison**

Crops	Alternative 5 (\$ millions)	Second Basis of Comparison (\$ millions)	Changes (\$ millions)
Grain Crops	150	150	-0.6
Rice	1,107	1,114	-7.1
Field Crops	77	77	-0.1
Forage Crops	243	245	-1.3
Vegetables and Truck Crops	967	967	-0.3
Orchards and Vineyards	3,192	3,193	-1.1
<b>Total</b>	<b>5,736</b>	<b>5,746</b>	<b>-10.5</b>

- 4 Notes:  
 5 Grain crops include corn, dry beans, and grain.  
 6 Field crops include cotton, grass, hay, safflower, and sugar beets.  
 7 Forage crops include alfalfa and pasture.  
 8 All values of production are in 2012 dollar equivalent values.

9 *San Joaquin Valley*

10 Results of the SWAP analysis indicated that irrigated acreage in the San Joaquin  
 11 Valley, including the Tulare Lake area, would be similar under Alternative 5 as  
 12 compared to the Second Basis of Comparison over long-term average conditions  
 13 and in dry and critical dry years, as summarized in Tables 12.60 and 12.61.

14 **Table 12.60 Changes in San Joaquin Valley Irrigated Acreage over the Long-term**  
 15 **Average Conditions under Alternative 5 as Compared to the Second Basis of**  
 16 **Comparison**

Crops	Alternative 5 (1000s acres)	Second Basis of Comparison (1000s acres)	Changes (1000s acres)
Grain Crops	1,024	1,024	0
Rice	17	17	0
Field Crops	828	828	0
Forage Crops	735	735	0
Vegetables and Truck Crops	633	633	0
Orchards and Vineyards	2,156	2,156	0
<b>Total</b>	<b>5,392</b>	<b>5,392</b>	<b>-1</b>

- 17 Notes:  
 18 Grain crops include corn, dry beans, and grain.  
 19 Field crops include cotton, grass, hay, safflower, and sugar beets.  
 20 Forage crops include alfalfa and pasture.

1 **Table 12.61 Changes in San Joaquin Valley Irrigated Acreage in Dry and Critical**  
 2 **Dry Years under Alternative 5 as compared to the Second Basis of Comparison**

Crops	Alternative 5 (1000s acres)	Second Basis of Comparison (1000s acres)	Changes (1000s acres)
<b>Grain Crops</b>	1,010	1,024	-14
<b>Rice</b>	17	17	0
<b>Field Crops</b>	827	828	0
<b>Forage Crops</b>	734	735	-1
<b>Vegetables and Truck Crops</b>	633	633	0
<b>Orchards and Vineyards</b>	2,153	2,156	-3
<b>Total</b>	5,374	5,392	-18

3 Notes:

4 Grain crops include corn, dry beans, and grain.

5 Field crops include cotton, grass, hay, safflower, and sugar beets.

6 Forage crops include alfalfa and pasture.

7 The agricultural production value under long-term average conditions and in dry  
 8 and critical dry conditions would be similar, as summarized in Tables 12.62 and  
 9 12.63, primarily due to an increase in groundwater pumping.

10 **Table 12.62 Changes in San Joaquin Valley Agricultural Production over the**  
 11 **Long-term Average Conditions under Alternative 5 as Compared to the Second**  
 12 **Basis of Comparison**

Crops	Alternative 5 (\$ millions)	Second Basis of Comparison (\$ millions)	Changes (\$ millions)
<b>Grain Crops</b>	1,373	1,373	-0.2
<b>Rice</b>	31	31	0.0
<b>Field Crops</b>	1,436	1,437	-0.5
<b>Forage Crops</b>	1,426	1,426	-0.1
<b>Vegetables and Truck Crops</b>	4,623	4,623	0.2
<b>Orchards and Vineyards</b>	16,547	16,547	-0.1
<b>Total</b>	25,437	25,438	-0.7

13 Notes:

14 Grain crops include corn, dry beans, and grain.

15 Field crops include cotton, grass, hay, safflower, and sugar beets.

16 Forage crops include alfalfa and pasture.

17 All values of production are in 2012 dollar equivalent values.

1 **Table 12.63 Changes in San Joaquin Valley Agricultural Production in Dry and**  
 2 **Critical Dry Years under Alternative 5 as Compared to the Second Basis of**  
 3 **Comparison**

Crops	Alternative 5 (\$ millions)	Second Basis of Comparison (\$ millions)	Changes (\$ millions)
<b>Grain Crops</b>	1,359	1,373	-14.5
<b>Rice</b>	31	31	0.0
<b>Field Crops</b>	1,435	1,437	-1.2
<b>Forage Crops</b>	1,426	1,426	-0.5
<b>Vegetables and Truck Crops</b>	4,622	4,623	-0.5
<b>Orchards and Vineyards</b>	16,540	16,547	-6.4
<b>Total</b>	25,414	25,437	-22.9

- 4 Notes:  
 5 Grain crops include corn, dry beans, and grain.  
 6 Field crops include cotton, grass, hay, safflower, and sugar beets.  
 7 Forage crops include alfalfa and pasture.  
 8 All values of production are in 2012 dollar equivalent values.

9 *Effects Related to Water Transfers*

10 Potential effects to agricultural resources could be similar to those identified in a  
 11 recent environmental analysis conducted by Reclamation for long-term water  
 12 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as  
 13 described above under the No Action Alternative compared to the Second Basis  
 14 of Comparison. For the purposes of this EIS, it is anticipated that similar  
 15 conditions would occur during implementation of cross Delta water transfers  
 16 under Alternative 5 and the Second Basis of Comparison, and that impacts on  
 17 agricultural resources would not be substantial in the seller’s service area due to  
 18 implementation requirements of the transfer programs.

19 Under Alternative 5, the timing of cross Delta water transfers would be limited to  
 20 July through September and include annual volumetric limits, in accordance with  
 21 the 2008 USFWS BO and 2009 NMFS BO. Under Second Basis of Comparison,  
 22 water could be transferred throughout the year without an annual volumetric limit.  
 23 Overall, the potential for cross Delta water transfers would be reduced under  
 24 Alternative 5 as compared to the Second Basis of Comparison.

25 *San Francisco Bay Area, Central Coast, and Southern California Regions*

26 *Potential Changes in Irrigated Agricultural*

27 It is anticipated that reductions in CVP and SWP water supplies within the San  
 28 Francisco Bay Area, Central Coast, and Southern California regions would not  
 29 result in reductions in irrigated acreage or land use changes due to the use of other  
 30 water supplies in the same manner that is projected to occur in the Central Valley  
 31 Region.

1 **12.4.3.7 Summary of Environmental Consequences**

2 The results of the environmental consequences of implementation of  
 3 Alternatives 1 through 5 as compared to the No Action Alternative and the  
 4 Second Basis of Comparison are presented in Tables 12.64 and 12.65. The results  
 5 of the impact analysis represents comparison of long-term changes that would  
 6 occur between alternatives by 2030. The impact analysis does not represent  
 7 short-term responses, especially during one to five years, in response to  
 8 emergency flood or drought conditions.

9 **Table 12.64 Comparison of Alternatives 1 through 5 to No Action Alternative**

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	No effects on agricultural resources.	None needed
Alternative 2	No effects on agricultural resources.	None needed
Alternative 3	No effects on agricultural resources.	None needed
Alternative 4	No effects on agricultural resources.	None needed
Alternative 5	No effects on agricultural resources.	None needed

10 **Table 12.65 Comparison of No Action Alternative and Alternatives 1 through 5 to**  
 11 **Second Basis of Comparison**

Alternative	Potential Change	Consideration for Mitigation Measures
No Action Alternative	No effects on agricultural resources.	Not considered for this comparison.
Alternative 1	No effects on agricultural resources.	Not considered for this comparison.
Alternative 2	No effects on agricultural resources.	Not considered for this comparison.
Alternative 3	No effects on agricultural resources.	Not considered for this comparison.
Alternative 4	No effects on agricultural resources.	Not considered for this comparison.
Alternative 5	No effects on agricultural resources.	Not considered for this comparison.

12 **12.4.3.8 Potential Mitigation Measures**

13 Mitigation measures are presented in this section to avoid, minimize, rectify,  
 14 reduce, eliminate, or compensate for adverse environmental effects of  
 15 Alternatives 1 through 5 as compared to the No Action Alternative. Mitigation  
 16 measures were not included to address adverse impacts under the alternatives as  
 17 compared to the Second Basis of Comparison because this analysis was included  
 18 in this EIS for information purposes only.

1 Changes in CVP and SWP operations under Alternatives 1 through 5 as compared  
 2 to the No Action Alternative, would not result in changes in agricultural  
 3 resources. Therefore, there would be no adverse impacts to agricultural  
 4 resources; and no mitigation measures are required.

5 **12.4.3.9 Cumulative Effects Analysis**

6 As described in Chapter 3, the cumulative effects analysis considers projects,  
 7 programs, and policies that are not speculative; and are based upon known or  
 8 reasonably foreseeable long-range plans, regulations, operating agreements, or  
 9 other information that establishes them as reasonably foreseeable.

10 The cumulative effects analysis Alternatives 1 through 5 for Agricultural  
 11 Resources are summarized in Table 12.66.

12 **Table 12.66 Summary of Cumulative Effects on Agricultural Resources of**  
 13 **Alternatives 1 through 5 as Compared to the No Action Alternative**

Scenarios	Actions	Cumulative Effects of Actions
Past & Present, and Future Actions included in the No Action Alternative and in All Alternatives in Year 2030	Consistent with Affected Environment conditions plus:  Actions in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives), including climate change and sea level rise  Actions not included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives):  <ul style="list-style-type: none"> <li>- Implementation of Federal and state policies and programs, including Clean Water Act (e.g., Total Maximum Daily Loads); Safe Drinking Water Act; Clean Air Act; and flood management programs</li> <li>- General plans for 2030.</li> <li>- Trinity River Restoration Program.</li> <li>- Central Valley Project Improvement Act programs</li> <li>- Iron Mountain Mine Superfund Site</li> <li>- Nimbus Fish Hatchery Fish Passage Project</li> <li>- Folsom Dam Water Control Manual Update</li> <li>- FERC Relicensing for the Middle Fork of the American River Project</li> <li>- Lower Mokelumne River Spawning Habitat Improvement Project</li> <li>- Dutch Slough Tidal Marsh Restoration</li> </ul>	<u>These effects would be the same under all alternatives.</u>  Climate change and sea level rise, development under the general plans, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce availability of CVP and SWP water supplies as compared to past conditions.  Some future water quality and habitat projects could modify surface water conditions; however, water supplies are not anticipated to be affected.  Future water supply projects are anticipated to both increase water supply reliability due to reduced surface water supplies and to accommodate planned growth in the general plans. Most of these programs were initiated prior to implementation of the 2008 USFWS BO and 2009 NMFS BO which reduced CVP and SWP water supply reliability.  Developments under the general plans and future water supply, water quality improvement, and restoration projects are anticipated to potentially affect agricultural resources. However, development of these future programs would include preparation of environmental documentation that would identify methods to minimize adverse impacts to agricultural resources.

Scenarios	Actions	Cumulative Effects of Actions
	<ul style="list-style-type: none"> <li>- Suisun Marsh Habitat Management, Preservation, and Restoration Plan Implementation</li> <li>- Tidal Wetland Restoration: Yolo Ranch, Northern Liberty Island Fish Restoration Project, Prospect Island Restoration Project, and Calhoun Cut/Lindsey Slough Tidal Habitat Restoration Project</li> <li>- San Joaquin River Restoration Program</li> <li>- Stockton Deep Water Ship Channel Dissolved Oxygen Project</li> <li>- Grasslands Bypass Project</li> <li>- Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS)</li> <li>- Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects with completed environmental documents)</li> </ul>	<p>Some of the future actions would reduce the effects of agricultural drainage and/or reduce salinity in the San Joaquin River and the Delta. These programs would result in a beneficial impact to remaining agricultural resources.</p>
<p>Future Actions considered as Cumulative Effects Actions with All Alternatives in Year 2030</p>	<p>Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives):</p> <ul style="list-style-type: none"> <li>- Bay-Delta Water Quality Control Plan Update</li> <li>- FERC Relicensing Projects</li> <li>- Bay Delta Conservation Plan (including the California WaterFix alternative)</li> <li>- Shasta Lake Water Resources, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations</li> <li>- El Dorado Water and Power Authority Supplemental Water Rights Project</li> <li>- Sacramento River Water Reliability Project</li> <li>- Semitropic Water Storage District Delta Wetlands</li> <li>- North Bay Aqueduct Alternative Intake</li> <li>- Irrigated Lands Regulatory Program</li> <li>- San Luis Reservoir Low Point Improvement Project</li> <li>- <i>Westlands Water District v. United States Settlement</i></li> <li>- Future water supply projects, including water recycling,</li> </ul>	<p><u>These effects would be the same under all alternatives.</u></p> <p>Most of the reasonably foreseeable actions are anticipated to reduce water supply impacts due to climate change, sea level rise, increased water allocated to improve habitat conditions, and future growth.</p> <p>Some of the reasonably foreseeable actions related to improved water quality and habitat conditions (e.g., Water Quality Control Plan Update and FERC Relicensing Projects), could in further reductions in CVP and SWP water deliveries.</p> <p>Developments under the future projects are anticipated to potentially affect agricultural resources. However, development of these future programs would include preparation of environmental documentation that would identify methods to minimize adverse impacts to agricultural resources.</p> <p>Some of the reasonably foreseeable actions would reduce the effects of agricultural drainage and/or reduce salinity in the San Joaquin River and the Delta. These programs would result in a</p>

Scenarios	Actions	Cumulative Effects of Actions
	desalination, groundwater banks and wellfields, and conveyance facilities (projects that did not have completed environmental documents during preparation of the EIS)	beneficial impact to agricultural resources.
No Action Alternative with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO	<p>Climate change and sea level rise, development under the general plans, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce availability of CVP and SWP water supplies.</p> <p>Future water supply projects are anticipated to both increase water supply reliability due to reduced surface water supplies and to accommodate planned growth in the general plans.</p> <p>Some of the reasonably foreseeable actions would reduce the effects of agricultural drainage and/or reduce salinity in the San Joaquin River and the Delta.</p>
Alternative 1 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternative 1 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 2 with Associated Cumulative Effects Actions in Year 2030	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions</p> <p>No implementation of structural improvements or other actions that require further study to develop a more detailed action description.</p>	Implementation of Alternative 2 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 3 with Associated Cumulative Effects Actions in Year 2030	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)</p> <p>Slight increase in positive Old and Middle River flows in the winter and spring months</p>	Implementation of Alternative 3 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 4 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternative 4 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 5 with Associated Cumulative Effects Actions in Year 20530	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO</p> <p>Positive Old and Middle River flows and increased Delta outflow in spring months</p>	Implementation of Alternative 5 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.



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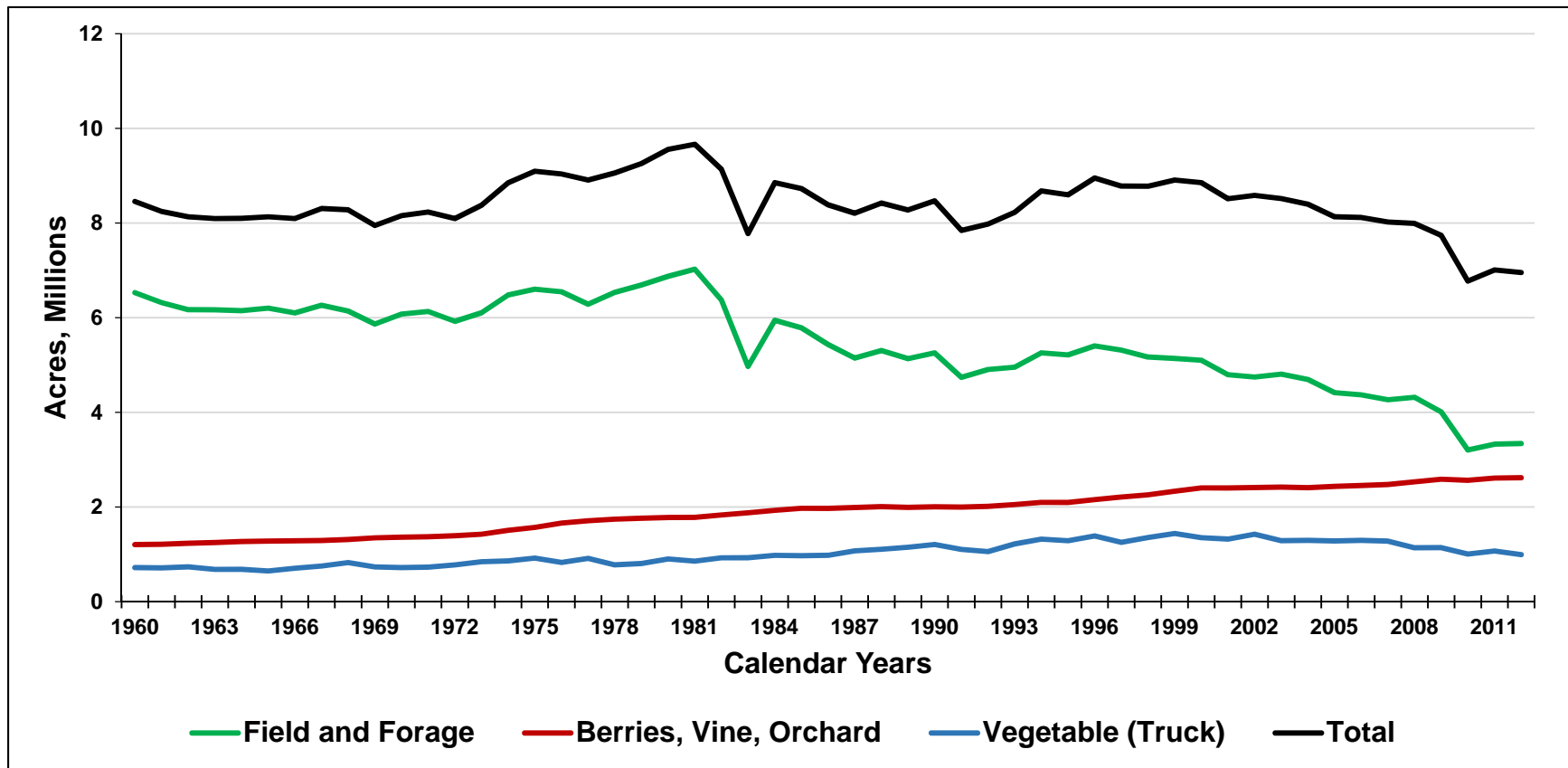


Figure 12.1 California Agricultural Production Acreage, 1960 to 2012

Source: USDA-NASS 2011, 2012a, 2012b, 2013b

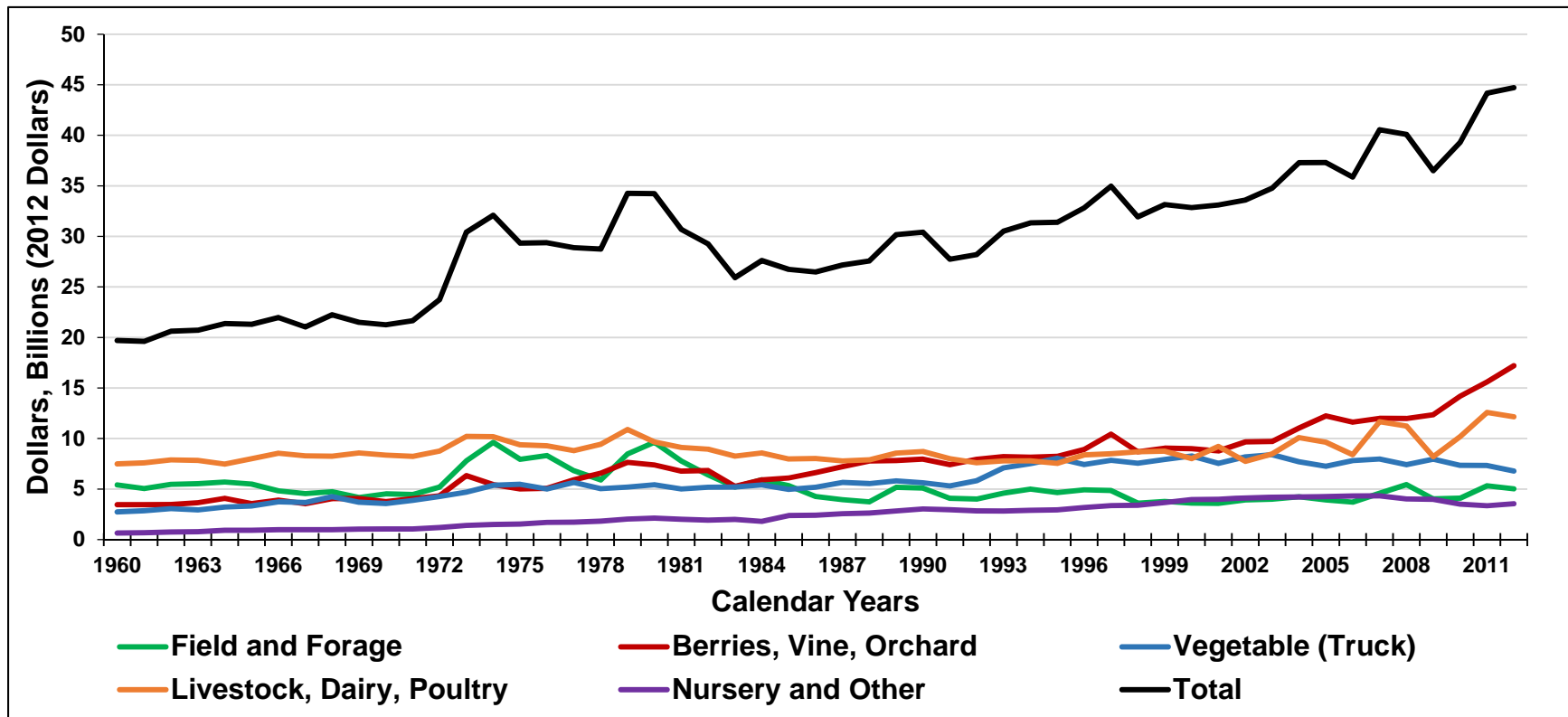
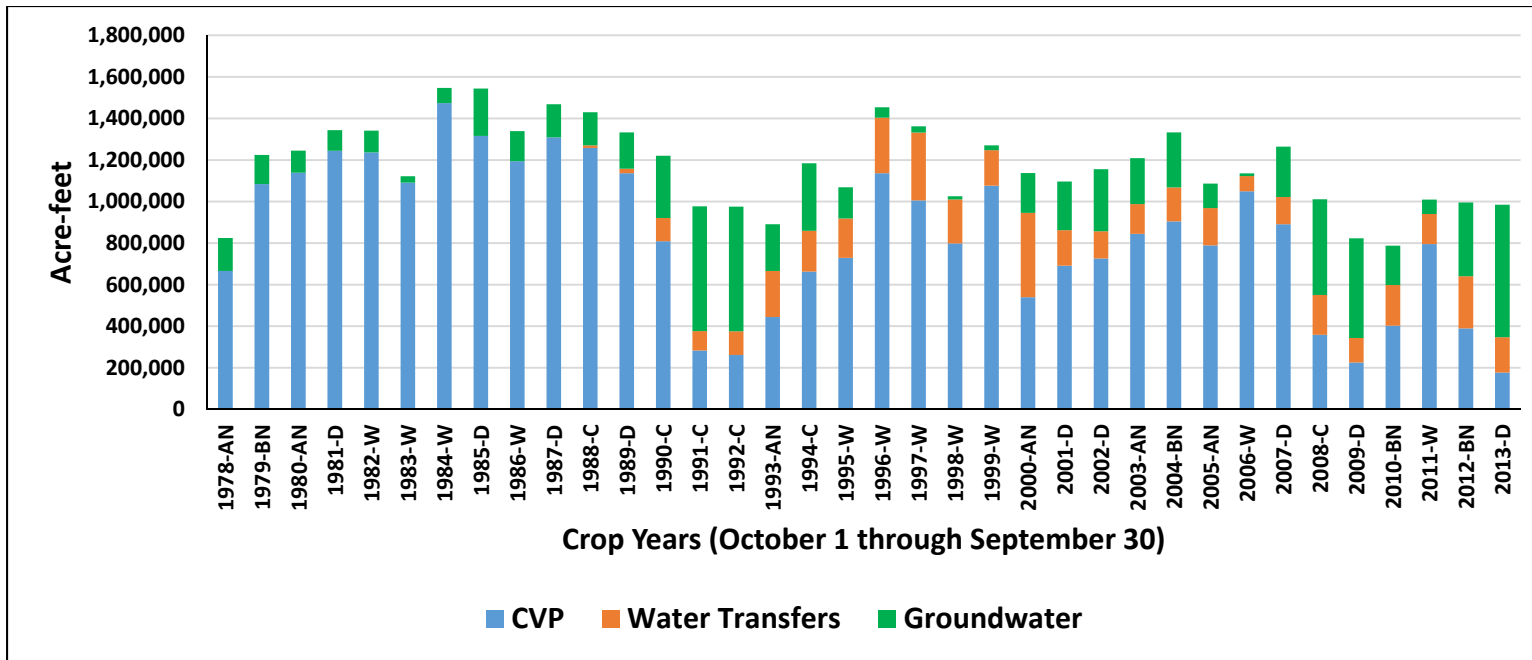


Figure 12.2 Total Value of California Agricultural Production, 1960 to 2012

Source: USDA 2014b; USDA-NASS 2008, 2009, 2010, 2011a, 2011b, 2012a, 2012b, 2013a, 2013b



**Figure 12.3 Historical Surface Water and Groundwater Supply Sources in Westlands Water District**

W = Wet Year; AN= Above Normal Year; BN = Below Normal Year; D = Dry Year; C = Critical Dry Year

Source: WWD 2013a, 2014a

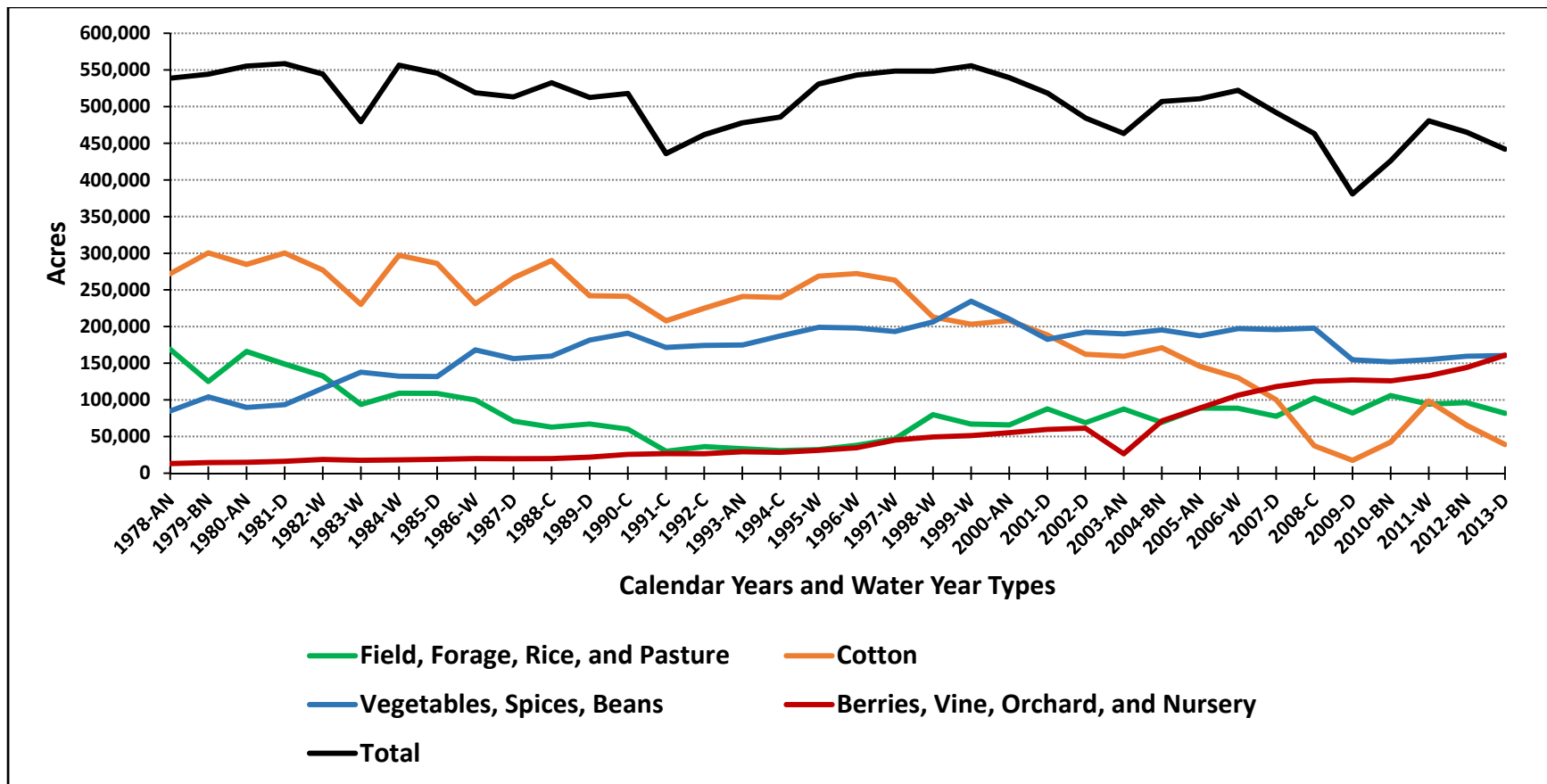
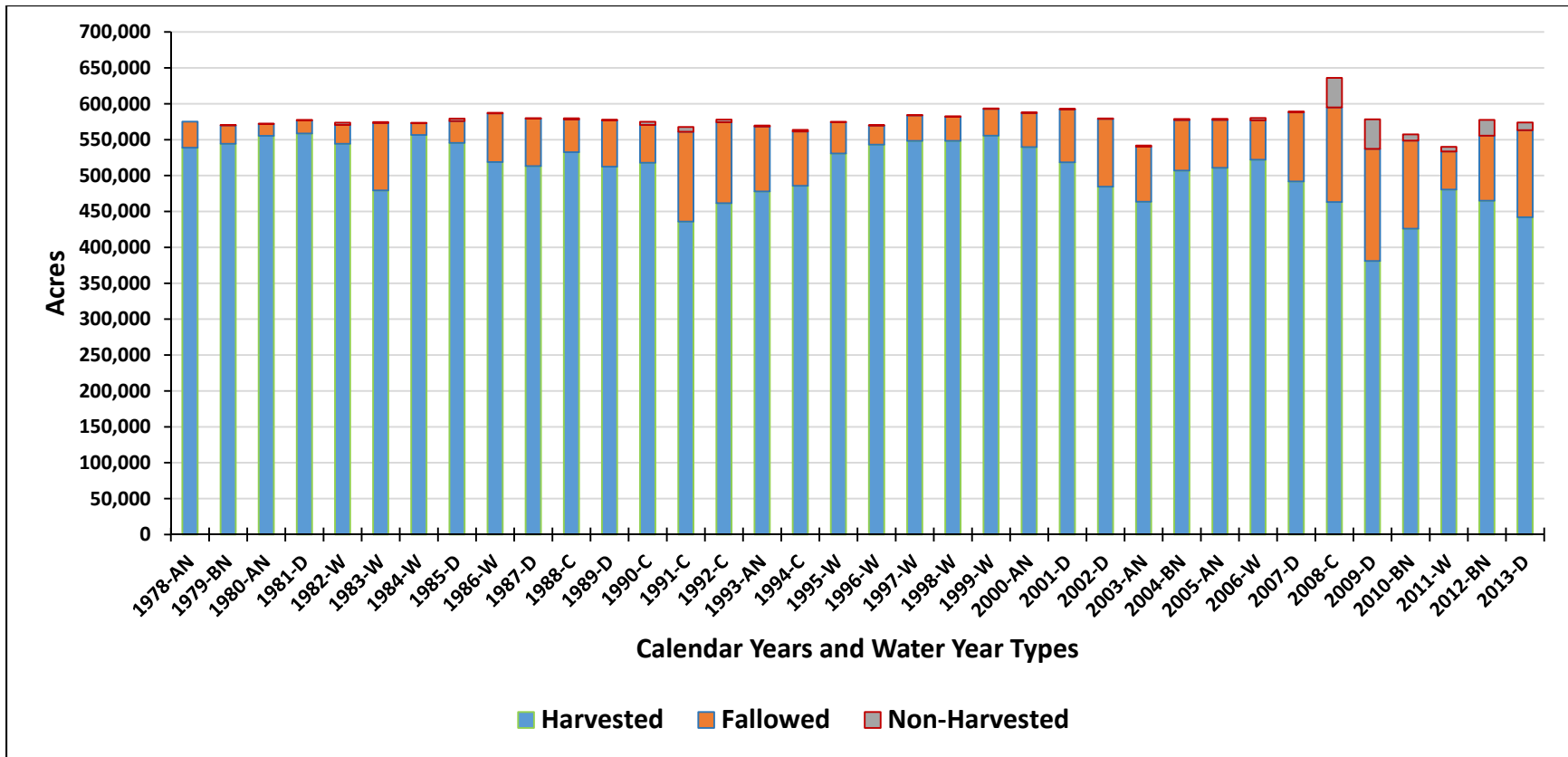


Figure 12.4 Historical Cropping Patterns in Westlands Water District

W = Wet Year; AN= Above Normal Year; BN = Below Normal Year; D = Dry Year; C = Critical Dry Year

Source: WWD 2013a, 2014b, 2014c



**Figure 12.5 Historical Harvested, Fallowed, and Non-Harvested Acreage in Westlands Water District**

W = Wet Year; AN= Above Normal Year; BN = Below Normal Year; D = Dry Year; C = Critical Dry Year

Source: WWD 2013a, 2014b, 2014c

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## Chapter 13

# 1 Land Use

## 2 13.1 Introduction

3 This chapter describes non-agricultural land use in the study area, and potential  
4 changes that could occur as a result of implementing the alternatives evaluated in  
5 this Environmental Impact Statement (EIS). Implementation of the alternatives  
6 could affect municipal and industrial land uses through potential changes in the  
7 Central Valley Project (CVP) and State Water Project (SWP) operation.

8 Changes in agricultural land use and resources are described in Chapter 12,  
9 Agricultural Resources. Changes to population are described in Chapter 19,  
10 Socioeconomics.

## 11 13.2 Regulatory Environment and Compliance 12 Requirements

13 Potential actions that could be implemented under the alternatives evaluated in  
14 this EIS could affect land uses served by CVP and SWP water supplies. Actions  
15 done on public agency lands, or implemented, funded, or approved by Federal and  
16 state agencies would need to be compliant with appropriate Federal and state  
17 agency policies and regulations (summarized in Chapter 4, Approach to  
18 Environmental Analysis).

## 19 13.3 Affected Environment

20 This section describes land use conditions potentially affected by the  
21 implementation of the alternatives considered in this EIS. Changes in land uses  
22 from changes in CVP and SWP operations may occur in the Trinity River, Central  
23 Valley, San Francisco Bay Area, Central Coast, and Southern California regions.

24 An extensive range of land uses are within this study area. However, direct or  
25 indirect land use effects from implementing the alternatives analyzed in this EIS  
26 are related to changes in agricultural, municipal, and industrial land uses from the  
27 availability and reliability of CVP and SWP water supplies. The following  
28 description of the affected environment is presented at the county-level for  
29 agricultural and municipal and industrial land uses. More detailed agricultural  
30 land use information is presented in Chapter 12, Agricultural Resources.

### 31 13.3.1 Trinity River Region

32 The Trinity River Region includes the area in Trinity County along the Trinity  
33 River from Trinity Lake to the confluence with the Klamath River; and in  
34 Humboldt and Del Norte counties along the Klamath River from the confluence



1 with the Trinity River to the Pacific Ocean. Tribal lands are also included for the  
2 entire Trinity River Region.

3 **13.3.1.1 Trinity County**

4 Trinity County encompasses approximately 3,206 square miles in northwestern  
5 California. It is bounded on the north by Siskiyou County, on the east by Shasta  
6 and Tehama Counties, on the south by Mendocino County, and on the west by  
7 Humboldt County. About 76 percent of the land area is within a national forest  
8 (Shasta-Trinity, Six Rivers, and Mendocino) and in four wilderness areas (Yolla  
9 Bolly-Middle Eel Reserve, Trinity Alps, Chanchellula, and North Fork). Another  
10 14 percent is zoned for timber use or held in agriculture land conservation  
11 contracts (Trinity County 2012).

12 The headwaters of the Trinity River are in the northeastern part of the County at  
13 an elevation of 6,200 feet, in the southern Siskiyou Mountains. Trinity Lake and  
14 Lewiston Reservoir are located along the middle reach of the mainstem  
15 Trinity River. Downstream of Lewiston Dam, the river flows northwest to join  
16 the Klamath River in Humboldt County (Trinity County 2012).

17 Development of communities is relatively limited in Trinity County because  
18 much of the land is within national forests and tribal lands or is characterized by  
19 steep slopes. The largest communities in Trinity County include Lewiston,  
20 Weaverville, and Hayfork (Trinity County 2012).

21 Trinity County's primary industries are tourism and timber and is the sixth largest  
22 timber producer in the state, with substantial acreage in National Forest and  
23 private holdings. There is one operating mill in the County. Recreational  
24 opportunities are also important in this area, as described in Chapter 15,  
25 Recreation Resources (Trinity County 2012).

26 The portion of Trinity County in the Trinity River Region that could be affected  
27 by changes in CVP and/or SWP operations and evaluated in this EIS includes  
28 areas in the vicinity of CVP facilities (Trinity Lake and Lewiston Reservoir) and  
29 areas along the Trinity River that use the river.

30 **13.3.1.2 Humboldt County**

31 Humboldt County encompasses approximately 3,570 square miles in  
32 northwestern California. It is bounded on the north by Del Norte County, on the  
33 east by Siskiyou and Trinity counties, on the south by Mendocino County, and on  
34 the west by the Pacific Ocean. About 25 percent of the land area is within the Six  
35 Rivers National Forest, Trinity Alps Wilderness Area, Redwood National and  
36 State National Park, national wildlife refuges, or other public land. About  
37 3 percent of the land area is within state park lands. The Yurok and Hoopa tribal  
38 lands represent about 5.6 percent of the land within Humboldt County boundaries  
39 (Humboldt County 2012).

40 Most of the population and developed areas are located in western Humboldt  
41 County along U.S. Highway 101 (Humboldt County 2012). Incorporated cities  
42 and residential lands in unincorporated portions of Humboldt County represent  
43 less than 1 percent of the county. Development of communities is relatively

1 limited in Humboldt County because much of the land is within national forests  
 2 and tribal lands, characterized by steep slopes, or within the coastal zone where  
 3 new large scale developments are minimized. Timber and agricultural lands are  
 4 located on over 60 percent of unincorporated areas of Humboldt County.

5 Humboldt County's primary industries are lumber manufacturing, retail, and  
 6 services (Humboldt County 2012). Humboldt County provides over 25 percent of  
 7 the lumber in the state.

8 The portion of Humboldt County in the Trinity River Region evaluated in this EIS  
 9 is located along the Trinity and Klamath rivers. Most of this area is located  
 10 within the Hoopa Valley Indian Reservation and Yurok Indian Reservation. This  
 11 portion of the county includes the communities of Willow Creek and Orleans  
 12 within Humboldt County; Hoopa in the Hoopa Valley Indian Reservation; and the  
 13 communities of Weitchpec, Cappel, Pecwan, and Johnson's in the Yurok Tribe  
 14 Indian Reservation (Humboldt County 2012).

### 15 **13.3.1.3 Del Norte County**

16 Del Norte County encompasses 1,070 square miles in northwestern California. It  
 17 is bounded on the north by the State of Oregon, on the east by Siskiyou County,  
 18 on the south by Humboldt County, and on the west by the Pacific Ocean.

19 Del Norte County includes lands within national forests (Six Rivers and Rogue  
 20 River-Siskiyou), Smith River National Recreation Area, Redwood National and  
 21 State Park, or other federally owned land. State lands include units of the  
 22 Redwoods State Park and the Lake Earl Wildlife Area. The Yurok tribal lands are  
 23 located along the lower Klamath River between the Del Norte and Humboldt  
 24 county boundaries to the Pacific Ocean (Del Norte County 2003).

25 Del Norte County's primary industries are retail and services (Del Norte County  
 26 2003).

27 The portion of Del Norte County in the Trinity River Region evaluated in this EIS  
 28 is located along the lower Klamath River. Most of this area is within the Yurok  
 29 Indian Reservation. This portion of the County includes the communities of  
 30 Requa and Klamath in the Yurok Tribe Indian Reservation (Del Norte  
 31 County 2003).

### 32 **13.3.1.4 Tribal Lands in Trinity River Region**

33 The major federally recognized tribes and tribal lands in the Trinity River Region  
 34 include the tribal lands of the Hoopa Valley Tribe, Yurok Tribe of the Yurok  
 35 Reservation, Resighini Rancheria, and Karuk Tribe. Aquatic and wildlife  
 36 resources associated with the Trinity and Klamath rivers and the surrounding  
 37 lands are very important to these tribes (NCRWQCB et al. 2009; Yurok Tribe  
 38 2005; Karuk Tribe 2010).

39 The Hoopa Valley Indian Reservation includes 93,702.73 acres (Hoopa Valley  
 40 Tribe 2008). The Trinity River flows through the Hoopa Valley Indian  
 41 Reservation.

1 The Yurok Indian Reservation includes about 55,890 acres within Tribal trust,  
2 Tribal fee, allotment, Tribal member fee, nonmember fee, Federal, state, and  
3 county lands (Yurok Tribe 2012). The Tribe employs over 250 in the government  
4 agency, as well as seasonal workers for fisheries, forestry, fire prevention, and  
5 other programs.

6 The Resighini Rancheria includes about 435 acres of land along the south bank  
7 of the lower Klamath River and extends from an inland area to the  
8 U.S. Highway 101 bridge along the western boundary of the Rancheria  
9 (Reclamation 2010). The Rancheria is surrounded by the Yurok Indian  
10 Reservation (Reclamation 2010; Resighini Rancheria 2014). The community  
11 includes tribal offices, a casino, campground, residences, agricultural lands, and  
12 open space.

13 The Karuk Ancestral Territory is located to the north of the Trinity River in the  
14 vicinity of Trinity County and east of the Trinity River in the vicinity of  
15 Humboldt County (Karuk Tribe 2010). The western boundary of the Karuk  
16 Ancestral Territory is relatively concurrent with the western boundary of the  
17 Six Rivers National Forest. Therefore, changes in the Trinity River flow or water  
18 quality that could be affected by changes in CVP and/or SWP operations  
19 considered in the alternatives in this EIS would not occur within the Karuk  
20 Ancestral Territory.

### 21 **13.3.2 Central Valley Region**

22 The Central Valley Region extends from above Shasta Lake to the  
23 Tehachapi Mountains, and includes the Sacramento Valley, San Joaquin Valley,  
24 Delta, and Suisun Marsh.

#### 25 **13.3.2.1 Sacramento Valley**

26 The Sacramento Valley includes the counties of Shasta, Plumas, Tehama, Glenn,  
27 Colusa, Butte, Sutter, Yuba, Nevada, Placer, El Dorado, and Sacramento counties.  
28 Yolo and Solano counties are also located within the Sacramento Valley;  
29 however, these counties are discussed as part of the Delta and Suisun Marsh  
30 subsection because potential changes in land use because of changes in CVP and  
31 SWP long-term operations would primarily occur within the Delta and Suisun  
32 marsh geography. Other counties in this region are not anticipated to be affected  
33 by changes in CVP and SWP operations, and are not discussed here, including:  
34 Alpine, Sierra, Lassen, and Amador counties. Tribal lands are also described for  
35 the entire Sacramento Valley.

##### 36 **13.3.2.1.1 Shasta County**

37 Shasta County encompasses approximately 3,793 square miles in northern  
38 California. It is bounded on the north by Siskiyou County, on the east by Lassen  
39 County, on the south by Tehama County, and on the west by Trinity County.  
40 Shasta County includes lands within national forests (Shasta-Trinity,  
41 Whiskeytown-Shasta-Trinity, and Lassen), Lassen Volcanic National Park, or  
42 other federally owned land. State lands include state forest and state parks  
43 (Shasta County 2004).

1 The Shasta County General Plan identifies four major categories of land use:  
 2 urban, rural, agricultural, and timber (Shasta County 2004). Of Shasta County's  
 3 2,416,440 acres, 613,495 acres (25 percent) are designated as timber preserve  
 4 zones pursuant to California's Forest Taxation Reform Act of 1976 (Shasta  
 5 County 2004). Approximately 169,127 acres (7 percent), are designated as  
 6 agricultural preserve lands.

7 Approximately 1.2 percent of the lands in the County are within incorporated  
 8 areas (Shasta County 2004). Urban development is concentrated in the southern  
 9 central portion of the county in the cities of Redding, Anderson, and Shasta Lake  
 10 (Reclamation 2005a).

11 The portion of the Central Valley Region, Sacramento Valley in Shasta County  
 12 that could be affected by changes in CVP and/or SWP operations and evaluated in  
 13 this EIS includes CVP facilities (Shasta Lake, Keswick Reservoir, and  
 14 Whiskeytown Lake), areas along the Sacramento River and Clear Creek that use  
 15 the surface waters (including agricultural lands), and CVP water service areas.

#### 16 **13.3.2.1.2 Plumas County**

17 Plumas County encompasses approximately 2,610 square miles in northern  
 18 California. It is bounded on the north by Shasta County, on the east by Lassen  
 19 County, on the west by Tehama and Butte counties, and on the south by Sierra  
 20 County. Plumas County includes lands within national forests (Plumas, Lassen,  
 21 Toiyabe, and Tahoe), Lassen Volcanic National Park, or other federally owned  
 22 land. State lands include Plumas-Eureka State Park (Plumas County 2012).

23 Prominent landscape features in Plumas County are the Sierra Valley, the Lake  
 24 Almanor Basin, and the Upper Feather River watershed which includes three  
 25 SWP lakes (Antelope Lake, Lake Davis, and Frenchman Lake). The largest land  
 26 uses in the county are agricultural and timber resource lands. Rural and  
 27 semi-rural development is scattered throughout the County, with most growth  
 28 concentrated in several designated planning areas. The county's only  
 29 incorporated area is the City of Portola.

30 The most recent Plumas County General Plan was adopted in 1984. The county is  
 31 in the process of updating its General Plan through 2030 (Plumas County 2012).  
 32 Approximately 76 percent of the land in Plumas County is National Forest land  
 33 owned and managed by the U.S. Forest Service. The U.S. Forest Service  
 34 prepared the Plumas National Forest Land and Resource Management Plan in  
 35 1988, to guide management and land use planning decisions in the forest. The  
 36 National Forest Land and Resource Management Plan provides a designation for  
 37 areas based on established priorities for various resources, including wilderness,  
 38 recreation, wildlife, timber, and visual resources (Plumas County 2012).

39 The portion of the Central Valley Region, Sacramento Valley in Plumas County  
 40 that could be affected by changes in CVP and/or SWP operations and evaluated in  
 41 this EIS is located at the SWP Antelope Lake, Lake Davis, and Frenchman Lake  
 42 and along the Feather River downstream of Frenchman Lake.

1 **13.3.2.1.3 Tehama County**

2 Tehama County encompasses approximately 2,951 square miles in northern  
3 California. It is bounded on the north by Shasta County, on the east by Plumas  
4 County, on the west by Trinity and Mendocino counties, and on the south by  
5 Glenn and Butte counties. Tehama County includes lands within national forests  
6 (Lassen, Mendocino, and Shasta-Trinity), Lassen Volcanic National Park, or other  
7 federally owned land (Tehama County 2008).

8 Tehama County is predominantly rural, with populations primarily concentrated  
9 in the incorporated cities of Corning, Red Bluff, and Tehama or along the major  
10 transportation corridors. The incorporated areas include less than 1 percent of the  
11 total land area in the county. The primary incorporated and unincorporated  
12 developed areas in the county are adjacent to major transportation centers, with  
13 most adjacent to Interstate 5 and State Route 99. Clustered commercial land uses  
14 are located primarily along the major state and county roadways, most of which  
15 are near Red Bluff, Corning, and the unincorporated community of Los Molinos.  
16 Residential land uses in the developed portions of the county tend to be located  
17 behind or beyond the commercial and service uses adjacent to the major street  
18 network (Tehama County 2008).

19 Ranches, timber company holdings, and government land dominate the county.  
20 Much of the land use is resource-based, such as cropland, rangeland, pasture land,  
21 and timber land (Tehama County 2008). The majority of land within the CVP  
22 water service area in Tehama County is designated for agricultural use (Tehama  
23 County 2008; Reclamation 2005b).

24 The portion of the Central Valley Region, Sacramento Valley in Tehama County  
25 that could be affected by changes in CVP and/or SWP operations and evaluated in  
26 this EIS includes CVP facilities, areas along the Sacramento River that use the  
27 surface waters (including agricultural lands), and CVP water service areas.

28 **13.3.2.1.4 Glenn County**

29 Glenn County encompasses 1,317 square miles in northern California. It is  
30 bounded on the north by Tehama County, on the east by Butte County, on the  
31 west by Lake and Mendocino counties, and on the south by Colusa County.  
32 Glenn County includes lands within the Mendocino National Forest, Sacramento  
33 National Wildlife Refuge, and other federally owned land (Glenn County 1993).

34 Approximately two-thirds (583,974 acres) are croplands and pasture. The two  
35 incorporated towns in the county are Willows, the County seat, and Orland  
36 (Reclamation 2004). Intensive agriculture provides a major segment of the  
37 county's economic base (Glenn County 1993; Reclamation 2005b). The portion of  
38 the Central Valley Region, Sacramento Valley in Glenn County that could be  
39 affected by changes in CVP and/or SWP operations and evaluated in this EIS  
40 includes wildlife refuges (described in Chapter 10, Terrestrial Biological  
41 Resources), and CVP facilities, areas along the Sacramento River that use the  
42 surface waters (including agricultural lands), and CVP water service areas.

1     **13.3.2.1.5 Colusa County**

2     Colusa County encompasses approximately 1,132 square miles in northern  
 3     California. It is bounded on the north by Glenn County, on the east by Butte and  
 4     Sutter counties, on the west by Lake County, and on the south by Yolo County.  
 5     Colusa County includes lands within the Mendocino National Forest, Sacramento  
 6     National Wildlife Refuge complex (Colusa, Delevan, and Sacramento national  
 7     wildlife refuges); East Park Reservoir; and other federally owned land (Colusa  
 8     County 2011). State lands in Colusa County include Willow Creek-Lurline,  
 9     North Central Valley, Colusa Bypass, and Sacramento River wildlife  
 10    management areas.

11    Existing land uses in Colusa County are predominantly agricultural.  
 12    Approximately 76 percent of the county’s total land area is cropland or  
 13    undeveloped rangeland. Twelve percent is national forest and national wildlife  
 14    refuge land. Less than 1 percent is covered by urban and rural communities.  
 15    Colusa and Williams are the only incorporated cities in the county and they  
 16    encompass about 2,574 acres (Colusa County 2011). Arbuckle is the largest  
 17    unincorporated town of the unincorporated communities, which includes  
 18    Arbuckle, College City, Century Ranch, Grimes, Maxwell, Princeton, and  
 19    Stonyford. Together, these established incorporated and unincorporated towns  
 20    cover a total area in “urban” uses of about 5,451 acres (Colusa County 2011).  
 21    The majority of land within the CVP water service area in Colusa County is  
 22    designated for agricultural use (Colusa County 2011; Reclamation 2005b).

23    The portion of the Central Valley Region, Sacramento Valley in Colusa County  
 24    that could be affected by changes in CVP and/or SWP operations and evaluated in  
 25    this EIS includes wildlife refuges (described in Chapter 10, Terrestrial Biological  
 26    Resources) and CVP facilities, areas along the Sacramento River that use the  
 27    surface waters (including agricultural lands), and CVP water service areas.

28    **13.3.2.1.6 Butte County**

29    Butte County encompasses 1,680 square miles in northern California. It is  
 30    bounded on the north by Tehama County, on the east by Plumas County, on the  
 31    west by Glenn and Colusa counties, and on the south by Sutter and Yuba counties.  
 32    Butte County includes lands within national forests (Plumas and Lassen),  
 33    Sacramento National Wildlife Refuge (Butte County 2010). State lands in Butte  
 34    County include Big Chico Creek and Butte Creek ecological preserves; Table  
 35    Mountain Reserve; Gray Lodge, Sacramento River, and Oroville wildlife areas;  
 36    SWP facilities at Lake Oroville and Thermalito Reservoir; and more than  
 37    750 miles of rivers and streams.

38    The county comprises three general topographical areas: valley region, foothills  
 39    east of the valley, and mountain region east of the foothills. Each of these regions  
 40    contains distinct environments with unique wildlife and natural resources.

41    The U.S. Forest Service manages 135,427 acres (12 percent) within Butte County,  
 42    including portions of the Plumas and Lassen National Forests. The Bureau of  
 43    Land Management owns and manages 16,832 acres (1.5 percent) in the county

1 (Butte County 2010). Agriculture is the dominant land use within unincorporated  
2 Butte County, accounting for approximately 599,040 acres (60 percent of the  
3 county area) (Butte County 2010).

4 Butte County contains five incorporated municipalities: Biggs, Chico, Gridley,  
5 Oroville, and Paradise. Each has a general plan that guides development within  
6 its limits and larger planning area (Butte County 2010).

7 The portion of the Central Valley Region, Sacramento Valley, in Butte County  
8 that could be affected by changes in CVP and/or SWP operations and evaluated in  
9 this EIS includes wildlife refuges (described in Chapter 10, Terrestrial Biological  
10 Resources), SWP facilities (Lake Oroville and Thermalito Afterbay), CVP  
11 facilities, areas along the Feather River that use the surface waters (including  
12 agricultural lands), and CVP and SWP water service areas.

### 13 **13.3.2.1.7 Sutter County**

14 Sutter County encompasses approximately 607 square miles in northern  
15 California. It is bounded on the north by Butte County, on the east by Yuba and  
16 Placer counties, on the west by Colusa and Yolo counties, and on the south by  
17 Sacramento County. Sutter County includes lands within the Sutter National  
18 Wildlife Refuge. State lands in Sutter County include Butte Slough, Feather  
19 River, Gray Lodge, Sutter Bypass, and Butte Sink wildlife management areas; and  
20 Sutter Buttes State Park (Sutter County 2010).

21 Sutter County's General Plan was updated in 2011. Approximately 98 percent of  
22 the land in the County is unincorporated, and approximately 98 percent of the  
23 unincorporated land is zoned for agricultural use (Reclamation 2004). The two  
24 incorporated cities within the county, Yuba City and Live Oak, encompass  
25 approximately 10,600 acres.

26 Existing land use in Sutter County is rural and dominated by agricultural areas.  
27 The county has significant natural and recreational resources, and a relatively low  
28 population density. Existing land uses in Yuba City and Live Oak contain the  
29 bulk of the county's urban land uses, such as residences, commercial and  
30 industrial uses, parks, and public facilities (Sutter County 2010). The county  
31 includes several incorporated rural communities: Meridian, Sutter, Robbins,  
32 Rio Oso, Trowbridge, Nicolaus, East Nicolaus, and Pleasant Grove (Sutter  
33 County 2010).

34 The portion of the Central Valley Region, Sacramento Valley in Sutter County  
35 that could be affected by changes in CVP and/or SWP operations and evaluated in  
36 this EIS includes wildlife refuges (described in Chapter 10, Terrestrial Biological  
37 Resources), CVP facilities, areas along the Sacramento River that use the surface  
38 waters (including agricultural lands), and CVP and SWP water service areas.

### 39 **13.3.2.1.8 Yuba County**

40 Yuba County encompasses approximately 634 acres in northern California. It is  
41 bounded on the north by Butte County, on the east by Sierra and Nevada counties,  
42 on the west by Sutter County, and on the south by Placer County. Federally

1 owned lands in Yuba County include Tahoe and Plumas National Forests, and the  
 2 22,944-acre Beale Air Force Base (Yuba County 2011). The Department of Fish  
 3 and Wildlife administers the state Spenceville Wildlife Area.

4 Yuba County is predominantly rural. Over 189,500 acres (46 percent of the  
 5 county), are designated for agricultural land uses. Most of the population lives in  
 6 the two incorporated cities in the county (Marysville and Wheatland); and the  
 7 major unincorporated communities including Brown's Valley, Brownsville,  
 8 Camptonville, Dobbins, Linda/Olivehurst, Log Cabin, Loma Rica, Oregon  
 9 House, Rackerby, and River Highlands (Yuba County 2011).

10 The portion of the Central Valley Region, Sacramento Valley in Yuba County  
 11 that could be affected by changes evaluated in this EIS includes areas within  
 12 Yuba County Water Agency facilities that provide water for environmental and  
 13 water supply purposes within the Central Valley.

#### 14 **13.3.2.1.9 Nevada County**

15 Nevada County encompasses approximately 634,880 acres in northern California.  
 16 It is bounded on the north by Sierra County, on the northwest by Yuba County, on  
 17 and on the south by Placer County. Federally owned lands in Nevada County  
 18 include 169,686 acres in the Tahoe National Forest; 2,574 acres in the Toiyabe  
 19 National Forest; and approximately 11,000 acres administered by the Bureau of  
 20 Land Management (Nevada County 1995). The State Lands Commission  
 21 manages approximately 4,600 acres; State Parks administers 6,300 acres at  
 22 several locations, including Malakoff Diggins State Historical Park and Empire  
 23 Mine State Park; and the Department of Fish and Wildlife administers  
 24 approximately 11,000 acres at the Spenceville Wildlife Management and  
 25 Recreation Area.

26 Nevada County is predominantly rural (Nevada County 2012). Approximately  
 27 91 percent of the county is used for agriculture, timber, or open space. Most of  
 28 the population lives in the three incorporated cities in the county (Grass Valley,  
 29 Nevada City, and Truckee).

#### 30 **13.3.2.1.10 Placer County**

31 Placer County encompasses approximately 1,506 square miles in northern  
 32 California. It is bounded on the north by Nevada County, on the east by the  
 33 California-Nevada boundary, on the west by Yuba and Sutter counties, and on the  
 34 south by Sacramento and El Dorado counties. Placer County includes lands  
 35 within the El Dorado and Tahoe National Forests and other federally owned land  
 36 (Placer County 2011).

37 Placer County is predominantly rural. Most of the population lives in the area  
 38 along Interstate 80 from the City of Auburn to the Sutter and Sacramento county  
 39 boundaries. Incorporated cities and towns include Roseville, Rocklin, Lincoln,  
 40 Colfax, Loomis, and Auburn (Placer County 2011; Reclamation 2005c; SACOG  
 41 2007). Residential land uses range from rural residential areas to medium and  
 42 high-density dwelling units in urbanized areas. Commercial land uses are  
 43 primarily located in the urbanized portions of the county; although a large



1 concentration of commercial development occurs outside existing urban areas  
2 along Interstate 80. Non-urban land uses include agriculture, resource extraction  
3 (timber and mining), and public lands and open space uses. The largest amount of  
4 public lands within Placer County is located in the eastern half of the county, and  
5 is under the jurisdiction of the Bureau of Land Management, U.S. Forest Service,  
6 or the Bureau of Reclamation. The CVP water service area within Placer County  
7 primarily includes the communities and agricultural areas in the western portion  
8 of the county. The portion of the Central Valley Region, Sacramento Valley in  
9 Placer County that could be affected by changes in CVP and/or SWP operations  
10 and evaluated in this EIS includes CVP water facilities (Folsom Lake), areas  
11 along the American River that use the surface waters (including agricultural  
12 lands), and CVP water service areas.

#### 13 **13.3.2.1.11 El Dorado County**

14 El Dorado County encompasses approximately 1,790 square miles in northern  
15 California along the American River. It is bounded on the north by  
16 Placer County, on the east by California-Nevada boundaries, on the west by  
17 Sacramento County, and on the south by Amador and Alpine counties. El Dorado  
18 County includes about 521,210 acres (45.5 percent of the total county), under  
19 Federal ownership or trust, including lands within the El Dorado and Tahoe  
20 national forests. About 9,751 acres (8.5 percent of the county), is under the State  
21 jurisdiction (El Dorado County 2003).

22 The county includes two specific regions: the Lake Tahoe Basin and the western  
23 slopes of the Sierra Nevada (El Dorado County 2003). The CVP water service  
24 area provides water to a large portion of the communities and some agricultural  
25 areas along the western slope. El Dorado County includes two incorporated  
26 cities, Placerville and South Lake Tahoe, which cover 621 acres of land. Other  
27 major communities include El Dorado Hills, Cameron Park, Shingle Springs,  
28 Rescue, Diamond Springs, Camino, Coloma and Gold Hill, Cool and Pilot Hill,  
29 Georgetown and Garden Valley, Pollock Pines, Pleasant Valley, Latrobe,  
30 Somerset, and Mosquito. The rural land uses in the county include over  
31 259,000 acres of private production forests, 153,472 acres of agricultural lands,  
32 and 35,282 acres within the waters of Folsom Lake and Lake Tahoe. The  
33 county's two largest crops are wine grapes and apples.

34 The portion of the Central Valley Region, Sacramento Valley in El Dorado  
35 County that could be affected by changes in CVP and/or SWP operations and  
36 evaluated in this EIS includes CVP water facilities (Folsom Lake), areas along the  
37 American River that use the surface waters, and CVP water service areas.

#### 38 **13.3.2.1.12 Sacramento County**

39 Sacramento County encompasses approximately 1,769 square miles in northern  
40 California. It is bounded on the north by Sutter and Placer counties, on the east  
41 by El Dorado and Amador counties, on the south by Contra Costa and San  
42 Joaquin counties, and on the west by Yolo and Solano counties. Sacramento  
43 County includes federally owned lands within Folsom Lake and Lake Natoma.

1 Residential areas in Sacramento County primarily occur in northern and central  
 2 Sacramento County. Sacramento County includes areas within the Delta,  
 3 including the southwestern portion of the City of Sacramento, City of Isleton and  
 4 the communities of Locke, Ryde, Courtland, Freeport, Hood, and Walnut Grove;  
 5 and areas located to the east of the Delta (Sacramento County 2011). Sacramento  
 6 County has seven incorporated cities located in about 56 percent of the county:  
 7 Sacramento, Elk Grove, Citrus Heights, Folsom, Galt, Isleton, and Rancho  
 8 Cordova. The County includes several unincorporated communities including  
 9 Antelope, Arden-Arcade, Carmichael, Cordova, Elverta, Foothill Farms, Fair  
 10 Oaks, Herold, Natomas, North Highlands, Orangevale, Rancho Murieta, Rio  
 11 Linda, Sloughhouse, and Wilton.

12 The leading agricultural crops in Sacramento County include dairy, wine grapes,  
 13 Bartlett pears, field corn, and turkeys (Sacramento County 2010). Agricultural  
 14 acreage has declined as urban development has continued. Between 1989 and  
 15 2004, the portion of the county designated as agriculture declined from 40 percent  
 16 to 34 percent. The southeastern portion of the county remains primarily rural with  
 17 smaller communities, such as Herald (Sacramento County 2011).

18 The portion of the Central Valley Region, Delta, in Sacramento County that could  
 19 be affected by changes in CVP and/or SWP operations and evaluated in this EIS  
 20 includes CVP facilities (Folsom Lake and Lake Natoma), areas along the  
 21 American and Sacramento rivers and Delta channels that use the surface waters  
 22 (including agricultural lands), and CVP water service areas.

### 23 **13.3.2.1.13 Tribal Lands in Sacramento Valley**

24 This section summarizes the tribal lands that could be affected by changes in CVP  
 25 and/or SWP operations and that are located within the county boundaries.

#### 26 *Tribal Lands within the Boundaries of Shasta County*

27 Major federally recognized tribes and tribal lands within the boundaries of Shasta  
 28 County include the Pit River Tribe and the Redding Rancheria, which is a federal  
 29 reservation of Wintun, Pit River, and Yana Indians near Redding (SDSU 2013).

#### 30 *Tribal Lands within the Boundaries of Tehama County*

31 There are approximately 2,000 acres within the total acreage of Tehama County  
 32 within tribal trust, including land near Corning owned by the Paskenta Band of  
 33 Nomlaki Indians of California (Paskenta 2014).

#### 34 *Tribal Lands within the Boundaries of Glenn County*

35 Major federally recognized tribes and tribal lands within the boundaries of Glenn  
 36 County include the Grindstone Indian Reservation near Elk Creek at the  
 37 Grindstone Indian Rancheria of Wintun-Wailaki Indians of California, and lands  
 38 of the Paskenta Band of Nomlaki Indians of California.

#### 39 *Tribal Lands within the Boundaries of Colusa County*

40 Major federally recognized tribes and tribal lands within the boundaries of Colusa  
 41 County include the Cachil Dehe Band of Wintun Indians of the Colusa Indian

1 Community of the Colusa Rancheria, and the Cortina Indian Rancheria of Wintun  
2 Indians of California (Colusa County 2011).

3 *Tribal Lands within the Boundaries of Butte County*

4 Major federally recognized tribes and tribal lands within the boundaries of Butte  
5 County include the Tyme Maidu of Berry-Creek Rancheria on approximately  
6 90 acres, and the Concow Maidu of Mooretown Rancheria on approximately  
7 300 acres (Butte County 2010).

8 *Tribal Lands within the Boundaries of Nevada County*

9 Major federally recognized tribes and tribal lands within the boundaries of  
10 Nevada County include tribal trust lands of the Shingle Springs Band of Miwok  
11 Indians.

12 *Tribal Lands within the Boundaries of Placer County*

13 Major federally recognized tribes and tribal lands within the boundaries of Placer  
14 County include tribal trust lands of the United Auburn Indian Community of the  
15 Auburn Rancheria of California.

16 *Tribal Lands within the Boundaries of El Dorado County*

17 Major federally recognized tribes and tribal lands within the boundaries of El  
18 Dorado County include the Shingle Springs Band of Miwok Indians.

19 *Tribal Lands within the Boundaries of Sacramento County*

20 Major federally recognized tribes and tribal lands within the boundaries of  
21 Sacramento County include lands of the Wilton Miwok Indians of the Wilton  
22 Rancheria near Elk Grove (SACOG 2007).

23 **13.3.2.2 San Joaquin Valley**

24 The San Joaquin Valley includes Stanislaus, Merced, Madera, San Joaquin,  
25 Fresno, Kings, Tulare, and Kern counties. Other counties in this region are not  
26 anticipated to be affected by changes in CVP and SWP operations, and are not  
27 discussed here. They include Calaveras, Mariposa, and Tuolumne counties.  
28 Tribal lands are also described for the entire San Joaquin Valley.

29 **13.3.2.2.1 Stanislaus County**

30 Stanislaus County encompasses approximately 1,521 square miles in central  
31 California. It is bounded on the north by San Joaquin County, on the east by  
32 Calaveras and Tuolumne counties, on the west by Santa Clara County, and on the  
33 south by Merced County. Stanislaus County includes lands within the San  
34 Joaquin River National Wildlife Refuge (Stanislaus Council of Governments  
35 2007).

36 Land use in the county is primarily agricultural, with nearly 80 percent of the land  
37 zoned for general agriculture or in agricultural production (Stanislaus Council of  
38 Governments 2007). Over the past 40 years, some portions of the county have  
39 been changing from a rural agricultural region to semi-urbanized, especially along  
40 major highways and freeways. There are nine incorporated cities in the county,  
41 including Ceres, Hughson, Modesto, Newman, Oakdale, Patterson, Riverbank,

1 Turlock, and Waterford. Stanislaus County has adopted community plans for  
 2 most of its unincorporated towns, including Crows Landing, Del Rio, Denair,  
 3 Hickman, Keyes, Knights Ferry, La Grange, Westley, and Salida (Stanislaus  
 4 County 2010, 2012).

5 The portion of the Central Valley Region, San Joaquin Valley, in Stanislaus  
 6 County that could be affected by changes in CVP and/or SWP operations and  
 7 evaluated in this EIS includes wildlife refuges (described in Chapter 10,  
 8 Terrestrial Biological Resources), CVP water facilities (New Melones Reservoir,  
 9 Delta-Mendota Canal, and San Luis Canal/California Aqueduct), areas along the  
 10 Stanislaus and San Joaquin rivers that use the surface waters (including  
 11 agricultural lands), and CVP water service areas.

#### 12 **13.3.2.2.2 Merced County**

13 Merced County encompasses approximately 1,977 square miles in central  
 14 California. It is bounded on the north by Stanislaus County, on the east by  
 15 Mariposa County, on the south by Fresno and Madera counties, and on the west  
 16 by Santa Clara and San Benito counties. Merced County includes federally  
 17 owned lands within the San Luis National Wildlife Refuge (Merced County  
 18 2013). State lands within the county include San Luis Reservoir State Recreation  
 19 Area; Great Valley Grasslands State Park; and the Los Banos, North Grasslands,  
 20 and Volta wildlife areas.

21 Merced County includes the six incorporated cities of Atwater, Dos Palos,  
 22 Gustine, Livingston, Los Banos, and Merced. The major unincorporated  
 23 communities include Delhi, Fox Hills, Franklin, Hilmar, LeGrand, Planada, Santa  
 24 Nella, Laguna San Luis, and Winton (Merced County 2013). Unincorporated  
 25 land within the county includes approximately 1.2 million acres (98.1 percent of  
 26 the land in the county). Agriculture is the primary land use, totaling just over  
 27 1 million acres (81.2 percent). Public and quasi-public land is the next largest use  
 28 with 131,582 acres or 10.6 percent of the unincorporated County. Commercial  
 29 land uses represent 3,025 acres (0.2 percent), industrial uses represent 2,488 acres  
 30 (0.2 percent), and mining represents 3,375 acres (0.3 percent). Incorporated cities  
 31 account for 24,138 acres (1.9 percent) (Merced County 2012a, 2013). The  
 32 Merced County Local Agency Formation Commission policies discourage  
 33 annexation of prime agricultural land when significant areas of non-prime  
 34 agricultural land are already available. The policies also encourage development  
 35 of vacant areas in cities before the annexation and development of outlying areas.  
 36 Local Agency Formation Commission policies encourage city annexations that  
 37 reflect a planned, logical, and orderly progression of urban expansion and  
 38 promote efficient delivery of urban services (Merced County 2012b).

39 The portion of the Central Valley Region, San Joaquin Valley in Merced County  
 40 that could be affected by changes in CVP and/or SWP operations and evaluated in  
 41 this EIS includes wildlife refuges (described in Chapter 10, Terrestrial Biological  
 42 Resources), CVP and SWP water facilities (San Luis Reservoir, Delta-Mendota  
 43 Canal, and San Luis Canal/California Aqueduct), areas along the San Joaquin

1 River that use the surface waters (including agricultural lands), and CVP water  
2 service areas.

### 3 **13.3.2.2.3 Madera County**

4 Madera County encompasses approximately 2,147 square miles in central  
5 California. It is bounded on the north by Merced and Mariposa counties, on the  
6 east by Mono County, and on the south and west by Fresno County. Madera  
7 County includes lands within the Sierra and Inyo national forests (Madera County  
8 1995). State lands within the county include the Millerton Lake State  
9 Recreation Area.

10 Land elevations in Madera County range from 180 feet to over 13,000 feet above  
11 mean sea level. Madera County can be divided generally into three regions – the  
12 San Joaquin Valley in the west, the foothills between the Madera Canal and the  
13 3,500-foot elevation contour, and the mountains from the 3,500-foot contour to  
14 the crest of the Sierra Nevada. The County has two incorporated cities, Madera  
15 and Chowchilla (Madera County 1995). Major unincorporated communities in  
16 the county include North Fork, South Fork, O’Neals, Oakhurst, Coarsegold,  
17 Gunner Ranch, and Rio Mesa.

18 The portion of the Central Valley Region, San Joaquin Valley, in Madera County  
19 that could be affected by changes in CVP and/or SWP operations and evaluated in  
20 this EIS includes CVP water facilities (Millerton Lake and the Madera Canal),  
21 areas along the San Joaquin River that use the surface waters (including  
22 agricultural lands), and CVP water service areas.

### 23 **13.3.2.2.4 San Joaquin County**

24 San Joaquin County encompasses approximately 1,426 square miles in central  
25 California. It is bounded on the north by Sacramento County, on the east by  
26 Calaveras and Amador counties, on the south by Stanislaus County, and on the  
27 west by Contra Costa and Alameda counties. San Joaquin County includes about  
28 6,000 acres of federally owned lands (San Joaquin County 2009).

29 San Joaquin County is currently in the process of updating its General Plan. Most  
30 of the county’s land is in agricultural production. Agriculture, the predominant  
31 land use, covers 686,109 acres (75 percent) of the county. Residential land is the  
32 second largest use in the unincorporated lands, encompassing 40,410 acres  
33 (4.4 percent of the county). Residential development in the county is  
34 concentrated in existing cities and in adjacent unincorporated communities. San  
35 Joaquin County has seven incorporated cities: Stockton, Tracy, Manteca, Escalon,  
36 Ripon, Lodi, and Lathrop. Stockton and Tracy are the largest cities in the county.  
37 The major unincorporated areas in the county include French Camp, Linden,  
38 Lockeford, Morada, Mountain House, New Jerusalem, Thornton, and  
39 Woodbridge (San Joaquin County 2009). The incorporated cities account for  
40 90,191 acres (approximately 10 percent of the county).

41 The portion of the Central Valley Region, Delta in San Joaquin County that could  
42 be affected by changes in CVP and/or SWP operations and evaluated in this EIS  
43 includes CVP and SWP facilities (including facilities associated with Rock

1 Slough Pumping Plant, Jones Pumping Plant, Clifton Court, and Banks Pumping  
 2 Plant), areas along the Delta channels that use the surface waters (including  
 3 agricultural lands), and CVP water service areas.

#### 4 **13.3.2.2.5 Fresno County**

5 Fresno County encompasses approximately 6,000 square miles in central  
 6 California. It is bounded on the north by Merced and Madera counties, on the  
 7 east by Mono and Inyo counties, on the south by Kings and Tulare counties, and  
 8 on the west by San Benito and Monterey counties. Fresno County includes lands  
 9 within Millerton Lake, Pine Flat Lake, the Sierra and Sequoia national forests,  
 10 Sequoia National Monument, and Kings Canyon National Park (Fresno County  
 11 2000). State lands within the county include the Millerton Lake State Recreation  
 12 Area, San Joaquin River Parkway, and Mendota Wildlife Area.

13 Fresno County is California's sixth-largest county. Agricultural land uses cover  
 14 over 48 percent of the county, and resource conservation lands (e.g., forests,  
 15 parks, and timber preserves) cover approximately 45 percent of the county. The  
 16 15 incorporated cities and unincorporated communities cover approximately  
 17 5 percent of the county (Fresno County 2000). Development constraints within  
 18 the county are primarily caused by lack of funding for infrastructure  
 19 improvement, availability of water supplies, air quality regulations, and physical  
 20 limitations, especially in the mountains and eastern foothills. The incorporated  
 21 communities include Clovis, Coalinga, Firebaugh, Fowler, Fresno, Huron,  
 22 Kerman, Kingsburg, Mendota, Orange Cove, Parlier-West Parlier, Reedley,  
 23 Sanger, San Joaquin, and Selma (Fresno County 2000). Major unincorporated  
 24 communities include Biola, Caruthers, Del Rey, Friant, Lanare, Laton, Riverdale,  
 25 Shaver Lake, and Tranquility.

26 The portion of the Central Valley Region, San Joaquin Valley in Fresno County  
 27 that could be affected by changes in CVP and/or SWP operations and evaluated in  
 28 this EIS includes CVP water facilities (Millerton Lake and the Friant-Kern  
 29 Canal), areas along the San Joaquin River that use the surface waters, and CVP  
 30 water service areas (including agricultural lands), and CVP water service areas.

#### 31 **13.3.2.2.6 Kings County**

32 Kings County encompasses approximately 1,280 square miles in south central  
 33 California. It is bounded on the north by Fresno County, on the east by Tulare  
 34 County, on the south by Kern County, and on the west by Monterey County.  
 35 Kings County includes lands within Naval Air Station Lemoore (Kings County  
 36 2009).

37 Land use is predominantly agricultural, with more than 90 percent of the county  
 38 designated for agricultural uses. Incorporated cities in Kings County include  
 39 Avenal, Corcoran, Hanford, and Lemoore. Residential land uses in  
 40 unincorporated areas and special districts cover less than 1 percent of the county's  
 41 total acreage including for the communities of Armona, Home Garden, Kettleman  
 42 City, and Stratford (Kings County 2009).

1 The portion of the Central Valley Region, San Joaquin Valley, in Kings County  
2 that could be affected by changes in CVP and/or SWP operations and evaluated in  
3 this EIS includes CVP and SWP water service areas.

4 **13.3.2.2.7 Tulare County**

5 Tulare County encompasses approximately 4,840 square miles in south central  
6 California. It is bounded on the north by Fresno County, on the east by Inyo  
7 County, on the south by Kern County, and on the west by Kings County.  
8 Tulare County includes federally owned lands within the Sequoia National Forest,  
9 Sequoia and Kings Canyon National Parks, Sequoia National Monument, several  
10 wilderness areas, Lake Kaweah, Lake Success, and Pixley National Wildlife  
11 Refuge (Tulare County 2010).

12 Agricultural land uses cover more than 2,150 square miles (approximately  
13 44 percent) of the county. Lands classified as open space (i.e., national forests,  
14 monuments, and parks; wilderness areas; and County parks) make up 25 percent  
15 of the land use in the county. Less than 3 percent of the county lands are in the  
16 incorporated cities of Dinuba, Exeter, Farmersville, Lindsay, Porterville, Tulare,  
17 Visalia, and Woodlake (Tulare County 2010). Less than 2 percent of the county  
18 is designated for unincorporated residential areas, including the major  
19 communities of Alpaugh, Cutler, Ducor, Earlimart, East Oros, Goshen, Ivanhoe,  
20 Lemoncove, London, Oros, Pixley, Plainview, Poplar-Cotton Center, Richgrove,  
21 Springville, Strathmore, Terra Bella, Three Rivers, Tipton, Traver, and  
22 Woodville.

23 The portion of the Central Valley Region, San Joaquin Valley, in Tulare County  
24 that could be affected by changes in CVP and/or SWP operations and evaluated in  
25 this EIS includes CVP water service areas.

26 **13.3.2.2.8 Kern County**

27 Kern County encompasses approximately 8,202 square miles in south central  
28 California. It is bounded on the north by Kings, Tulare, and Inyo counties; on the  
29 east by San Bernardino County, on the south by Ventura and Los Angeles  
30 counties; and on the west by San Luis Obispo County. Kern County includes  
31 lands within the Sequoia National Forest, Kern and Bitter Creek national wildlife  
32 refuges, Lake Isabella, China Lake Naval Air Weapons Station, and Edwards Air  
33 Force Base (Kern County 2004). State lands within the county include the Tule  
34 Elk State Reserve.

35 The county's geography includes mountainous regions, agricultural lands, and  
36 deserts. There are 11 incorporated cities in the county, including Arvin,  
37 Bakersfield, California City, Delano, Maricopa, McFarland, Ridgecrest, Shafter,  
38 Taft, Tehachapi, and Wasco (Kern County 2009). The major unincorporated  
39 communities include Kernville, Lake Isabella, Inyokern, Mojave, Boron,  
40 Rosamond, Golden Hills, Stallion Springs, and Buttonwillow. Agricultural land  
41 uses are designated for approximately 85 percent of the unincorporated lands that  
42 are under the jurisdiction of the county (not including lands under the jurisdiction

1 of the Federal, state, tribes, or incorporated cities). Less than 6 percent of the  
 2 unincorporated lands under county jurisdiction are designated for residential uses.  
 3 The portion of the Central Valley Region, San Joaquin Valley, in Kern County  
 4 that could be affected by changes in CVP and/or SWP operations and evaluated in  
 5 this EIS includes CVP and SWP water service areas.

#### 6 **13.3.2.2.9 Tribal Lands in San Joaquin Valley**

7 This section summarizes the tribal lands that could be affected by changes in CVP  
 8 and/or SWP operations and that are located within the county boundaries  
 9 described above.

##### 10 *Tribal Lands within the Boundaries of Madera County*

11 Major federally recognized tribes and tribal lands within the boundaries of  
 12 Madera County include the Picayune Rancheria of the Chuckchansi Indians of  
 13 California near the community of Coarsegold and the Northfork Rancheria of the  
 14 Mono Indians of California near Northfork (SDSU 2013).

##### 15 *Tribal Lands within the Boundaries of Fresno County*

16 Major federally recognized tribes and tribal lands within the boundaries of Fresno  
 17 County include the lands of the Big Sandy Rancheria of the Western Mono  
 18 Indians of California and Table Mountain Rancheria of California.

##### 19 *Tribal Lands within the Boundaries of Kings County*

20 Major federally recognized tribes and tribal lands within the boundaries of Kings  
 21 County includes the lands of the Santa Rosa Indian Community of Santa Rosa  
 22 Rancheria near the town of Lemoore (SDSU 2013).

##### 23 *Tribal Lands within the Boundaries of Tulare County*

24 Major federally recognized tribes and tribal lands within the boundaries of Tulare  
 25 County includes the Tule River Indian Tribe of the Tule River Reservation of the  
 26 Yokut Indians about 20 miles east of Porterville and covers 55,356 acres  
 27 (SDSU 2013).

#### 28 **13.3.2.3 Delta and Suisun Marsh**

29 The Delta and Suisun Marsh includes Sacramento, Yolo, Solano, San Joaquin,  
 30 and Contra Costa counties. Sacramento County is discussed in the Sacramento  
 31 Valley subsection because more of the land that could be affected by changes in  
 32 CVP and SWP long-term operations is located within the Sacramento Valley than  
 33 in the Delta and Suisun Marsh geographical areas. San Joaquin County is  
 34 discussed in the San Joaquin Valley subsection because more of the land that  
 35 could be affected by changes in CVP and SWP long-term operations is located  
 36 within the San Joaquin Valley than in the Delta and Suisun Marsh geographical  
 37 areas. Contra Costa County is discussed as part of the San Francisco Bay Region  
 38 because more of the land that could be affected by changes in CVP and SWP  
 39 long-term operations is located within the San Francisco Bay Region than in the  
 40 Delta and Suisun Marsh geographical areas.



1     **13.3.2.3.1 Yolo County**

2     Yolo County encompasses approximately 1,021 square miles in northern  
3     California. It is bounded on the north by Colusa County, on the east by Sutter and  
4     Sacramento counties, on the south by Solano County, and on the west by Lake  
5     and Napa counties. Yolo County includes federally owned lands in the Yolo  
6     Bypass and Cache Creek areas and state lands within the Yolo Bypass.

7     Residential areas in Yolo County primarily occur in the county's four  
8     incorporated cities (Davis, West Sacramento, Winters, and Woodland) that  
9     comprise approximately 32,325 acres (5 percent) of county lands (Yolo County  
10    2009). Yolo County includes areas within the Delta, including the City of West  
11    Sacramento and the community of Clarksburg. The unincorporated portion of the  
12    county encompasses 35 community areas, including Capay, Clarksburg,  
13    Dunnigan, Esparto, Guinda, Knights Landing, Madison, Monument Hills,  
14    Rumsey, Yolo, and Zamora.

15    Yolo County adopted its 2030 General Plan in 2011. The general plan designates  
16    more than 92 percent of the County area for agricultural and open space uses.  
17    The major crops are tomatoes, alfalfa, wine grapes, rice, seed crops, almonds,  
18    organic production, walnuts, cattle, and wheat (Yolo County 2009).

19    The 59,000-acre Yolo Bypass is primarily located within Yolo County and  
20    includes a portion of the Sacramento River Flood Control Project, as described in  
21    Chapter 5, Surface Water Resources and Water Supplies (CALFED et al. 2001).  
22    The upper section of the Yolo Bypass is defined as the area between Fremont  
23    Weir and Interstate 80 and is located within Yolo County. The lower section is  
24    defined as the area between Interstate 80 and the southern boundary of Egbert  
25    Tract at the Sacramento River. The portion of the southern area located to the  
26    north of the upper Holland Tract and upper Liberty Island is within Yolo County.  
27    In the northern area, agricultural crops include rice, corn, and safflower with  
28    melons and tomatoes planted in years when the bypass is not inundated with flood  
29    waters. The southern bypass crops include corn, milo, safflower, beans, and  
30    sudan grass. Approximately 16,770 acres in the southern Yolo Bypass is within  
31    the Yolo Bypass Wildlife Area (Yolo County 2009).

32    The portion of the Central Valley Region, Delta in Yolo County that could be  
33    affected by changes in CVP and/or SWP operations and evaluated in this EIS  
34    includes areas in the Yolo Bypass and along the Delta channels that use the  
35    surface waters (including agricultural lands), and CVP water service areas.

36    **13.3.2.3.2 Solano County**

37    Solano County encompasses approximately 910 square miles in northern  
38    California. It is bounded on the north by Yolo County, on the east by Sutter and  
39    Sacramento counties, on the south by Contra Costa County, and on the west by  
40    Napa County. Solano County includes federally owned lands within Travis Air  
41    Force Base (Solano County 2008). State lands include areas within Suisun Marsh  
42    and the Cache Slough area of Yolo Bypass.

1 Solano County's General Plan was adopted in 2008. Approximately 81,678 acres  
 2 of the county (14 percent of the total land area), lies within seven incorporated  
 3 cities: Benicia, Dixon, Fairfield, Rio Vista, Suisun City, Vacaville, and Vallejo.  
 4 Urban development is generally concentrated within the incorporated cities or  
 5 surrounding suburban communities. Travis Air Force Base is located on  
 6 approximately 7,100 acres (1 percent of the land within the county). In 2006,  
 7 agriculture accounted for 56.5 percent of the total land use in Solano County  
 8 (Solano County 2008). The southern section of the Yolo Bypass, as described  
 9 under the Yolo County subsection, is located within Solano County.

10 The portion of the Central Valley Region, Delta in Solano County that could be  
 11 affected by changes in CVP and/or SWP operations and evaluated in this EIS  
 12 includes SWP facilities (North Bay Aqueduct intakes at Barker Slough), areas in  
 13 the Yolo Bypass and along the Delta channels that use the surface waters  
 14 (including agricultural lands), and CVP and SWP water service areas.

### 15 **13.3.2.3.3 Tribal Lands in Delta and Suisun Marsh**

16 This section summarizes the tribal lands that could be affected by changes in CVP  
 17 and/or SWP operations and that are located within the county boundaries  
 18 described above.

#### 19 *Tribal Lands within the Boundaries of Yolo County*

20 Major federally recognized tribes and tribal lands within the boundaries of Yolo  
 21 County include lands of the Yocha Dehe Wintun Nation (previously called the  
 22 Rumsey Indian Rancheria of Wintun Indians of California) (Yolo County 2009).

### 23 **13.3.3 San Francisco Bay Area Region**

24 The San Francisco Bay Area Region includes portions of Napa, Contra Costa,  
 25 Alameda, Santa Clara, and San Benito counties that are within the CVP and SWP  
 26 service areas.

#### 27 **13.3.3.1.1 Napa County**

28 Napa County encompasses approximately 793 square miles in northern  
 29 California. It is bounded on the north by Lake County, on the east by Yolo  
 30 County, on the south by Solano County, and on the west by Sonoma County.  
 31 Napa County includes 62,865 acres of federally owned and 40,307 acres of state-  
 32 owned lands throughout the county, including approximately 28,000 acres related  
 33 to Lake Berryessa and the State Cedar Rough Wilderness and Wildlife Area  
 34 (Napa County 2007).

35 Approximately 479,000 acres (95 percent) of the county, are unincorporated. The  
 36 five incorporated cities include American Canyon, Calistoga, Napa, and  
 37 St. Helena, and the town of Yountville. Land use in the county is predominantly  
 38 agricultural (Napa County 2007, 2008).

39 The portion of the San Francisco Bay Area Region in Napa County that could be  
 40 affected by changes in CVP and/or SWP operations and evaluated in this EIS  
 41 includes SWP water service areas.

1     **13.3.3.1.2 Contra Costa County**

2     Contra Costa County encompasses approximately 805 square miles in northern  
3     California. It is bounded on the north by Solano and Sacramento counties, on the  
4     east by San Joaquin County, on the south by Alameda County, and on the west by  
5     San Francisco Bay. Contra Costa County includes federally owned and state-  
6     owned lands throughout the county, including approximately 20,000 acres within  
7     Mount Diablo State Park (Contra Costa County 2005).

8     Over 40 percent of the county’s land is in agricultural production, or about  
9     200,370 acres. Residential land is the second largest use in the county,  
10    encompassing approximately 122,100 acres (25.4 percent of the county).  
11    Approximately 46,700 acres (9 percent of the land within the county), are within  
12    surface waters (Contra Costa County 2005).

13    Residential development is concentrated in existing cities and adjacent  
14    unincorporated communities. The Contra Costa County incorporated cities  
15    include Antioch, Brentwood, Clayton, Danville, El Cerrito, Hercules, Lafayette,  
16    Martinez, Moraga, Oakley, Orinda, Pinole, Pleasant Hill, Pittsburg, Richmond,  
17    San Pablo, San Ramon, and Walnut Creek. The major unincorporated areas in the  
18    county include Alamo, Bethel Island, Byron, Crockett, Discovery Bay,  
19    Kensington, Knightsen, North Richmond, Pacheco, Port Costa, and Rodeo  
20    (Contra Costa County 2005). Portions of the cities of Pittsburg, Antioch, Oakley,  
21    and Brentwood and eastern Contra Costa County are located within the Delta.

22    The portion of the San Francisco Bay Area Region in Contra Costa County that  
23    could be affected by changes in CVP and/or SWP operations and evaluated in this  
24    EIS includes CVP facilities (including facilities associated with Rock Slough),  
25    areas along the Delta channels that use the surface waters (including agricultural  
26    lands), and CVP water service areas.

27    **13.3.3.1.3 Alameda County**

28    Alameda County encompasses approximately 738 square miles in northern  
29    California. It is bounded on the north by Contra Costa County, on the east by San  
30    Joaquin County, on the south by Santa Clara County, and on the west by San  
31    Francisco Bay. Alameda County includes federally owned and state-owned lands  
32    throughout the county (Alameda County 2009).

33    Western Alameda County and the portions of the Livermore-Amador Valley are  
34    heavily urbanized. The incorporated cities include Oakland, which is the County  
35    seat; Alameda, Albany, Berkeley, Dublin, Emeryville, Fremont, Hayward,  
36    Livermore, Newark, Piedmont, Pleasant, San Leandro, and Union City. The  
37    unincorporated area of the County covers approximately 277,760 acres  
38    (59 percent) of the total land area, includes the unincorporated areas of Castro  
39    Valley, Eden Area, and (Alameda County Community Development Agency  
40    2010; Alameda County 2000, 2009). Large portions of the unincorporated areas  
41    located to the east of Castro Valley and within the Livermore-Amador Valley hills  
42    include agricultural and open space lands which are not served by the CVP or  
43    SWP water supplies.

1 The portion of the San Francisco Bay Area Region in Alameda County that could  
 2 be affected by changes in CVP and/or SWP operations and evaluated in this EIS  
 3 includes CVP and SWP facilities (including the SWP South Bay Aqueduct),  
 4 reservoirs that store CVP or SWP water, and CVP and SWP water service areas.

#### 5 **13.3.3.1.4 Santa Clara County**

6 Santa Clara County encompasses approximately 1,306 square miles in northern  
 7 California. It is bounded on the north by Alameda County, on the east by  
 8 Stanislaus and Merced counties, on the south by San Benito County, and on the  
 9 west by San Mateo and Santa Cruz counties. Santa Clara County includes  
 10 federally owned and state-owned lands throughout the county, including  
 11 approximately 87,000 acres within Henry W. Coe State Park (Santa Clara County  
 12 1994, 2012).

13 Approximately 83 percent of the county's population resides in the  
 14 15 incorporated cities. The incorporated cities include Campbell, Cupertino,  
 15 Gilroy, Los Altos, Los Altos Hills, Los Gatos, Milpitas, Monte Sereno, Morgan  
 16 Hill, Mountain View, Palo Alto, San Jose, Santa Clara, Saratoga, and Sunnyvale.  
 17 The southern portion of the county near Gilroy and Morgan Hill is predominantly  
 18 rural, with low-density residential developments scattered though the valley and  
 19 foothill areas (Santa Clara County 1994, 2012).

20 The portion of the San Francisco Bay Area Region in Santa Clara County that  
 21 could be affected by changes in CVP and/or SWP operations and evaluated in this  
 22 EIS includes CVP and SWP facilities (including the SWP South Bay Aqueduct  
 23 and CVP facilities that convey water from San Luis Reservoir) and CVP and  
 24 SWP water service areas.

#### 25 **13.3.3.1.5 San Benito County**

26 San Benito County encompasses approximately 1,386 square miles in central  
 27 California. It is bounded on the north by Santa Clara County, on the east by  
 28 Merced and Fresno counties, and on the south and west by Monterey County.  
 29 San Benito County includes federally owned and state-owned lands throughout  
 30 the county, including approximately 26,000 acres within Pinnacles National  
 31 Monument, over 105,403 acres owned by Bureau of Land Management, and over  
 32 8,800 acres associated with the Hollister Hills State Vehicular Recreation Area  
 33 and San Juan Bautista State Historic Park (San Benito County 2010, 2013).

34 San Benito County has approximately 882,675 acres of unincorporated lands  
 35 (nearly 99.5 percent of the total land area). The incorporated cities of Hollister  
 36 and San Juan Bautista account for approximately 4,044 acres (0.5 percent of the  
 37 county land area). Agriculture is the predominant land use, totaling 747,409 acres  
 38 (84 percent of the county) (San Benito County 2010, 2013).

39 The portion of the San Francisco Bay Area Region in San Benito County that  
 40 could be affected by changes in CVP and/or SWP operations and evaluated in this  
 41 EIS includes CVP and SWP facilities (including San Justo Reservoir and other  
 42 facilities to convey water from San Luis Reservoir) and CVP water service areas.

1    **13.3.4    Central Coast Region**

2    The Central Coast Region includes portions of San Luis Obispo and Santa  
3    Barbara counties served by the SWP. Tribal lands are also described for the  
4    Central Coast Region.

5    **13.3.4.1    San Luis Obispo County**

6    San Luis Obispo County encompasses approximately 3,594 square miles in  
7    central California, including over 200,000 acres of surface waters (San Luis  
8    Obispo County 2013). It is bounded on the north by Monterey County, on the  
9    east by Kern County, on the south by Santa Barbara County, and on the west by  
10   the Pacific Ocean. Federally owned land in San Luis Obispo County includes  
11   Los Padres National Forest, Carizzo Plain National Monument, several wilderness  
12   areas, and Guadalupe-Nipomo Dunes National Wildlife Refuge. State-owned  
13   lands include Hearst-San Simeon State Historical Monument, Montano de Oro  
14   State Park, and state beaches and marine conservation areas.

15   Land uses in the County are predominantly rural and agricultural with over  
16   1,672,000 acres in agricultural and rural land uses (83 percent of the total county  
17   lands). Incorporated cities include Arroyo Grande, Atascadero, Grover Beach,  
18   Morro Bay, Paso Robles, Pismo Beach, and San Luis Obispo. Major  
19   unincorporated communities include Avila, California Valley, Creston Village,  
20   Edna Village, Heritage Ranch, Los Ranchos, Nipoma, Oak Shores, Oceano, San  
21   Miguel, Santa Margarita, and Templeton (San Luis Obispo County 2013).

22   The portion of the Central Coastal Region in San Luis Obispo County that could  
23   be affected by changes in CVP and/or SWP operations and evaluated in this EIS  
24   includes SWP facilities (including facilities associated with the Central Coast  
25   Water Authority) and SWP water service areas.

26   **13.3.4.2    Santa Barbara County**

27   Santa Barbara County encompasses approximately 2,744 square miles in central  
28   California. It is bounded on the north by San Luis Obispo, on the east by Ventura  
29   County, and on the south and west by the Pacific Ocean. Federally owned land in  
30   Santa Barbara County includes 629,120 acres in the Los Padres National Forest,  
31   98,560 acres in the Vandenberg Air Force Base, Channel Islands National Park,  
32   and Guadalupe-Nipomo Dunes National Wildlife Refuge. The state-owned lands  
33   include the University of California at Santa Barbara, Sedgwick Reserve, La  
34   Purissima Mission State Park and other state parks, and Burton Mesa Ecological  
35   Reserve (Santa Barbara County 2009; SBCAG 2013).

36   Agricultural is the predominant land use in the county with over 1,440,000 acres  
37   (82 percent of the land) (Santa Barbara County 2009; SBCAG 2013). Santa  
38   Barbara County includes eight incorporated cities, Buellton, Carpinteria, Goleta,  
39   Guadalupe, Lompoc, Santa Barbara, Santa Maria, and Solvang. Less than  
40   3 percent of the County is within incorporated cities. The major unincorporated  
41   communities include Cuyuama, Los Alamos, Los Olivos, Mission Hills,  
42   Montecito, New Cayamu, Orcutt, Summerland, and Vandenberg Village. The  
43   portion of the Central Coastal Region, in Santa Barbara County, that could be

1 affected by changes in CVP and/or SWP operations and evaluated in this EIS  
2 includes SWP facilities (including facilities associated with the Central Coast  
3 Water Authority), recreation facilities at Cachuma Lake that stores SWP water,  
4 and SWP water service areas.

#### 5 **13.3.4.3 Tribal Lands in Central Coast Region**

6 This section summarizes the tribal lands that could be affected by changes in CVP  
7 and/or SWP operations and that are located within the county boundaries  
8 described above.

##### 9 *Tribal Lands within the Boundaries of Santa Barbara County*

10 Major federally recognized tribes and tribal lands within the boundaries of Santa  
11 Barbara County include the Santa Ynez Reservation, which is home to the Santa  
12 Ynez Band of Chumash Mission Indians of the Santa Ynez Reservation near  
13 Santa Barbara (SDSU 2013).

#### 14 **13.3.5 Southern California Region**

15 The Southern California Region includes portions of Ventura, Los Angeles,  
16 Orange, San Diego, Riverside, and San Bernardino counties served by the SWP.  
17 Tribal lands are also described for the Southern California Region.

##### 18 **13.3.5.1 Ventura County**

19 Ventura County encompasses approximately 1,873 square miles in southern  
20 California. It is bounded on the north by Kern County, on the east and south by  
21 Los Angeles County, and on the west by Santa Barbara County and the Pacific  
22 Ocean. Ventura County includes federally owned and state-owned lands  
23 throughout the county, including 550,211 acres in Los Padres National Forest,  
24 Chumash and Sespe wilderness area, 4,331 acres at the Point Mugu Naval Air  
25 Station, 670 acres at the California State University Channel Islands, and over  
26 410 acres in state beach parks (Ventura County 2013).

27 Ventura County has 10 incorporated cities, including Camarillo, Fillmore,  
28 Moorpark, Ojai, Oxnard, Port Hueneme, Santa Paula, San Buenaventura, Simi  
29 Valley, and Thousand Oaks (Ventura County 2013). Major unincorporated  
30 communities within the county include Bell Canyon, Box Canyon, Camarillo  
31 Heights, Del Norte, El Rio, Hidden Valley, Lake Sherwood, Matilija Canyon,  
32 Montalvo, Oak Park, Ojai Valley, Piru, Saticoy, and Somis (Ventura County  
33 2005).

34 The portion of the Southern California Region in Ventura County that could be  
35 affected by changes in CVP and/or SWP operations and evaluated in this EIS  
36 includes recreation at Lake Piru that stores SWP water, and SWP water service  
37 areas.

##### 38 **13.3.5.2 Los Angeles County**

39 Los Angeles County encompasses approximately 4,083 square miles in northern  
40 California. It is bounded on the north by Kern County, on the east by San  
41 Bernardino County, on the south by Orange County, and on the west by Ventura

1 County and the Pacific Ocean. Los Angeles County includes federally owned and  
2 state-owned lands throughout the county, including nearly 650,000 acres in Los  
3 Padres and Angeles national forests, portions of Edwards Air Force Base, over  
4 29,000 acres of other federally owned open space (including wilderness areas),  
5 and approximately 50,893 acres of state-owned land, including Hungry Valley  
6 State Vehicular Recreation Area (Los Angeles County 2011).

7 More than half of Los Angeles County's 1,698,240 acres of unincorporated land  
8 area is designated a natural resources land use category. The next highest land  
9 use is rural, which accounts for 39 percent of the unincorporated areas, followed  
10 by residential, which accounts for 3 percent of the unincorporated areas. The  
11 remaining land area is in the county's 88 incorporated cities, the most populous of  
12 which is the City of Los Angeles (Los Angeles County 2012). The County has  
13 approximately 140 unincorporated areas (Los Angeles County 2014).

14 The portion of the Southern California Region in Los Angeles County that could  
15 be affected by changes in CVP and/or SWP operations and evaluated in this EIS  
16 includes SWP facilities and SWP water service areas.

#### 17 **13.3.5.3 Orange County**

18 Orange County encompasses 948 square miles in southern California. It is  
19 bounded on the north by Los Angeles County, on the east by San Bernardino and  
20 Riverside counties, on the south by San Diego County, and on the west by the  
21 Pacific Ocean. Orange County includes federally owned lands, including lands in  
22 the Cleveland National Forests.

23 Orange County has 34 incorporated cities in Orange County. The unincorporated  
24 lands cover approximately 192,758 acres (Orange County 2005). Land zoned as  
25 open space forms the largest land use type (143,313 acres).

26 The portion of the Southern California Region in Orange County that could be  
27 affected by changes in CVP and/or SWP operations and evaluated in this EIS  
28 includes SWP facilities and SWP water service areas.

#### 29 **13.3.5.4 San Diego County**

30 San Diego County encompasses approximately 4,525 square miles in southern  
31 California. It is bounded on the north by Orange and Riverside counties, on the  
32 east by Imperial County, on the south by Mexico, and on the west by the Pacific  
33 Ocean. San Diego County includes federally owned land, including Camp  
34 Pendleton Marine Corps Base, Cleveland National Forest, and San Diego and  
35 San Diego national wildlife refuges. State-owned lands throughout the county,  
36 includes Cuyamaca Rancho State Park, Anza-Borrego Desert State Park, Felipe  
37 Wildlife Area, and Ocotillo Wells State Vehicular Recreation Area (San Diego  
38 County 2011).

39 The incorporated cities include Carlsbad, Chula Vista, Coronado, Del Mar,  
40 El Cajon, Encinitas, Escondido, Imperial Beach, La Mesa, Lemon Grove,  
41 National City, Oceanside, Poway, San Marcos, Santee, Solano Beach, and Vista  
42 San Diego (San Diego County 2011). The unincorporated communities include  
43 Lakeside, Ramona, San Dieguito, Spring Valley, and Valle de Oro.

1 The portion of the Southern California Region in San Diego County that could be  
 2 affected by changes in CVP and/or SWP operations and evaluated in this EIS  
 3 includes SWP facilities, non-SWP reservoirs that store SWP water (including  
 4 Dixon Lake; and San Vicente, Lower Otay, and Sweetwater Reservoir), and CVP  
 5 water service areas.

6 **13.3.5.5 Riverside County**

7 Riverside County encompasses approximately 7,295 square miles in southern  
 8 California. It is bounded on the north by San Bernardino County, on the east by  
 9 the state of Nevada, on the south by San Diego and Imperial counties, and on the  
 10 west by Orange County. Riverside County includes federally owned lands  
 11 throughout the county, including March Air Reserve Base, Chocolate Mountains  
 12 Naval Gunnery Range, Joshua Tree National Park, San Bernardino and Cleveland  
 13 national forests, numerous wilderness areas, and Coachella Valley National  
 14 Wildlife Refuge; and state-owned lands including San Jacinto and Santa Rose  
 15 wildlife areas and Mount San Jacinto State Park (RCIP 2000).

16 Residential land use accounts for approximately 184,000 acres, nearly 57 percent  
 17 of which are within incorporated cities. Approximately 1,313,000 acres  
 18 (28 percent) is in open space, recreation, agriculture, and wildland preservation  
 19 (RCIP 2000).

20 Most of the population is concentrated in the 24 incorporated cities of Banning,  
 21 Beaumont, Calimesa, Canyon Lake, Cathedral City, Coachella, Corona, Desert  
 22 Hot Springs, Hemet, Indian Wells, Indio, Lake Elsinore, La Quinta, Moreno  
 23 Valley, Murrieta, Norco, Palm Desert, Palm Springs, Perris, Rancho Mirage,  
 24 Riverside, San Jacinto, and Temecula. The major unincorporated communities in  
 25 the county include Banning Bench, Bermuda Dunes, Cabazon, Cherry Valley,  
 26 Cleveland Ridge, Desert Center, Eagle Mountain, El Cerrito, Lakeview/Nuevo,  
 27 Meadowbrook, Mecca, Menifee Valley, North Palm Springs, Ripley, Sun City,  
 28 Temescal Canyon, Tenaja, Thermal, Thousand Palms, Warm Springs, and  
 29 Wildomar.

30 The portion of the Southern California Region in Riverside County that could be  
 31 affected by changes in CVP and/or SWP operations and evaluated in this EIS  
 32 includes SWP facilities, reservoirs that store SWP water (including Diamond  
 33 Valley Lake and Lake Skinner), and SWP water service areas.

34 **13.3.5.6 San Bernardino County**

35 San Bernardino County encompasses approximately 20,106 square miles in  
 36 southern California. It is bounded on the north by Inyo County, on the east by the  
 37 state of Nevada, on the south by Riverside County, and on the west by Kern, Los  
 38 Angeles, and Orange counties. Most of the land in San Bernardino County is  
 39 federally owned and state-owned lands, including approximately 10,500,000 acres  
 40 (81 percent of the county) (San Bernardino County 2007, 2012). The federally  
 41 owned lands include 28 Bureau of Land Management wilderness areas  
 42 (approximately 47 percent of the total county), San Bernardino and Angeles  
 43 National Forests (676,666 and 655,387 acres, respectively), Mojave National



1 Preserve, Joshua Tree and Death Valley National Parks, and four military bases  
2 (Edwards Air Force Base, Twentynine Palms Marine Corps Air Ground Combat  
3 Training Center, Fort Irwin, and China Lake Naval Weapons Center). State-  
4 owned lands include Silverwood Lake State Recreation Area at the SWP  
5 reservoir, Wildwood Canyon State Park, and Providence Mountain and Chino  
6 Hills state recreation areas.

7 San Bernardino County includes 24 incorporated cities, including Adelanto,  
8 Apple Valley, Barstow, Big Bear Lake, Chino, Chino Hills, Colton, Fontana,  
9 Grand Terrace, Hesperia, Highland, Loma Linda, Montclair, Needles, Ontario,  
10 Rancho Cucamonga, Redlands, Rialto, San Bernardino, Twentynine Palms,  
11 Upland, Victorville, Yucaipa, and Yucca Valley. Major unincorporated  
12 communities in the county include Amboy, Baker, Bear Valley, Bloomington,  
13 Crest Forest, Earp, Essex, Fontana suburbs, Goffs, Harvard, Havasu Lake,  
14 Helendale, Hilltop, Hinckley, Homestead Valley, Joshua Tree, Kelso, Kramer  
15 Junction, Lake Arrowhead, Landers, Lucerne Valley, Ludlow, Lytle Creek,  
16 Mentone, Moronga Valley, Muscoy, Newberry Springs, Nipton, Oak Glen, Oak  
17 Hills, Parker, Phelan/Pinon Hills, Pioneertown, Red Mountain, Rimrock, Silver  
18 Lake, Trona, Vidal, and Yerno.

19 The portion of the Southern California Region in San Bernardino County that  
20 could be affected by changes in CVP and/or SWP operations and evaluated in this  
21 EIS includes SWP water service areas.

22 **13.3.5.7 Tribal Lands in Southern California Region**

23 This section summarizes the tribal lands that could be affected by changes in CVP  
24 and/or SWP operations and that are located within the county boundaries  
25 described above.

26 *Tribal Lands within the Boundaries of San Diego County*

27 Major federally recognized tribes and tribal lands within the boundaries of  
28 San Diego County includes lands of the Capitan Grande Band of Diegueno  
29 Mission Indians of California (Barona Reservation and Viejas Reservation),  
30 Cahuilla Band of Mission Indians of the Cahuilla Reservation, Campo Band of  
31 Diegueno Mission Indians of the Campo Indian Reservation, Ewiiapaayp Band  
32 of Kumeyaay Indians, Inaja Band of Diegueno Mission Indians of the Inaja and  
33 Cosmit Reservation, Jamul Indian Village of California, La Jolla Band of Luiseno  
34 Indians, La Posta Band of Diegueno Mission Indians of the La Posta Indian  
35 Reservation, Los Coyotes Band of Cahuilla and Cupeno Indians, Manzanita Band  
36 of Diegueno Mission Indians of the Manzanita Reservation, Mesa Grade Band of  
37 Diegueno Mission Indians of the Mesa Grande Reservation, Pala Band of Luiseno  
38 Mission Indians of the Pala Reservation, Pauma Band of Luiseno Mission Indians  
39 of the Pauma & Yuima Reservation, Rincon Band of Luiseno Indians of the  
40 Rincon Reservation, San Pasqual Band of Diegueno Mission Indians of  
41 California, Iipay Nation of Santa Ysabel, and Sycuan Band of Kumeyaay Nation.

1 *Tribal Lands within the Boundaries of Riverside County*  
 2 Major federally recognized tribes and tribal lands within the boundaries of  
 3 Riverside County include lands of the Agua Caliente Band of Cahuilla Indians of  
 4 the Agua Caliente Reservation, Augustine Band of Cahuilla Indians, Cabazon  
 5 Band of Mission Indians, Cahuilla Band of Mission Indians of the Cahuilla  
 6 Reservation, Morongo Band of Mission Indians, Pechanga Band of Luiseno  
 7 Mission Indians of the Pechanga Reservation, Ramona Band of Cahuilla, Santa  
 8 Rosa Band of Cahuilla Indians, Soboba Band of Luiseno Indians, Torres-Martinez  
 9 Desert Cahuilla Indians, Twenty-Nine Palms Band of Mission Indians of  
 10 California, and Colorado River Indian Tribes of the Colorado River Indian  
 11 Reservation (RCIP 2000).

12 *Tribal Lands within the Boundaries of San Bernardino County*  
 13 Major federally recognized tribes and tribal lands within the boundaries of San  
 14 Bernardino County include the lands of the San Manual Band of Mission Indians  
 15 and the Twenty-Nine Palms Band of Mission Indians of California (SDSU 2013).  
 16 The Chemehuevi Indian Tribe of the Chemehuevi Reservation is also located in  
 17 San Bernardino County near the Colorado River.

## 18 **13.4 Impact Analysis**

19 This section describes the potential mechanisms for change in non-agricultural  
 20 land uses and analytical methods; results of the impact analysis; potential  
 21 mitigation measures; and potential cumulative effects.

### 22 **13.4.1 Potential Mechanisms for Change and Analytical Tools**

23 As described in Chapter 4, Approach to Environmental Analysis, the  
 24 environmental consequences assessment considers changes in non-agricultural  
 25 land uses related to changes in CVP and SWP operations under the alternatives as  
 26 compared to the No Action Alternative and Second Basis of Comparison.

#### 27 **13.4.1.1 Changes in Land Uses**

28 Land uses in 2030 are assumed to be consistent with the future projections  
 29 included in existing general plans. The general plans were developed assuming  
 30 adequate water supplies to support the projected lands uses. Changes in CVP and  
 31 SWP operations under the No Action Alternative and Alternatives 1 through 5  
 32 could change the availability of CVP and SWP water supplies. If the CVP and  
 33 SWP water supplies were reduced as compared to the No Action Alternative and  
 34 Second Basis of Comparison to a level that would not support planned municipal  
 35 and industrial water demands, development of future land uses may not occur.  
 36 Potential changes to agricultural land uses are described in Chapter 12,  
 37 Agricultural Resources.

38 Availability of CVP and SWP water supplies were analyzed using CalSim II  
 39 model output (see Chapter 5, Surface Water Resources and Water Supplies).  
 40 Most of the CVP and SWP municipal and industrial water users prepared Urban

1 Water Management Plans (UWMPs) that project availability of water supplies to  
2 support land uses in 2030. That information was used with projected CVP and  
3 SWP water supply availability under each of the alternatives to determine if  
4 projected municipal and industrial water demands could be met in 2030 using the  
5 CWEST model, as described in Chapter 19, Socioeconomics. The results of the  
6 CWEST model indicated that municipal and industrial water demands of CVP  
7 and SWP water users in the Central Valley, San Francisco Bay Area, Central  
8 Coast, and Southern California regions would be met through a combination of  
9 water conservation, available CVP and SWP water supplies, local and regional  
10 surface water supplies, groundwater, recycled water, and, in some cases,  
11 desalination.

12 Alternative 4 includes provisions for floodway development regulations. It is  
13 assumed that under the No Action Alternative and Alternatives 1 through 5,  
14 existing programs to protect floodways would continue to be implemented,  
15 including Federal and state requirements as implemented by the U.S. Army Corps  
16 of Engineers (USACE), Central Valley Flood Protection Board, and Department  
17 of Water Resources (DWR). Within the Delta, the floodways are further  
18 regulated by the Delta Protection Commission and Delta Stewardship Council to  
19 preserve and protect the natural resources of the Delta; and prevent encroachment  
20 into Delta floodways, including the Delta Stewardship Council's recently adopted  
21 Delta Plan. These regulations would continue to be implemented in the No  
22 Action Alternative, Alternatives 1 through 5, and the Second Basis of  
23 Comparison. Therefore, future development would be prevented from occurring  
24 within the Delta floodplains and floodways; and in the Sacramento, Feather,  
25 American, and San Joaquin river corridors upstream of the Delta. Provisions in  
26 Alternative 4 would require additional setbacks along the floodways as compared  
27 to other alternatives and the Second Basis of Comparison. The potential change  
28 in land use is analyzed qualitatively in this chapter.

29 The No Action Alternative, Alternatives 1 through 5, and Second Basis of  
30 Comparison include restoration of more than 10,000 acres of intertidal and  
31 associated subtidal wetlands in Suisun Marsh and Cache Slough; 17,000 to  
32 20,000 acres of seasonal floodplain restoration in the Yolo Bypass; and continued  
33 delivery of refuge water supplies under the Central Valley Project Improvement  
34 Act, as described in Chapter 3, Description of Alternatives. Land uses in 2030  
35 due to implementation of these programs would be consistent between all  
36 alternatives and the Second Basis of Comparison. Therefore, this EIS does not  
37 analyze changes due to these programs.

#### 38 **13.4.1.2 Effects Related to Cross Delta Water Transfers**

39 Cross Delta water transfers involving the CVP and SWP facilities or water  
40 supplies would be required to be implemented in accordance with all existing  
41 regulations and requirements, including not causing adverse impacts to other  
42 water users in accordance with the requirements of Reclamation, DWR, and the  
43 State Water Resources Control Board. It is anticipated that water transfers would  
44 continue under all alternatives to provide water supplies to agricultural, municipal  
45 and industrial, and wildlife refuges under all alternatives and the Second Basis of

1 Comparison in a similar manner. Transfers for municipal and industrial water  
 2 users would be one of several water supply sources to meet the future water  
 3 demands in Year 2030. If the availability of transferred water is reduced, it is  
 4 anticipated that other water supplies (e.g., recycled water and desalination) would  
 5 be increased, as described in the UWMPs for 2030 water demands.

6 Reclamation recently prepared a long-term regional water transfer environmental  
 7 document which evaluated potential changes in surface water conditions related to  
 8 water transfer actions (Reclamation 2014c). Results from this analysis were used  
 9 to inform the impact assessment of potential effects of water transfers under the  
 10 alternatives as compared to the No Action Alternative and the Second Basis of  
 11 Comparison. The analysis indicated that water transfers would not result in  
 12 changes to non-agricultural land uses.

13 Under all of the alternatives and Second Basis of Comparison, it is assumed that  
 14 these transfers would continue to occur each year to meet the water demands in  
 15 the existing general plans. It is not anticipated that water transfers would change  
 16 municipal and industrial land uses as defined in the existing general plans. If a  
 17 water transfer program was implemented for the purposes of changing existing  
 18 general plan land uses, separate environmental documentation would be required  
 19 for the changes to the general plan and the water transfer. Potential effects due to  
 20 Cross Delta water transfers on agricultural land uses are described in  
 21 Chapter 12, Agricultural Resources. Therefore, this chapter does not include  
 22 separate analyses of changes in municipal and industrial land uses due to cross  
 23 Delta water transfers.

#### 24 **13.4.2 Conditions in Year 2030 without Implementation of** 25 **Alternatives 1 through 5**

26 This EIS includes two bases of comparison (described in Chapter 3, Description  
 27 of Alternatives): the No Action Alternative and the Second Basis of Comparison.  
 28 Both of these bases are evaluated at 2030 conditions.

##### 29 **13.4.2.1 No Action Alternative**

30 The impact analysis in this EIS is based upon the comparison of the alternatives to  
 31 the No Action Alternative and the Second Basis of Comparison in the Year 2030.  
 32 Many of the changed conditions would occur in the same manner under both the  
 33 No Action Alternative and the Second Basis of Comparison (e.g., climate change,  
 34 sea level rise, projected development under existing general plans, and  
 35 implementation of reasonable and foreseeable projects). Due to these changes,  
 36 especially climate change and sea level rise, it is anticipated that CVP and SWP  
 37 water supply availability would be less than under recent conditions (described in  
 38 Chapter 5, Surface Water Resources and Water Supplies). However, it is  
 39 anticipated that projected land uses would occur by 2030 with implementation of  
 40 water conservation programs and the development of other water supplies,  
 41 including ongoing recycled water programs, desalination, and groundwater use.

1 By 2030 under the No Action Alternative and the Second Basis of Comparison, it  
2 is assumed that ongoing programs would result in restoration of more than  
3 10,000 acres of intertidal and associated subtidal wetlands in Suisun Marsh and  
4 Cache Slough; and 17,000 to 20,000 acres of seasonal floodplain restoration in the  
5 Yolo Bypass.

6 Under the No Action Alternative and the Second Basis of Comparison, land uses  
7 in 2030 would occur in accordance with the general plans for counties and cities  
8 within the Central Valley Region; tribal lands; and regulations of state and  
9 regional agencies, including Central Valley Flood Protection Board, Delta  
10 Protection Commission, and Delta Stewardship Council.

11 Development along the river corridors in the Central Valley would continue to be  
12 limited by the state regulations to protect floodways. The Central Valley Flood  
13 Protection Board adopts floodway boundaries and approves uses within those  
14 floodways (DWR 2010). Various uses are permitted in the floodways, such as  
15 agriculture, canals, low dikes and berms, parks and parkways, golf courses, sand  
16 and gravel mining, structures that will not be used for human habitation, and other  
17 facilities and activities that will not be substantially damaged by the base flood  
18 event and will not cause adverse hydraulic impacts that will raise the water  
19 surface in the floodway.

20 Within the Delta, future development also is subject to the requirements of the  
21 Delta Protection Commission and Delta Stewardship Council. The general plans  
22 within the Delta are required by state laws to be consistent with the Delta  
23 Protection Commission's *Land Use and Resource Management Plan for the*  
24 *Primary Zone of the Delta* (DPC 2010; OAL 2010), which does not allow  
25 development within the Primary Zone of the Delta unless proponents can  
26 demonstrate that implementing their projects would preserve and protect natural  
27 resources of the Delta, promote protection of remnants of riparian and aquatic  
28 habitat, not result in loss of wetlands or riparian habitat, would not degrade water  
29 quality, would not interfere with migratory birds or public access, would not harm  
30 agricultural operations, and would not degrade levees or expose the public to  
31 increased flood hazards. Farmers are encouraged to implement management  
32 practices to maximize habitat values for migratory birds and wildlife.

33 The Delta Plan adopted by the Delta Stewardship Council in May 2013 included a  
34 policy that protects floodways within the entire Delta that are not regulated by  
35 other Federal or state agencies (23 California Code of Regulations Section 5014).  
36 This policy prevents encroachment into floodways that would impede the free  
37 flow of water in the floodway or jeopardize public safety.

### 38 **13.4.3 Evaluation of Alternatives**

39 As described in Chapter 4, Approach to Environmental Analysis, Alternatives 1  
40 through 5 have been compared to the No Action Alternative; and the No Action  
41 Alternative and Alternatives 1 through 5 have been compared to the Second Basis  
42 of Comparison.

1 During review of the numerical modeling analyses used in this EIS, an error was  
 2 determined in the CalSim II model assumptions related to the Stanislaus River  
 3 operations for the Second Basis of Comparison, Alternative 1, and Alternative 4  
 4 model runs. Appendix 5C includes a comparison of the CalSim II model run  
 5 results presented in this chapter and CalSim II model run results with the error  
 6 corrected. Appendix 5C also includes a discussion of changes in the comparison  
 7 of the following alternative analysis:

- 8 • No Action Alternative compared to the Second Basis of Comparison
- 9 • Alternative 1 compared to the No Action Alternative
- 10 • Alternative 3 compared to the Second Basis of Comparison
- 11 • Alternative 5 compared to the Second Basis of Comparison.

#### 12 **13.4.3.1 No Action Alternative**

13 As described in Chapter 4, Approach to Environmental Analysis, the No Action  
 14 Alternative is compared to the Second Basis of Comparison.

##### 15 **13.4.3.1.1 Changes in Land Use**

16 No municipal and industrial land uses in the Trinity River Region are served by  
 17 CVP and SWP water supplies. Therefore, the municipal and industrial land uses  
 18 would be the same under the No Action Alternative and the Second Basis of  
 19 Comparison in the Trinity River Region.

20 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
 21 and SWP water deliveries to municipal and industrial Sacramento River Water  
 22 Rights Settlement Contractors and water rights holders would be similar under the  
 23 No Action Alternative and the Second Basis of Comparison. CVP water  
 24 deliveries to water service contractors over the long-term conditions would be  
 25 6 percent less for the North of Delta water users and 10 percent less for the South  
 26 of Delta users under the No Action Alternative, compared to the Second Basis of  
 27 Comparison. SWP water deliveries to water contractors over the long-term  
 28 conditions (without Article 21 water) would be reduced by 18 percent throughout  
 29 the SWP service area under the No Action Alternative, compared to the Second  
 30 Basis of Comparison. However, as described in Chapter 19, Socioeconomics,  
 31 2030 municipal and industrial water demands would be met through a  
 32 combination of available CVP and SWP water supplies and other water supplies,  
 33 including water conservation, water transfers, local and regional surface water and  
 34 groundwater, recycled water, and desalination. Adequate water supplies would be  
 35 available to support future municipal and industrial land uses projected in existing  
 36 general plans under the No Action Alternative and the Second Basis of  
 37 Comparison. Therefore, land use in 2030 would be the same under the No Action  
 38 Alternative and the Second Basis of Comparison in the Trinity River, Central  
 39 Valley, San Francisco Bay Area, Central Coast, and Southern California regions.

##### 40 **13.4.3.2 Alternative 1**

41 Alternative 1 is identical to the Second Basis of Comparison. Alternative 1 is  
 42 compared to the No Action Alternative and the Second Basis of Comparison.  
 43 However, because land use conditions under Alternative 1 are identical to land

1 use conditions under the Second Basis of Comparison, Alternative 1 is only  
2 compared to the No Action Alternative.

### 3 **13.4.3.2.1 Alternative 1 Compared to the No Action Alternative**

#### 4 *Change in Land Use*

5 No municipal and industrial land uses in the Trinity River Region are served by  
6 CVP and SWP water supplies. Therefore, the municipal and industrial land uses  
7 would be the same under Alternative 1 and the No Action Alternative in the  
8 Trinity River Region.

9 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
10 and SWP water deliveries to municipal and industrial Sacramento River Water  
11 Rights Settlement Contractors and water rights holders would be similar under  
12 Alternative 1 and the No Action Alternative. CVP water deliveries to water  
13 service contractors over the long-term conditions would be 7 percent greater for  
14 the North of Delta water users and 11 percent greater for the South of Delta users  
15 under Alternative 1 as compared to the No Action Alternative. SWP water  
16 deliveries to water contractors over the long-term conditions (without Article 21  
17 water) would be increased by 22 percent under Alternative 1 as compared to the  
18 No Action Alternative. The increased CVP and SWP water supply availability  
19 would allow water users to reduce other water supplies, including groundwater. It  
20 is anticipated that the additional water supplies would not result in changes in the  
21 general plan development plans without subsequent environmental  
22 documentation. Adequate water supplies would be available to support future  
23 municipal and industrial land uses projected in existing general plans under  
24 Alternative 1 and the No Action Alternative. Therefore, land use in 2030 would  
25 be the same under Alternative 1 and the No Action Alternative in the Trinity  
26 River, Central Valley, San Francisco Bay Area, Central Coast, and Southern  
27 California regions.

### 28 **13.4.3.2.2 Alternative 1 Compared to the Second Basis of Comparison**

29 Alternative 1 is identical to the Second Basis of Comparison.

### 30 **13.4.3.3 Alternative 2**

31 The land use conditions under Alternative 2 would be identical to the conditions  
32 under the No Action Alternative; therefore, Alternative 2 is only compared to the  
33 Second Basis of Comparison.

### 34 **13.4.3.3.1 Alternative 2 Compared to the Second Basis of Comparison**

35 Changes to land use under Alternatives 2 as compared to the Second Basis of  
36 Comparison would be the same as the impacts described in Section 13.4.3.1,  
37 No Action Alternative.

### 38 **13.4.3.4 Alternative 3**

39 The CVP and SWP operations under Alternative 3 are similar to the Second Basis  
40 of Comparison with modified Old and Middle River flow criteria and New  
41 Melones Reservoir operations.

1 Alternative 3 would include changed water demands for American River water  
 2 supplies as compared to the No Action Alternative or Second Basis of  
 3 Comparison. Alternative 3 would provide water supplies of up to 17 thousand  
 4 acre feet (TAF)/year under a Warren Act Contract for El Dorado Irrigation  
 5 District and 15 TAF/year under a CVP water service contract for El Dorado  
 6 County Water Agency. These demands are not included in the analysis presented  
 7 in this section of the EIS. A sensitivity analysis comparing the results of the  
 8 analysis with and without these demands is presented in Appendix 5B of this EIS.

#### 9 **13.4.3.4.1 Alternative 3 Compared to the No Action Alternative**

##### 10 *Changes in Land Use*

11 No municipal and industrial land uses in the Trinity River Region are served by  
 12 CVP and SWP water supplies. Therefore, the municipal and industrial land uses  
 13 would be the same under Alternative 3 and the No Action Alternative in the  
 14 Trinity River Region.

15 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
 16 and SWP water deliveries to municipal and industrial Sacramento River Water  
 17 Rights Settlement Contractors and water rights holders would be similar under  
 18 Alternative 3 and the No Action Alternative. CVP water deliveries to water  
 19 service contractors over the long-term conditions would be similar for the North  
 20 of Delta water users and 9 percent greater for the South of Delta users under  
 21 Alternative 3, compared to the No Action Alternative. SWP water deliveries to  
 22 water contractors over the long-term conditions (without Article 21 water) would  
 23 be increased by 17 percent under Alternative 3, compared to the No Action  
 24 Alternative. The increased CVP and SWP water supply availability would allow  
 25 water users to reduce other water supplies, including groundwater. It is  
 26 anticipated that the additional water supplies would not result in changes in the  
 27 general plan development plans without subsequent environmental  
 28 documentation. Adequate water supplies would be available to support future  
 29 municipal and industrial land uses projected in existing general plans under  
 30 Alternative 3 and the No Action Alternative. Therefore, land use in 2030 would  
 31 be the same under Alternative 3 and the No Action Alternative in the Trinity  
 32 River, Central Valley, San Francisco Bay Area, Central Coast, and Southern  
 33 California regions.

#### 34 **13.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison**

##### 35 *Changes in Land Use*

36 No municipal and industrial land uses in the Trinity River Region are served by  
 37 CVP and SWP water supplies. Therefore, the municipal and industrial land uses  
 38 would be the same under Alternative 3 and the Second Basis of Comparison in the  
 39 Trinity River Region.

40 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
 41 and SWP water deliveries to municipal and industrial Sacramento River Water  
 42 Rights Settlement Contractors and water rights holders would be similar under  
 43 Alternative 3 and the Second Basis of Comparison. CVP water deliveries to



1 water service contractors over the long-term conditions would be similar for the  
2 North of Delta water users and South of Delta users under Alternative 3 and the  
3 Second Basis of Comparison. SWP water deliveries to water contractors over the  
4 long-term conditions (without Article 21 water) would be similar under  
5 Alternative 3 and the Second Basis of Comparison. Adequate water supplies  
6 would be available to support future municipal and industrial land uses projected  
7 in existing general plans under Alternative 3 and the Second Basis of  
8 Comparison. Therefore, land use in 2030 would be the same under Alternative 3  
9 and the Second Basis of Comparison in the Trinity River, Central Valley, San  
10 Francisco Bay Area, Central Coast, and Southern California regions.

11 **13.4.3.5 Alternative 4**

12 The CVP and SWP operations under Alternative 4 are identical to the CVP and  
13 SWP operations under the Second Basis of Comparison and Alternative 1. Under  
14 Alternative 4, new development and substantial improvements would be  
15 prohibited within floodways or within 170 feet of the ordinary high water line of  
16 any floodway.

17 **13.4.3.5.1 Alternative 4 Compared to the No Action Alternative**

18 *Changes in Land Use*

19 The CVP and SWP operations under Alternative 4 are identical to the CVP and  
20 SWP operations under Alternative 1. Therefore, the land use conditions  
21 influenced by availability of CVP and SWP water supplies under Alternative 4  
22 would be the same as conditions under Alternative 1.

23 Under Alternative 4, new development and substantial improvements would be  
24 prohibited within floodways or within 170 feet of the ordinary high water line of  
25 any floodway. Development within floodways is currently prohibited in  
26 accordance with existing general plans and state and regional plans (e.g.,  
27 requirements of the Delta Protection Commission and Delta Stewardship  
28 Council). Structures that either cannot be moved before flood events or that  
29 would reduce the flood management function of the floodway are not allowed. It  
30 is anticipated that these requirements would continue to be implemented in 2030,  
31 to protect the floodways. However, Alternative 4 would include additional  
32 restrictions on new development within 170 feet of the ordinary high water line of  
33 any floodway. It is anticipated that the provisions under Alternative 4 could result  
34 in site-specific parcel changes as compared to the No Action Alternative.  
35 However, the development that would have occurred on these parcels could be  
36 incorporated within the general plan development plans and guidelines.  
37 Therefore, land use conditions under Alternative 4 would be similar to conditions  
38 under the No Action Alternative; and would be the same as the impacts described  
39 in Section 13.4.3.2.1, Alternative 1 Compared to the No Action Alternative.

1    **13.4.3.5.2 Alternative 4 Compared to the Second Basis of Comparison**

2    *Changes in Land Use*

3    The CVP and SWP operations under Alternative 4 are identical to the CVP and  
4    SWP operations under Second Basis of Comparison. Therefore, the land use  
5    conditions influenced by availability of CVP and SWP water supplies under  
6    Alternative 4 would be the same as conditions under the Second Basis of  
7    Comparison.

8    Under Alternative 4, new development and substantial improvements would be  
9    prohibited within floodways or within 170 feet of the ordinary high water line of  
10   any floodway. Development within floodways is currently prohibited in  
11   accordance with existing general plans and state and regional plans (e.g.,  
12   requirements of the Delta Protection Commission and Delta Stewardship  
13   Council). Structures that either cannot be moved prior to flood events or that  
14   would reduce the flood management function of the floodway are not allowed. It  
15   is anticipated that these requirements would continue to be implemented in 2030  
16   to protect the floodways. However, Alternative 4 would include additional  
17   restrictions on new development within 170 feet of the ordinary high water line of  
18   any floodway. It is anticipated that the provisions under Alternative 4 could result  
19   in site-specific parcel changes as compared to the Second Basis of Comparison.  
20   However, the development that would have occurred on these parcels could be  
21   incorporated within the general plan development plans and guidelines.  
22   Therefore, land use conditions under Alternative 4 would be identical to  
23   conditions under the Second Basis of Comparison.

24   **13.4.3.6 Alternative 5**

25   The CVP and SWP operations under Alternative 5 are similar to the No Action  
26   Alternative with modified Old and Middle River flow criteria and New Melones  
27   Reservoir operations.

28   Alternative 5 would include changed water demands for American River water  
29   supplies as compared to the No Action Alternative or Second Basis of  
30   Comparison. Alternative 5 would provide water supplies of up to 17 TAF/year  
31   under a Warren Act Contract for El Dorado Irrigation District and 15 TAF/year  
32   under a CVP water service contract for El Dorado County Water Agency. These  
33   demands are not included in the analysis presented in this section of the EIS. A  
34   sensitivity analysis comparing the results of the analysis with and without these  
35   demands is presented in Appendix 5B of this EIS.

36   **13.4.3.6.1 Alternative 5 Compared to the No Action Alternative**

37   *Changes in Land Use*

38   No municipal and industrial land uses in the Trinity River Region are served by  
39   CVP and SWP water supplies. Therefore, the municipal and industrial land uses  
40   would be the same under Alternative 5 and the No Action Alternative in the  
41   Trinity River Region.

1 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
2 and SWP water deliveries to municipal and industrial Sacramento River Water  
3 Rights Settlement Contractors and water rights holders would be similar under  
4 Alternative 5 and the No Action Alternative. CVP water deliveries to water  
5 service contractors over the long-term conditions would be similar for the North  
6 of Delta and South of Delta water users under Alternative 5, compared to the No  
7 Action Alternative. SWP water deliveries to water contractors over the long-term  
8 conditions (without Article 21 water) would be similar under Alternative 5,  
9 compared to the No Action Alternative. Adequate water supplies would be  
10 available to support future municipal and industrial land uses projected in existing  
11 general plans under Alternative 5 and the No Action Alternative. Therefore, land  
12 use in 2030 would be the same under Alternative 5 and the No Action Alternative  
13 in the Trinity River, Central Valley, San Francisco Bay Area, Central Coast, and  
14 Southern California regions.

#### 15 **13.4.3.6.2 Alternative 5 Compared to the Second Basis of Comparison**

##### 16 *Changes in Land Use*

17 No municipal and industrial land uses in the Trinity River Region are served by  
18 CVP and SWP water supplies. Therefore, the municipal and industrial land uses  
19 would be the same under Alternative 5 and the Second Basis of Comparison in the  
20 Trinity River Region.

21 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
22 and SWP water deliveries to municipal and industrial Sacramento River Water  
23 Rights Settlement Contractors and water rights holders would be similar under the  
24 No Action Alternative and the Second Basis of Comparison. CVP water  
25 deliveries to water service contractors over the long-term conditions would be  
26 similar for the North of Delta water users and 10 percent less for the South of  
27 Delta water users under Alternative 5 as compared to the Second Basis of  
28 Comparison. SWP water deliveries to water contractors over the long-term  
29 conditions (without Article 21 water) would be reduced by 19 percent throughout  
30 the SWP service area under the Alternative 5, compared to the Second Basis of  
31 Comparison. However, as described in Chapter 19, Socioeconomics, 2030  
32 municipal and industrial water demands would be met through a combination of  
33 available CVP and SWP water supplies and other water supplies, including water  
34 conservation, water transfers, local and regional surface water and groundwater,  
35 recycled water, and desalination. Adequate water supplies would be available to  
36 support future municipal and industrial land uses projected in existing general  
37 plans under Alternative 5 and the Second Basis of Comparison. Therefore, land  
38 use in 2030 would be the same under Alternative 5 and the Second Basis of  
39 Comparison in the Trinity River, Central Valley, San Francisco Bay Area, Central  
40 Coast, and Southern California regions.

#### 41 **13.4.3.7 Summary of Impact Analysis**

42 The results of the environmental consequences of implementation of  
43 Alternatives 1 through 5, compared to the No Action Alternative and the Second  
44 Basis of Comparison are presented in Tables 13.1 and 13.2.

1 **Table 13.1 Comparison of Alternatives 1 through 5 to No Action Alternative**

<b>Alternative</b>	<b>Potential Change</b>	<b>Consideration for Mitigation Measures</b>
Alternative 1	No effects to municipal and industrial and regional land uses	None needed
Alternative 2	No effects to municipal and industrial and regional land uses	None needed
Alternative 3	No effects to municipal and industrial and regional land uses	None needed
Alternative 4	No effects to municipal and industrial and regional land uses	None needed
Alternative 5	No effects to municipal and industrial and regional land uses	None needed

2 **Table 13.2 Comparison of No Action Alternative and Alternatives 1 through 5 to**  
 3 **Second Basis of Comparison**

<b>Alternative</b>	<b>Potential Change</b>	<b>Consideration for Mitigation Measures</b>
No Action Alternative	No effects to municipal and industrial and regional land uses	None needed
Alternative 1	No effects to municipal and industrial and regional land uses	None needed
Alternative 2	No effects to municipal and industrial and regional land uses	None needed
Alternative 3	No effects to municipal and industrial and regional land uses	None needed
Alternative 4	No effects to municipal and industrial and regional land uses	None needed
Alternative 5	No effects to municipal and industrial and regional land uses	None needed

4 **13.4.3.8 Potential Mitigation Measures**

5 Mitigation measures are presented in this section to avoid, minimize, rectify,  
 6 reduce, eliminate, or compensate for adverse environmental effects of  
 7 Alternatives 1 through 5, as compared to the No Action Alternative. Mitigation  
 8 measures were not included to address adverse impacts under the alternatives as  
 9 compared to the Second Basis of Comparison because this analysis was included  
 10 in this EIS for information purposes only.

11 Changes in CVP and SWP operations under Alternatives 1 through 5, compared  
 12 to the No Action Alternative, would not result in changes in municipal and  
 13 industrial land uses or regional lands use plans. Therefore, there would be no  
 14 adverse impacts to land use and no mitigation measures are required.

1 **13.4.3.9 Cumulative Effects Analysis**

2 As described in Chapter 3, Description of Alternatives, the cumulative effects  
 3 analysis considers projects, programs, and policies that are not speculative; and  
 4 are based upon known or reasonably foreseeable long-range plans, regulations,  
 5 operating agreements, or other information that establishes them as reasonably  
 6 foreseeable.

7 The cumulative effects analysis for Alternatives 1 through 5 for Land Use are  
 8 summarized in Table 13.3.

9 **Table 13.3 Summary of Cumulative Effects on Land Use with Implementation of**  
 10 **Alternatives 1 through 5 as Compared to the No Action Alternative**

Scenarios	Actions	Cumulative Effects of Actions
Past & Present, and Future Actions included in the No Action Alternative and all Alternatives in Year 2030	Consistent with Affected Environment conditions plus:  Actions in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives), including climate change and sea level rise  Actions not included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives):  <ul style="list-style-type: none"> <li>- Implementation of Federal and state policies and programs, including Clean Water Act (e.g., Total Maximum Daily Loads); Safe Drinking Water Act; Clean Air Act; and flood management programs</li> <li>- General plans for 2030.</li> <li>- Trinity River Restoration Program.</li> <li>- Central Valley Project Improvement Act programs</li> <li>- Iron Mountain Mine Superfund Site</li> <li>- Nimbus Fish Hatchery Fish Passage Project</li> <li>- Folsom Dam Water Control Manual Update</li> <li>- FERC Relicensing for the Middle Fork of the American River Project</li> <li>- Lower Mokelumne River Spawning Habitat Improvement Project</li> <li>- Dutch Slough Tidal Marsh Restoration</li> <li>- Suisun Marsh Habitat Management, Preservation, and Restoration Plan Implementation</li> <li>- Tidal Wetland Restoration: Yolo Ranch, Northern Liberty Island Fish</li> </ul>	<u>These effects would be the same under all alternatives.</u>  Community development would occur in accordance with general plan projections for 2030. Development within the Delta would be subject to the requirements of the Delta Protection Commission and Delta Stewardship Council.  Restoration plans for the ongoing programs would be completed. Development along river corridors in the Central Valley would continue to be limited by the state regulations to protect floodways.  Climate change and sea level rise, development under the general plans, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce availability of CVP and SWP water supplies as compared to past conditions.  Future water supply projects are anticipated to both increase water supply reliability due to reduced surface water supplies and to accommodate planned growth in the general plans. Most of these programs were initiated prior to implementation of the 2008 USFWS BO and 2009 NMFS BO which reduced CVP and SWP water supply reliability.

Scenarios	Actions	Cumulative Effects of Actions
	Restoration Project, Prospect Island Restoration Project, and Calhoun Cut/Lindsey Slough Tidal Habitat Restoration Project - San Joaquin River Restoration Program - Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects with completed environmental documents)	
Future Actions considered as Cumulative Effects Actions in All Alternatives in Year 2030	Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives): - Bay-Delta Water Quality Control Plan Update - FERC Relicensing Projects - Bay Delta Conservation Plan(including the California WaterFix alternative) - Shasta Lake Water Resources, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations - El Dorado Water and Power Authority Supplemental Water Rights Project - Sacramento River Water Reliability Project - Semitropic Water Storage District Delta Wetlands - North Bay Aqueduct Alternative Intake - San Luis Reservoir Low Point Improvement Project - Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects that did not have completed environmental documents during preparation of the EIS)	<p><u>These effects would be the same under all alternatives.</u></p> <p>Most of the reasonably foreseeable actions are anticipated to reduce water supply impacts due to climate change, sea level rise, increased water allocated to improve habitat conditions, and future growth.</p> <p>Some of the reasonably foreseeable actions related to improved water quality and habitat conditions (e.g., Water Quality Control Plan Update and FERC Relicensing Projects), could in further reductions in CVP and SWP water deliveries.</p>

Scenarios	Actions	Cumulative Effects of Actions
<p>No Action Alternative with Associated Cumulative Effects Actions in Year 2030</p>	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO</p>	<p>Community development would occur in accordance with general plan projections for 2030. Development within the Delta would be subject to the requirements of the Delta Protection Commission and Delta Stewardship Council.</p> <p>Restoration plans for the ongoing programs would be completed. Development along river corridors in the Central Valley would continue to be limited by the state regulations to protect floodways.</p> <p>Climate change and sea level rise, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce availability of CVP and SWP water supplies as compared to past conditions.</p> <p>Future water supply projects are anticipated to both increase water supply reliability due to reduced surface water supplies and to accommodate planned growth in the general plans.</p>
<p>Alternative 1 reasonably foreseeable actions in Year 2030</p>	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)</p>	<p>Implementation of Alternative 1 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.</p>
<p>Alternative 2 reasonably foreseeable actions in Year 2030</p>	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions No implementation of structural improvements or other actions that require further study to develop a more detailed action description.</p>	<p>Implementation of Alternative 2 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.</p>
<p>Alternative 3 reasonably foreseeable actions in Year 2030</p>	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant) Slight increase in positive Old and Middle River flows in the winter and spring months</p>	<p>Implementation of Alternative 3 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.</p>

Scenarios	Actions	Cumulative Effects of Actions
Alternative 4 reasonably foreseeable actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant) Increased restrictions for development within floodways.	Implementation of Alternative 4 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 5 reasonably foreseeable actions in Year 20530	Full implementation of the 2008 USFWS BO and 2009 NMFS BO Positive Old and Middle River flows and increased Delta outflow in spring months	Implementation of Alternative 5 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.

1

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## Chapter 14

# 1 Visual Resources

## 2 14.1 Introduction

3 This chapter describes the visual resources in the study area related to natural and  
4 artificial landscape features and potential changes that could occur as a result of  
5 implementing the alternatives evaluated in this Environmental Impact Statement  
6 (EIS). Implementation of the alternatives considered in this EIS could affect  
7 visual resources through changes in surface water elevations at Central Valley  
8 Project (CVP) and State Water Project (SWP) reservoirs and changes in land use  
9 related to potential changes in operation of the CVP and SWP and ecosystem  
10 restoration.

11 Changes in reservoir surface water elevations, agricultural resources, and land use  
12 are described in more detail in Chapter 5, Surface Water Resources and Water  
13 Supplies; Chapter 12, Agricultural Resources; and Chapter 13, Land Use,  
14 respectively.

### 15 14.1.1 Visual Effects

16 Natural and artificial landscape features contribute to perceived visual images and  
17 aesthetic values of views. The values of views frequently are determined by  
18 contrasts of forms and textures related to geology, hydrology, vegetation and  
19 wildlife, agricultural crops, and other land uses. For example, a small water  
20 feature in a plain may be a significant visual feature; however, a small water  
21 feature within an area with vast rivers or larger ponds may be of less significance.

22 Visual effects are dependent upon the viewpoint of individuals because each  
23 person can respond differently to changes in the physical environment depending  
24 upon expectations, historical perspective, duration and frequency of the views,  
25 and extent of a viewshed. A viewshed is defined by the Federal Highway  
26 Administration (DOT 1981) as a surface area visible from a particular location.  
27 The character of a viewshed can also vary daily, seasonally, and with changing  
28 weather.

29 Visual effects also are affected by the general activities of the viewers.

30 Passengers in automobiles and trains with relatively short exposure to views may  
31 have a different experience than recreationists or residents who view the area for  
32 longer periods of time. Residents and recreationists frequently select a location  
33 for their activities due to the views. Changes in views could affect the quality of  
34 their activities, including housing, camping, hiking, or boating locations.

35 Therefore, changes in visual effects are dependent upon the visual quality of the  
36 landscape within the context of the setting (DOT 1981).

37 Visual quality, or scenic value, has been classified with respect to the lines, forms,  
38 colors, textures, and composition of landforms, vegetation, rocks, cultural  
39 features, and water features by the U.S. Department of Agriculture (USDA),

1 Forest Service (USDA 1995). The classification system includes Class A,  
2 Distinctive; Class B, Typical (or ordinary or common features); and Class C,  
3 Indistinctive. This classification system also considers the scenic integrity, or the  
4 completeness of the landscape character.

## 5 **14.2 Regulatory Environment and Compliance** 6 **Requirements**

7 Potential actions that could be implemented under the alternatives evaluated in  
8 this EIS could affect visual resources at reservoirs and lands served by CVP and  
9 SWP water supplies. Actions located on public agency lands or implemented,  
10 funded, or approved by Federal and state agencies, would need to be compliant  
11 with appropriate Federal and state agency policies and regulations, as summarized  
12 in Chapter 4, Approach to Environmental Analysis.

## 13 **14.3 Affected Environment**

14 This section describes visual resources that could be potentially affected by the  
15 implementation of the alternatives considered in this EIS. Changes in visual  
16 resources due to changes in CVP and SWP operations may occur in the Trinity  
17 River, Central Valley, San Francisco Bay Area, and Central Coast and Southern  
18 California regions.

19 Physical form and visual character are the result of the interaction of natural and  
20 engineered elements. Natural elements, including topography, hydrology,  
21 vegetation, and climate create the physical context. Engineered elements, such as  
22 buildings, roads, infrastructure, and settlement patterns, are secondary elements  
23 that act on the natural physical context to establish a visual environment.

24 Both the natural and engineered landscape features contribute to perceived views  
25 and the aesthetic value of those views. In areas considered to have high resource  
26 value and scenic character, it is important to evaluate and protect the visual  
27 character and aesthetic value of landscapes that may undergo alteration.

### 28 **14.3.1 Trinity River Region**

29 The Trinity River Region includes the area along the Trinity River from Trinity  
30 Lake to the confluence with the Klamath River, and along the Klamath River  
31 from the confluence with the Trinity River to the Pacific Ocean.

#### 32 **14.3.1.1 Trinity River Watershed**

33 The Trinity River drains an area of the Coast Range, northwest of the Sacramento  
34 Valley. Dams on the river form Trinity Lake and Lewiston Lake, both of which  
35 are in the Whiskeytown-Shasta-Trinity National Recreation Area, as described in  
36 Chapter 15, Recreation Resources. The Trinity River flows through sparsely  
37 populated and heavily forested, mountainous terrain, jagged cliffs that can be  
38 viewed during numerous recreational opportunities, including fishing, rafting,

1 kayaking, and canoeing. The forests offer visual resources which include snow-  
 2 covered peaks, volcanoes, rock outcroppings, mountain creeks, lakes, meadows,  
 3 and a wide variety of trees and vegetation. Downstream of Lewiston Dam, the  
 4 Trinity River corridor is characterized by gravel bars, riparian vegetation, and  
 5 human-built features (NCRWQCB et al. 2009). Artificial lights occur related to  
 6 passing vehicles and local residential and commercial buildings. Glare related to  
 7 the water surfaces may occur from some view locations.

8 **14.3.1.1.1 Wild and Scenic Rivers and Scenic Highways in the Trinity River**  
 9 **Watershed**

10 On January 19, 1981, the Secretary of the Interior designated portions of the  
 11 Trinity River watershed as part of the National Wild and Scenic Rivers System,  
 12 including the Trinity River downstream of Lewiston Dam, and portions of the  
 13 South Fork, North Fork, and New River (BLM et al. 2012). The State of  
 14 California adopted similar reaches as wild and scenic under Public Resources  
 15 Code sections 5093.54 and 5093.545.

16 The Trinity River Region includes two highways in Trinity County and one  
 17 highway in Humboldt County that are eligible for State Scenic Highway  
 18 designations. The two highways in Trinity County are eligible for State Scenic  
 19 Highway designation and include the Siskiyou-Trinity Scenic Byway (State Route  
 20 3, which extends from south of Hayfork to north of Trinity Lake to Interstate 5)  
 21 and Trinity Scenic Byway (State Route 299, which extends from the Pacific  
 22 Ocean to Redding) (CalTrans 2014a). In Humboldt County, State Route 96 along  
 23 the Trinity River from Willow Creek to the confluence with the Klamath River is  
 24 eligible for State Scenic Highways designation (CalTrans 2014b).

25 **14.3.1.2 Lower Klamath River Watershed**

26 The Klamath River from the confluence with the Trinity River to the Pacific  
 27 Ocean is characterized by a forested river canyon with riparian vegetation along  
 28 the river. Reduced flows in the summer have frequently resulted in algal blooms  
 29 which has reduced water clarity and visual quality of the river corridor (DOI and  
 30 DFG 2012).

31 **14.3.1.2.1 Wild and Scenic Rivers and Scenic Highways in the Klamath**  
 32 **River Watershed**

33 The portion of the Klamath River watershed within the Trinity River Region  
 34 considered in this EIS (from the confluence with the Trinity River to the Pacific  
 35 Ocean) was designated as part of the entire reach of the Klamath River from Iron  
 36 Gate to the Pacific Ocean by the Secretary of the Interior to be part of the  
 37 National Wild and Scenic Rivers System on January 19, 1981. The State of  
 38 California also adopted this reach of Klamath River as wild and scenic under  
 39 Public Resources Code sections 5093.54 and 5093.545.

40 Caltrans has not designated highways within the Klamath River watershed in the  
 41 Trinity River Region as Scenic Highways or identified roadways to be eligible for  
 42 Scenic Highways status (CalTrans 2014b, 2014c).

1 **14.3.2 Central Valley Region**

2 The Central Valley Region extends from above Shasta Lake to the Tehachapi  
3 Mountains, and includes the Sacramento Valley, San Joaquin Valley, Delta, and  
4 Suisun Marsh.

5 The Central Valley Region is predominantly made up of lowlands and plains  
6 surrounded by foothills and tall mountains of the Coast Range to the west, the  
7 Cascade Range to the north, the Sierra Nevada to the east, and the Tehachapi  
8 Mountains to the south. Communities and roadways of various sizes are located  
9 throughout the valley. Land use outside of the communities is primarily  
10 agricultural, with riparian, wetland and oak woodlands along the major  
11 waterways.

12 **14.3.2.1 Sacramento Valley**

13 The Sacramento Valley extends from the northern mountainous areas to the less  
14 dramatic landscapes of the Central Valley at the lower elevations. The  
15 mountainous areas are characterized by rugged and deep river canyons and  
16 valleys that extend from jagged peaks to forested areas with pine and deciduous  
17 trees. Large rivers flow from the mountain areas through the foothills into the  
18 agricultural areas and communities along the valley floor. Oak woodlands are  
19 located at middle and lower elevations of the foothills and along riparian corridors  
20 on the valley floor.

21 The Sacramento Valley extends from Shasta Lake and Whiskeytown Lake to the  
22 Delta. The Sacramento Valley portion of the Central Valley Region considered in  
23 this EIS includes the middle and lower portions of the Feather River and  
24 American River watersheds that are influenced by CVP and SWP water supply  
25 facilities, respectively.

26 **14.3.2.1.1 Shasta Lake, Keswick Reservoir, and Whiskeytown Lake**

27 Shasta Lake, Keswick Reservoir, and Whiskeytown Lake are in the  
28 Whiskeytown-Shasta-Trinity National Recreation Area, as described in  
29 Chapter 15, Recreation Resources. These watersheds provide opportunities for  
30 high quality visual attractions, such as mountains, forests, waterfalls, streams,  
31 open water, and vistas of the sky that can be experienced during numerous  
32 recreational activities such as boating, water skiing, swimming, fishing, camping,  
33 picnicking, hiking, hunting, and mountain biking. Panoramic views for travelers  
34 through the area can be seen from many locations, including State Route 151 vista  
35 point, Shasta Dam Visitor Center, and Interstate 5. The contrast between the open  
36 water bodies and surrounding mountains provides a wide diversity of views. The  
37 quality and diversity of visual resources at the lakes and the surrounding areas is  
38 influenced by human-built features such as highways, railroads, resorts, bridges,  
39 communities, and electrical transmission facilities. The visual quality of open  
40 waters also is influenced by fluctuating water levels. Typically, the water levels  
41 decline from an annual maximum in May to a minimum in October. In extremely  
42 dry years, exposed bare mineral soils in a “bathtub ring” are in substantial contrast  
43 to the open water and the upslope vegetation (Reclamation 2013a).

1 Between the lakes, pine and oak forests predominate, with intermittent chaparral  
 2 and rock outcrops. The landscape includes mountain ranges, volcanoes, and  
 3 waterways, opening below the reservoir to the agricultural vistas and communities  
 4 of the Central Valley.

5 **14.3.2.1.2 Sacramento River Watershed: Keswick Reservoir to**  
 6 **Feather River**

7 The scenic qualities of the upper reaches of the Sacramento River watershed south  
 8 of Keswick Reservoir are generally considered to be of high quality, especially in  
 9 areas where little to no development has occurred. Varied topography, geologic  
 10 formations, and natural and manmade water bodies provide striking vistas.

11 Similar conditions are found in the Sierra Nevada Mountains and foothills near  
 12 the upper and middle Feather, Yuba, American, Mokelumne, Calaveras, and  
 13 Stanislaus rivers watersheds.

14 The foothills provide views of rolling hills, open grasslands, and scattered oak and  
 15 pine woodlands. In the lower elevations of the Central Valley, the human-built  
 16 environment becomes more dominant, and detracts from views of the natural  
 17 landscape. Outside of the urban and suburban areas, land use is rural in character,  
 18 with agricultural areas that include irrigated row crops, orchards, and grazing  
 19 lands. Sporadically, flooded agricultural fields, especially rice fields managed for  
 20 wetlands, are used heavily by migrating birds.

21 Between the Keswick Reservoir and Feather River confluence with the  
 22 Sacramento River, the landscape also includes human-built reservoirs and canals.  
 23 Black Butte Reservoir is operationally integrated with the CVP, and the canal  
 24 system includes the CVP Corning Canal, Tehama-Colusa Canal, and Glenn-  
 25 Colusa Irrigation District's canal. The canals provide visual interest in localized  
 26 areas with limited viewing opportunities (Reclamation 1997).

27 Visual resources that could be affected in the Feather River and American River  
 28 watersheds are described below. The remaining portions of the Sacramento  
 29 Valley between the Feather River and the San Francisco Bay Area Region  
 30 includes the Delta (described in following subsections of this chapter) and areas  
 31 located to the east and west of the Delta. Land uses located to the south of the  
 32 Feather River and outside of the Delta include agricultural, open space, and major  
 33 urban centers that all use SWP water supplies. The urban areas include the cities  
 34 of Vacaville, Fairfield, and Vallejo in Solano County and unincorporated areas of  
 35 Napa County.

36 *Scenic Highways in the Sacramento River Area*

37 In the Sacramento Valley portion of the Central Valley Region, there are several  
 38 designated State Scenic Highways and several roads that are eligible for this  
 39 designation, including the following roadways:

- 40 • Shasta County: State Route 151 from Shasta Dam to Lake Boulevard is  
 41 designated as a State Scenic Highway due to views of the Sacramento River,  
 42 Shasta Lake, and distant hills. State Routes 299, 44, and 89 are eligible for  
 43 State Scenic Highway designation (CalTrans 2014a, 2014d).

- 1 • Tehama County: State Routes 89 and 36 are eligible for State Scenic Highway  
2 designation (CalTrans 2014e).
- 3 • Yolo County: A portion of State Route 16 is eligible for State Scenic  
4 Highways designation (CalTrans 2014f).
- 5 • Solano County: A portion of State Route 37 is eligible for State Scenic  
6 Highways designation (CalTrans 2014g).
- 7 • Napa County: Portions of State Routes 29 and 121 are eligible for State  
8 Scenic Highways designation (CalTrans 2014h).

### 9 **14.3.2.1.3 Feather River Watershed**

10 Antelope Lake, Lake Davis, Frenchman Lake, Lake Oroville, and Thermalito  
11 Afterbay on the Feather River are human-built reservoirs providing visual contrast  
12 with surrounding terrain.

#### 13 *Upper Feather River*

14 Antelope Lake, Lake Davis, and Frenchman Lake are located in the upper Feather  
15 River watershed (DWR 2013a; USFS 2006a, 2006b, 2011). Antelope Lake,  
16 located on Indian Creek, has the longest dam of the three reservoirs. This remote  
17 lake, surrounded by pine and fir trees, can be viewed from Fruit Growers  
18 Boulevard and Indian Creek Road. Lake Davis is formed by Grizzly Dam on Big  
19 Grizzly Creek, and is the largest of the three dams. It is located in the upper  
20 watershed surrounded by many trees, and can be viewed from Beckwourth-  
21 Taylorsville Road and Lake Davis Road. Frenchman Lake, located on Last  
22 Chance Creek, is formed by the tallest dam of the three dams. This lake also is  
23 surrounded by trees to the waterline and can be viewed from Little Last Chance  
24 Creek Road and Frenchman Lake Road.

#### 25 *Lake Oroville and Thermalito Reservoir*

26 The terrain adjacent to Lake Oroville is generally quite steep with limited  
27 vehicular access. Most views of the water are from the bridges on State Route  
28 162, State Route 70, and several county roads. Some residents live in the lands  
29 around Lake Oroville and Thermalito Afterbay. The residents can easily view the  
30 water and visitors can view the structures. As described above for Shasta Lake  
31 and other reservoirs in the upper Sacramento River watershed, Lake Oroville  
32 water levels decline as summer progresses, leaving a ring of bare soil along the  
33 water's edge. In extremely dry years at Lake Oroville, more than 200 vertical feet  
34 of bare mineral soils in a "bathtub ring" may be exposed when the surface water  
35 elevation approaches 710 feet above mean sea level (DWR 2007).

36 The Diversion Pool between Oroville Dam and Thermalito Diversion Dam  
37 extends about 4.5 miles along the Feather River and meanders through hillsides  
38 with substantial vegetation within widths ranging from 50 to 200 feet (DWR  
39 2007). Vistas of the Diversion Pool are primarily viewed by recreationists on the  
40 water or along the adjacent trails. A 1.9-mile-long concrete Thermalito Power  
41 Canal appears as a contrast from State Route 70 and county roads to the  
42 undeveloped landscape between the Diversion Dam and the Thermalito Forebay.

1 The Thermalito Forebay is a 630-acre reservoir, approximately 3 miles in length  
 2 that can be viewed by recreationists along or within the open water and travelers  
 3 along State Route 70 as the roadway extends from the foothills to the valley floor.  
 4 Water levels in these human-built features generally vary by 2 to 4 feet during a  
 5 week. When the water levels are low, exposed bare soils create a “bathtub ring”  
 6 effect.

7 Thermalito Afterbay is located in a more flat terrain than Lake Oroville and can  
 8 be viewed from many locations and residences. The Thermalito Afterbay Dam is  
 9 located parallel to State Route 99 and rises over 30 feet above the roadway (DWR  
 10 2007). The Thermalito Afterbay is approximately 4,300 acres and is visible from  
 11 State Route 162, several county roads, recreation areas, and neighboring  
 12 residences. Because the afterbay is located on flat lands with minimal foothills,  
 13 vistas from the water or lands surrounding the afterbay extend from the Sierra  
 14 Nevada foothills to the Feather River on the valley floor. Water levels in the  
 15 afterbay generally vary by 2 to 6 feet during a week, but can decline by as much  
 16 as 11 feet. When the water levels are low, exposed bare soils create a “bathtub  
 17 ring” effect.

18 The low flow channel of the Feather River extends from the Diversion Dam  
 19 through the community of Oroville (DWR 2007). Urban land uses and other  
 20 buildings, including the Feather River Fish Hatchery, are located along the  
 21 channel upstream of the State Route 70 bridge. The Oroville Wildlife Area  
 22 extends from State Route 70 on the east, downstream of the bridge, and includes  
 23 the Thermalito Afterbay area. Dredge tailings from hydraulic mining that  
 24 occurred over 100 years ago occur along the low flow channel with some of the  
 25 tailings reaching heights of more than 40 feet above the roadway.

26 *Wild and Scenic Rivers and Scenic Highways in the Feather River Watershed*

27 Within the Central Valley Region considered in this EIS, the Middle Fork Feather  
 28 River (from Beckworth to Lake Oroville) was designated as part of Public Law  
 29 90-542 (Wild and Scenic Rivers Act) to be part of the National Wild and Scenic  
 30 Rivers System on October 2, 1968.

31 In the Feather River watershed and adjacent Bear River watershed of the Central  
 32 Valley Region, there is one designated State Scenic Highway and several roads  
 33 that are eligible for this designation, including the following roadways.

- 34 • Butte County: State Route 70 is eligible for State Scenic Highways designation  
 35 (CalTrans 2014i).
- 36 • Plumas County: State Routes 70 and 89 are eligible for State Scenic Highways  
 37 designation (CalTrans 2014j).
- 38 • Nevada County: State Route 20 from Skillman Flat Campground to half-mile  
 39 east of Lowell Hill Road is designated as a State Scenic Highway and a U.S.  
 40 Forest Service (USFS) Scenic Byway due to views of pine forests and results  
 41 of hydraulic mining. Interstate 80 and State Routes 20, 49, and 174 are  
 42 eligible for State Scenic Highways designation (CalTrans 2014k).



1 **14.3.2.1.4 Yuba River Watershed**

2 The middle and lower Yuba River watershed extends through Nevada and Yuba  
3 counties. Upstream of New Bullards Bar Reservoir, the watershed is  
4 characterized by coniferous, mixed conifer/hardwood, and ponderosa pine forests  
5 along steep canyons. Most of the upper watershed is undeveloped with rural  
6 communities located along State Route 49 (DWR et al. 2007).

7 New Bullards Bar Reservoir, on the Yuba River and in Yuba County, is a human  
8 built reservoir providing visual contrast of the lake surface with mountainous  
9 landscape with conifers and mixed hardwood forests (DWR et al. 2007). There  
10 are many locations in the watershed to view the lake and the adjacent forests.  
11 Recreational developments are located near the marina and campgrounds near the  
12 shoreline.

13 Downstream of New Bullards Bar Reservoir along the Middle Yuba River and to  
14 Englebright Reservoir (located in Nevada and Yuba counties), the landscape is  
15 characterized by rolling hills with hardwood and coniferous trees and grasslands  
16 (DWR et al. 2007, USACE 2012). This portion of the watershed is rural with  
17 communities located along State Route 20.

18 Downstream of Englebright Reservoir, the landscape includes grasslands and  
19 agricultural fields with several small communities (USACE 2012). Along the  
20 river, the landscape is dominated by remnants of historic gold and gravel mining  
21 and ongoing gravel mining activities with minimal riparian vegetation. This  
22 portion of the watershed can be viewed from State Route 20.

23 **14.3.2.1.5 Middle and Lower American River Watershed**

24 The middle and lower American River watershed extends through Placer, El  
25 Dorado, and Sacramento counties. Upstream of Folsom Dam, much of Placer and  
26 El Dorado counties are characterized by undeveloped rolling grasslands and oak  
27 woodlands with sporadic agricultural activities related to orchards, vineyards,  
28 ornamental flowers, and Christmas tree farms in the wooded foothills.  
29 Communities have been developed throughout the counties especially near  
30 Interstate 80, U.S. Highway 50, and State Routes 49 and 89.

31 Folsom Lake, on the American River, is a human built reservoir providing visual  
32 contrast with the foothill landscape. Views from the water surface provide  
33 panoramic vistas of the foothills with open grasslands, oak woodlands, and pine  
34 woodlands. Folsom Lake is generally considered to provide a pleasing visual  
35 setting for recreationists, residences, and from roadways along the foothills above  
36 the reservoir, especially from the Lake Overlook and the Folsom Dam  
37 Observation Point vista points. Increased population in the communities around  
38 the lake have provided more scenic view points, including increased vistas of  
39 human-built structures such as electric transmission facilities, roadways, dams,  
40 and residential subdivisions. Reservoir levels fluctuate and decline as summer  
41 progresses, leaving a “bathtub ring” of bare soil along the water’s edge. The  
42 visual quality also degrades because visitors drive vehicles onto the exposed soils  
43 which cause tire tracks and erosion (Reclamation et al. 2006).

1 Lake Natoma extends from Folsom Dam along the American River to Nimbus  
 2 Dam. The land along the river is mostly undeveloped and includes wooded  
 3 canyon areas, sheer bluffs, and dredge tailings from the gold mining era.  
 4 Residential and community developments have been constructed along the  
 5 foothills that overlook the canyon, and these structures can be seen by  
 6 recreationists from the water or adjacent trails. Lake Natoma can be viewed from  
 7 U.S. Highway 50 and local roads.

8 Downstream of Nimbus Dam to Gristmill Recreation Area (downstream of  
 9 William B. Pond Recreation Area and approximately 2 miles upstream from the  
 10 Watt Avenue Bridge), the American River flows through a landscape  
 11 characterized by steep bluffs, terraces, mid-river sand and gravel bars, backwater  
 12 areas along the edges, and riparian vegetation. This viewshed is seen from the  
 13 recreational areas on the water and adjoining trails, from the bridge crossings, and  
 14 from residences along the terraces and foothills. Downstream of the Gristmill  
 15 Dam Recreation Area, the visual characteristics are less complex with an  
 16 increased number of bridges, water treatment plant intake, and artificial bank  
 17 protection. The communities along the American River corridor include the cities  
 18 of Folsom, Roseville, Rancho Cordova, and Sacramento and unincorporated  
 19 areas. The communities, transportation infrastructure, and water-river corridor  
 20 are visible from multiple vantage points.

21 *Wild and Scenic Rivers and Scenic Highways in the American River Watershed*  
 22 Within the American River watershed, the Lower American River from Nimbus  
 23 Dam to the confluence with the Sacramento River were designated by the  
 24 Secretary of the Interior to be part of the National Wild and Scenic Rivers System  
 25 on January 19, 1981. The State of California also designated the Lower American  
 26 River as wild and scenic under Public Resources Code sections 5093.54 and  
 27 5093.545. In addition, the state designated the North Fork American River from  
 28 the source to Iowa Hill Bridge as wild and scenic.

29 In the portion of the American River watershed in the study area of this EIS, there  
 30 is one roadway designated as a State Scenic Highway and one road that is eligible  
 31 for this designation. In El Dorado County, U.S. Highway 50 from Government  
 32 Center Interchange in Placerville to South Lake Tahoe is designated as a State  
 33 Scenic Highway due to vistas of the American River canyon, suburban foothills,  
 34 granite peaks, and Lake Tahoe. Also in El Dorado County, State Route 49 is  
 35 eligible for State Scenic Highways designation (CalTrans 2014).

#### 36 **14.3.2.2 San Joaquin Valley**

37 The San Joaquin Valley land cover ranges from high alpine vegetation near the  
 38 crest of the Sierra Nevada Mountains, through coniferous forest, mixed forest, oak  
 39 woodlands and oak savanna, to grasslands and agricultural areas at the lower  
 40 elevations (Reclamation 1997, 2005a, 2005b). Water bodies include reservoirs,  
 41 natural lakes and ponds, rivers, and tributary streams. The human-built  
 42 environment is more dominant at lower elevations, and includes roadways,  
 43 communities, roadside businesses, and transmission lines, detracting from views  
 44 of the natural environment. On the valley floor, the San Joaquin Valley is

1 characterized by agricultural lands, including many that are irrigated with CVP  
2 and/or SWP water supplies. The valley is arid to semi-arid, and there are few  
3 natural lakes or streams on the valley floor.

4 Several wetlands have been established as wildlife refuges in the San Joaquin  
5 Valley (as described in Chapter 10, Terrestrial Biological Resources), providing  
6 views of water and vegetation, enhanced seasonally by waterfowl and seasonal  
7 wildflowers.

8 The predominant land use is agricultural, with sparse to moderate populations.  
9 Interstate 5 and major railroads pass along the western San Joaquin Valley at the  
10 base of the Coast Ranges foothills. State Route 99 and other railroads are located  
11 along the eastern San Joaquin Valley at the base of the Sierra Nevada foothills.  
12 Interstate 580 and State Routes 152, 198, and 46 cross the San Joaquin Valley  
13 from east to west between Interstate 5 and State Route 99. Larger cities have  
14 been established in the northern San Joaquin Valley, including Lodi, Stockton,  
15 Lathrop, Manteca, and Tracy; and along State Route 99, including Merced,  
16 Fresno, Visalia, and Bakersfield. Both Interstate 5 and State Route 99 are  
17 extensively traveled and provide numerous viewing opportunities.

#### 18 **14.3.2.2.1 Northern San Joaquin Valley**

19 In the northern San Joaquin Valley, the foothills range from rolling hills to  
20 mountainous terrain with riparian corridors that range from narrow canyons to  
21 alluvial plains. The San Joaquin, Stanislaus, Merced, and Tuolumne rivers are the  
22 principal water features that flow from the Sierra Nevada foothills. One or more  
23 reservoirs are located along each of these rivers, including the CVP New Melones  
24 Reservoir on the Stanislaus River and Millerton Lake on the San Joaquin River.  
25 Other reservoirs are owned and operated by local and regional water suppliers, as  
26 described in Chapter 5, Surface Water Resources and Water Supplies. Dredge  
27 tailings have been deposited along some of the rivers as the streams flow from the  
28 mountains into the foothills.

29 The CVP New Melones Reservoir is located in the western foothills of the Sierra  
30 Nevada along the Stanislaus River. The area is characterized by foothills, ridges,  
31 and small valleys with vegetated slopes and the open water surface (Reclamation  
32 2010). The vegetation is primarily grasslands and oak woodlands with varying  
33 densities, with gray pine and low shrubs along some slopes. Views of the water  
34 are primarily from the water surface, adjacent recreation areas, and State  
35 Route 49. The surrounding lands are rural and undeveloped except for the  
36 infrastructure associated with the dam, canals, and power generation facilities and  
37 some minor structures associated with the recreation areas and utility lines. When  
38 the reservoir is drawn down, broad bands of bare soil are exposed.

39 Millerton Lake also is located in the western foothills of the Sierra Nevada along  
40 the San Joaquin River in an area that ranges from grasslands and rolling hills near  
41 Friant Dam to steep, craggy slopes in the upper reaches of the lake (Reclamation  
42 et al. 2011a). The lake, dam infrastructure, and surrounding hills can be viewed  
43 from the lake surface and adjacent county roads. Development has occurred  
44 along the hillsides that can be viewed from the lake surface and adjacent

1 recreation areas; however; future development will be regulated by Madera and  
 2 Fresno counties to protect visual and scenic resources. When the reservoir is  
 3 drawn down, broad bands of bare soil are exposed. The Madera Canal and Friant-  
 4 Kern Canal extend from Millerton Lake to the north and south, respectively. The  
 5 canals are located along the Sierra Nevada foothills through mostly agricultural  
 6 landscapes and limited residences (Reclamation et al. 2011, Reclamation 1997).  
 7 The canals are only intermittently visible from county roads.

#### 8 **14.3.2.2.2 Western San Joaquin Valley**

9 The Coast Range foothills on the western side of the northern San Joaquin Valley  
 10 are sparsely populated and characterized by mountainous to hilly terrain with  
 11 grasslands and scattered oak woodlands along narrow streams. The CVP and  
 12 SWP San Luis Reservoir complex is located within the western foothills; and the  
 13 CVP and SWP water supply canals are located at the base of the foothills to the  
 14 north and south of the San Luis Reservoir.

15 The CVP and SWP water supply facilities are prominent features in the viewshed  
 16 of the San Joaquin Valley, including facilities at or near San Luis Reservoir,  
 17 Delta-Mendota Canal, San Luis Canal-California Aqueduct, Cross Valley Canal,  
 18 New Melones Reservoir, and Millerton Lake. The San Luis Reservoir, O'Neill  
 19 Forebay, and Los Banos Creek Reservoir are located in northwestern San Joaquin  
 20 Valley. State Route 152 is located along the northern and eastern rims of San  
 21 Luis Reservoir and the western rim of O'Neill Forebay (Reclamation and State  
 22 Parks 2013). O'Neill Forebay and Los Banos Creek Reservoir can be seen to the  
 23 west from Interstate 5. The reservoirs are also part of the visual resources for the  
 24 San Luis Reservoir State Recreation Area, Pacheco State Park, and Upper and  
 25 Lower Cottonwood Wildlife Areas (which are described in Chapter 10, Terrestrial  
 26 Biological Resources, and Chapter 15, Recreation Resources). The shorelines of  
 27 the reservoirs are undeveloped, except for recreational facilities. Views included  
 28 annual grassland, coastal sage, and riparian woodland. When the reservoirs are  
 29 drawn down, broad bands of bare soil are exposed. Open water viewing  
 30 opportunities also occur to the south of the San Luis complex at the Little  
 31 Panoche Reservoir located to the west of Interstate 5.

32 The open water and canal infrastructure of the Delta-Mendota Canal, San Luis  
 33 Canal-California Aqueduct, Cross Valley Canal, and irrigation district canals can  
 34 be viewed from Interstate 5 and the railroad lines along the western San Joaquin  
 35 Valley. The open water of Mendota Pool is located at the terminus of the Delta  
 36 Mendota Canal and can be viewed from county roads.

#### 37 **14.3.2.2.3 Southern San Joaquin Valley**

38 In the southern portion of the San Joaquin Valley, the Kings, Kaweah, Tule, and  
 39 Kern rivers are the principal water features along the eastern Sierra Nevada  
 40 foothills. One or more reservoirs are located along each of these rivers. Riparian  
 41 vegetation and oak woodlands occur along these river corridors. The western  
 42 Coast Ranges foothills are characterized by distinct, folded foothills with

1 grasslands and infrequent oak woodlands along small drainages. The Tehachapi  
2 Mountains rise abruptly along the southern boundary of the valley.

3 **14.3.2.2.4 Wild and Scenic Rivers and Scenic Highways in the San Joaquin**  
4 **Valley**

5 In the San Joaquin Valley within or near the Central Valley Region considered in  
6 this EIS, four rivers were designated to be part of the National Wild and Scenic  
7 Rivers System. Portions of the Tuolumne River from the source waters to Don  
8 Pedro Reservoir were designated through Public Law 98-425 as wild and scenic.  
9 Portions of the Merced River were designated through Public Laws 100-149 and  
10 102-432 as wild and scenic, including the entire South Fork and the mainstem  
11 from the source waters to Lake McClure. Portions of the Kings River were  
12 designated as wild and scenic through Public Law 100-150, including the Middle  
13 Fork and South Fork from their respective sources to the confluences with the  
14 mainstem; and the mainstem from these confluences to an elevation of 1595 feet  
15 above mean sea level (upstream of the confluence with the North Fork and Pine  
16 Flat Lake). Portions of the Kern River were designated as wild and scenic  
17 through Public Law 100-174, including the North Fork from the source to the  
18 Tulare County/Kern County boundary; and the South Fork from the source to the  
19 Domeland Wilderness. Most of these reaches are located outside of the Central  
20 Valley Region; however, the flows from these reaches could influence the visual  
21 resources of downstream reaches in the Central Valley Region.

22 In the San Joaquin Valley of the Central Valley Region, there are five roadway  
23 sections designated as a State Scenic Highway and seven roadway sections that  
24 are eligible for this designation.

- 25 • San Joaquin County and Alameda County: Interstate 580 from Interstate 5 to  
26 State Route 205 is designated as a State Scenic Highway due to vistas of the  
27 Coast Ranges and Central Valley. Interstate 5 from the Stanislaus County  
28 boundary to Interstate 580 is designated as a State Scenic Highway due to  
29 vistas of agricultural lands and the Delta Mendota Canal and California  
30 Aqueduct (CalTrans 2014m, 2014n).
- 31 • Stanislaus County: Interstate 5 from the San Joaquin County boundary to the  
32 Merced County boundary is designated as a State Scenic Highway due to  
33 vistas of agricultural lands and the Delta Mendota Canal and California  
34 Aqueduct (CalTrans 2014o).
- 35 • Merced County: Interstate 5 from State Route 152 to the Stanislaus County  
36 boundary is designated as a State Scenic Highway due to vistas of agricultural  
37 lands and the Delta Mendota Canal and California Aqueduct (CalTrans  
38 2014p). State Route 152 from Interstate 5 to the Santa Clara County boundary  
39 is designated as a State Scenic Highway due to vistas of agricultural lands and  
40 the San Luis Reservoir State Recreational Area.
- 41 • Fresno County: State Routes 168, 180, and 198 are eligible for State Scenic  
42 Highways designation (CalTrans 2014q).

- 1 • Tulare County: State Routes 190 and 198 are eligible for State Scenic  
2 Highways designation (CalTrans 2014s).
- 3 • Kern County: State Routes 14 and 58 are eligible for State Scenic Highways  
4 designation (CalTrans 2014t).

### 5 **14.3.2.3 Delta and Suisun Marsh**

6 Most of the Delta is used for agricultural purposes with major waterways and  
7 sloughs that connect the Sacramento, San Joaquin, Mokelumne, Cosumnes, and  
8 Calaveras rivers (CALFED 2000). Flood management and irrigation facilities  
9 include levees, impoundments, pumping plants, and control gate structures.  
10 Bodies of open water occur where historic levee failures were not repaired,  
11 including Franks Tract and Liberty Island. The Sacramento Deep Water Ship  
12 Channel is a larger water feature between levees that extends from the  
13 Sacramento River near Rio Vista to West Sacramento. Cities within the Delta  
14 include the southern portion of Sacramento, Isleton, West Sacramento, Rio Vista,  
15 Lathrop, western portions of Stockton and Manteca, Tracy, Brentwood, Oakley,  
16 Antioch, and Pittsburg. Small communities to serve the agriculture and recreation  
17 users include Freeport, Clarksburg, Hood, Courtland, Locke, Walnut Grove,  
18 Ryde, Thornton, Knightsen, and Collinsville. Vistas of the Delta can be seen  
19 from residences and agricultural areas in the Delta, open water areas used by  
20 recreationists, and from vehicles on roadways and railroads that cross the Delta.  
21 Waterfront industries are located along the rivers, especially along the San  
22 Joaquin River.

23 The Suisun Marsh is characterized by tidal and freshwater wetlands and riparian  
24 woodlands (Reclamation et al. 2010). The area is bounded by Interstate 80 and  
25 State Route 12 on the north; the Montezuma Hills and Sulphur Springs Mountains  
26 on the east and west, respectively; and on the south by the open waters of Suisun  
27 Bay, Grizzly Bay, and Honker Bay with adjoining wetlands, marshes, and riparian  
28 forests. The marsh is relatively flat and comprised primarily of tidal marsh and  
29 submerged lands. Upland areas serve as a backdrop with grasslands and nearby  
30 rolling foothills. Vistas of Suisun Marsh can be viewed from adjacent roadways  
31 railroads; roads and trails within the marsh; a few residences within the marsh;  
32 and open water that can be accessed by boats, kayaks, and canoes. Much of  
33 Suisun Marsh is managed wetlands and provides habitat for resident and  
34 migrating birds and waterfowl.

#### 35 **14.3.2.3.1 Scenic Highways in the Delta**

36 In the Delta and Suisun Marsh portion of the Central Valley Region, there two  
37 roadway sections designated as a State Scenic Highway and two roadway sections  
38 that are eligible for this designation.

- 39 • Sacramento County: State Route 160 between the southern limits of the City  
40 of Sacramento to the Contra Costa County boundary is designated as a State  
41 Scenic Highway due to the views of historic Delta agriculture and small towns  
42 along the Sacramento River (CalTrans 2014u).

- 1 • Contra Costa County: State Route 160 from the Antioch Bridge to State  
2 Route 4 and State Route 4 continuing on towards Brentwood are eligible for  
3 State Scenic Highways designation (CalTrans 2014v).

#### 4 **14.3.3 San Francisco Bay Area Region**

5 The San Francisco Bay Area Region includes portions of Contra Costa, Alameda,  
6 Santa Clara, and San Benito counties that are within the CVP and SWP service  
7 areas. The San Francisco Bay Area Region ranges in topography from sea level  
8 to the East Bay and South Bay foothills that reach elevations of 3,500 feet and  
9 higher (CALFED 2000; WTA 2003; Reclamation 2005c). It offers a diverse  
10 physical and natural environment, and a wide range of visual resources. Typical  
11 views and landscapes include urban development, natural and altered open-space  
12 areas, major ridgelines, and scenic waterways. The terrain ranges from alluvial  
13 plains to gently sloping hills and wooded ravines. Striking views of iconic scenes  
14 are available throughout the area, of San Francisco Bay, the San Francisco  
15 skyline, Angel Island, Mount Tamalpais, Peninsula foothills, and the East Bay  
16 hills. Views to the east are dominated by Mount Diablo and adjacent Diablo  
17 Ridge and valleys. Views in the South Bay extend through the baylands that  
18 extend along the Contra Costa, San Mateo, Santa Clara, and Alameda counties  
19 shorelines; the river floodplains of the Guadalupe River and Coyote Creek in  
20 Santa Clara County; and towards the Santa Cruz Mountains (Santa Clara County  
21 1994).

22 Urban and industrial areas are located throughout the San Francisco Bay Area  
23 Region, including along the San Francisco Bay shoreline. Smaller, localized  
24 scenic resources include wetlands, isolated hilltops, rock outcroppings, mature  
25 stands of trees, lakes, reservoirs, and other natural features. City parks and  
26 recreation areas, open-space areas adjacent to ravines, golf courses, and resource  
27 preserves provide visual opportunities in urban areas. The reservoirs that store  
28 CVP or SWP water or water from other surface water sources are human built  
29 reservoirs located in the foothills or at the edge of the foothills. The water can be  
30 viewed from roadways located at elevations higher than the reservoirs and by  
31 recreationists on the reservoirs. Agricultural areas that use CVP and SWP water  
32 are located within coastal valleys especially within the Livermore-Amador valleys  
33 of Alameda County, southern Santa Clara County, and northern San Benito  
34 County.

##### 35 **14.3.3.1 Scenic Highways in the San Francisco Bay Area Region**

36 In the San Francisco Bay Area Region, there are four roadway sections designated  
37 as a State Scenic Highway and five roadway sections that are eligible for this  
38 designation.

- 39 • Contra Costa County: State Route 24 from the Alameda County boundary to  
40 Interstate 680, and Interstate 680 from State Route 24 to Interstate 580 at the  
41 Alameda County boundary are designated as State Scenic Highways due to  
42 the views of Mount Diablo and attractive residential and commercial areas  
43 (CalTrans 2014v).

- 1 • Alameda County: Interstate 580 between Interstate 80 and State Route 92 are  
2 designated as a State Scenic Highways (CalTrans 2014n). Portions of  
3 Interstate 680 from the Contra Costa County boundary to Mission Boulevard  
4 in Fremont and portions of State Route 84 are designated as State Scenic  
5 Highways due to vistas of wooded hillsides and valleys. Other portions of  
6 Interstate 580 are eligible for State Scenic Highways designation.
- 7 • Santa Clara County: Portions of State Routes 152 and 280 within the San  
8 Francisco Bay Area Region are eligible for State Scenic Highways  
9 designation (CalTrans 2014w).
- 10 • San Benito County: Portions of State Routes 156 and 25 within the San  
11 Francisco Bay Area Region are eligible for State Scenic Highways  
12 designation (CalTrans 2014x).

### 13 **14.3.4 Central Coast and Southern California Regions**

14 The Central Coast and Southern California Regions include portions of San Luis  
15 Obispo, Santa Barbara, Ventura, Los Angeles, Orange, San Diego, Riverside, and  
16 San Bernardino counties served by the SWP.

17 Areas along the Pacific Coast in San Luis Obispo, Santa Barbara, Ventura,  
18 portions of Los Angeles, portions of Orange, and San Diego counties are  
19 characterized by steep, craggy coastal mountains and coastal plains that can be  
20 viewed from the roadways, residences, and the Pacific Ocean. The visual  
21 resources include beaches, sand dunes, coastal bluffs, headlands, wetlands,  
22 estuaries, islands, hillsides, and canyons (Santa Barbara County 2009, SBCAG  
23 2013). The foothills extend from the Pacific Ocean to more than 800 feet above  
24 mean sea level; and the mountains extend to more than 3,000 feet above mean sea  
25 level. The foothills are generally covered with mature trees and shrubs, including  
26 native oaks, deciduous trees, and eucalyptus. The coastal plains gradually slope  
27 towards the foothills with streams through the plains. Small to medium size  
28 communities occur along the coast and the coastal plains in San Luis Obispo,  
29 Santa Barbara, and Ventura counties and within portions of the coastline in Los  
30 Angeles, Orange and San Diego counties. Larger communities also are located  
31 along the coastline separated by large areas of undeveloped lands.

32 Inland from the Pacific Ocean, urban areas extend throughout large portions of  
33 the foothills and valleys of Los Angeles, Orange, San Diego, Riverside, and San  
34 Bernardino counties. Reduced abundance of natural features, vistas, and non-  
35 urban land uses may diminish the visual resources for many viewers (SCAG  
36 2010). However, in many inland areas urban areas are separated by areas of  
37 undeveloped or agricultural lands, especially in Riverside and San Bernardino  
38 counties. Minimal development has occurred within the higher elevations of the  
39 Central Coast and Southern California regions, as described in Chapter 13, Land  
40 Use. Therefore, the mountainous areas (such as the San Gabriel, Santa Monica,  
41 Santa Ana, Santa Rosa, and San Jacinto mountains) provide dramatic viewsheds  
42 from the valleys (Los Angeles 2011, RCIP 2000, San Bernardino County 2007).  
43 The mountains also are characterized by deep canyons, rock outcroppings, and  
44 sparse vegetation. In the Coachella Valley portion of Riverside County, the visual



1 resources are dominated by dramatic vistas of the Santa Rosa, San Jacinto, San  
2 Bernardino, Cottonwood, and Chocolate mountains with high desert craggy rock  
3 outcroppings and sparse vegetation. The Salton Sea in the southern Coachella  
4 Valley provides dramatic vistas from the shoreline and highways that extend  
5 around the open water.

6 The inland areas also include major surface water resources that provide open  
7 water vistas, including Twitchell Reservoir, Silverwood Lake, Diamond Valley  
8 Lake, Lake Perris, Lake Skinner, Vail Lake, and Lake Mathews; and smaller  
9 water supply reservoirs. Many of these reservoirs store CVP and SWP water and  
10 are human built reservoirs located in the foothills or at the edge of the foothills.  
11 The water can be viewed from highways located at elevations higher than the  
12 reservoirs and by recreationists on the reservoirs.

13 **14.3.4.1 Wild and Scenic Rivers and Scenic Highways in the Central**  
14 **Coast and Southern California Regions**

15 The wild and scenic rivers in the Central Coast and Southern California areas are  
16 not located within the study area of this EIS.

17 In the Central Coast and Southern California regions, there are seven roadway  
18 sections designated as State Scenic Highways and several roadway sections that  
19 are eligible for this designation.

- 20 • San Luis Obispo County: U.S. Highway 1 from the Monterey County  
21 boundary to the City of San Luis Obispo is designated as a State Scenic  
22 Highway and an All American Road due to dramatic vista along the  
23 mountains and rocky headlands of the Pacific Ocean coastline (CalTrans  
24 2014y). Portions of State Route 41 and Interstate 101 are eligible for State  
25 Scenic Highways designation.
- 26 • Santa Barbara County: U.S. Highway 1 from Interstate 101 near Las Cruces to  
27 near Lompoc is designated as a State Scenic Highway due to dramatic vista  
28 along the mountains and rocky headlands of the Pacific Ocean coastline  
29 (CalTrans 2014z). Portions of Interstate 101 are eligible for State Scenic  
30 Highways designation.
- 31 • Ventura County: State Route 33 from the Santa Barbara County boundary to  
32 the north of the junction with State Route 150 is designated as a State Scenic  
33 Highway and a USFS Scenic Byway due to dramatic vista along the  
34 mountains between the Coast Ranges and the Central Valley with landscapes  
35 that range from pine forests to semi-desert vegetation (CalTrans 2014aa).  
36 Portions of Interstate 101 and State Routes 33 and 1 are eligible for State  
37 Scenic Highways designation.
- 38 • Los Angeles County: State Route 2 from near La Cañada-Flintridge to the San  
39 Bernardino County boundary is designated as a State Scenic Highway and a  
40 U.S. Forest Service Scenic Byway due to dramatic vista along the San Gabriel  
41 Mountains with vistas of the Mojave Desert and the Los Angeles Basin  
42 (CalTrans 2014ab). Portions of Interstate 101, 210, and 110 and State

- 1 Routes 1, 23, 27, 39, 118, and 126 are eligible for State Scenic Highways  
 2 designation.
- 3 • Orange County: State Route 91 from State Route 55 to the City of Anaheim is  
 4 designated as a State Scenic Highway due vistas of the Santa Ana River and  
 5 urban development with intermittent riparian and chaparral vegetation  
 6 (CalTrans 2014ac). State Routes 1, 57, and 74 and portions of State Route 91  
 7 are eligible for State Scenic Highways designation.
  - 8 • San Diego County: State Route 75 from the City of Imperial Beach to  
 9 Coronado is designated as a State Scenic Highway due to vistas of the Pacific  
 10 Ocean, San Diego Harbor, and the Coronado Bridge (CalTrans 2014ad). State  
 11 Route 125 between State Routes 94 and 8 is designated as a State Scenic  
 12 Highway due to vistas of Mt. Helix and attractive residential and commercial  
 13 areas. Interstate 5 and 8 and portions of State Routes 52, 76, and 93 within  
 14 the Southern California Region are eligible for State Scenic Highways  
 15 designation.
  - 16 • Riverside County: State Route 243 from the City of Banning to State Route 74  
 17 is designated as a State Scenic Highway and a U.S. Forest Service Scenic  
 18 Byway due to the vistas of the San Bernardino Mountains and valley  
 19 (CalTrans 2014ae). Interstate 15 and State Routes 71, 74, 91, and 111 are  
 20 eligible for State Scenic Highways designation.
  - 21 • San Bernardino County: State Routes 2, 18, 38, 138, 173, 189, and 247 are  
 22 eligible for State Scenic Highways designation (CalTrans 2014af).

23 **14.4 Impact Analysis**

24 This section describes the potential mechanisms and analytical methods for  
 25 change in visual resources; results of the impact analysis; potential mitigation  
 26 measures; and cumulative effects.

27 **14.4.1 Potential Mechanisms for Change and Analytical Methods**

28 As described in Chapter 4, Approach to Environmental Analysis, the impact  
 29 analysis considers changes in visual resources conditions related to changes in  
 30 CVP and SWP operations under the alternatives as compared to the No Action  
 31 Alternative and Second Basis of Comparison.

32 Changes in CVP and SWP operations under the alternatives as compared to the  
 33 No Action Alternative and Second Basis of Comparison could change the vistas at  
 34 reservoirs that store CVP and SWP water during dry and critical dry water years  
 35 and at irrigated agricultural lands during dry and critical dry water years when the  
 36 crops are idled.

1     **14.4.1.1   Changes in Visual Resources at Reservoirs that Store CVP and**  
2                    **SWP Water**

3     Vistas at reservoirs that store CVP and SWP water provide a wide diversity of  
4     visual experiences related to the contrasts between the open water surface and  
5     surrounding foothills or mountains. By the end of September, the surface water  
6     elevations decline, and a bare “bathtub ring” appears in contrast to the open water  
7     and the upslope vegetation. Changes in CVP and SWP operations under the  
8     alternatives could change the extent of the “bathtub” ring over the long-term  
9     average condition and in dry and critical dry years as compared to the No Action  
10    Alternative and Second Basis of Comparison.

11    The CalSim II model output includes monthly reservoir elevations for CVP and  
12    SWP reservoirs in the Central Valley and Trinity Lake. The end-of-September  
13    reservoir elevations in dry and critical dry water years generally indicate low  
14    reservoir elevations. To assess changes in visual resources, changes in reservoir  
15    storage elevations for the end of September in dry and critical dry years were  
16    compared between alternatives and the No Action Alternative and Second Basis  
17    of Comparison.

18    Reservoirs in the San Francisco Bay Area, Central Coast, and Southern California  
19    regions store water from multiple water supplies including CVP and SWP water;  
20    however, these reservoirs are not included in the CalSim II model simulation. For  
21    the purposes of this EIS analysis, changes in surface water elevations in these  
22    reservoirs were assumed to be related to changes in CVP and SWP water  
23    deliveries to the areas located to the south of the Delta.

24    **14.4.1.2   Changes in Vista at Irrigated Agricultural Lands**

25    Agrarian vistas of irrigated row crops, orchards, and grazing lands intermixed  
26    within a landscape of grasslands, large water canals, isolated riparian corridors,  
27    and several small communities occur throughout the Central Valley, San  
28    Francisco Bay Area, Central Coast, and Southern California regions. Changes in  
29    CVP and SWP operations under the alternatives could change the extent of  
30    irrigated acreage and the associated vistas over the long-term average condition  
31    and in dry and critical dry years as compared to the No Action Alternative and  
32    Second Basis of Comparison. However, as described in Chapter 12, Agricultural  
33    Resources, the extents of irrigated acreage between Alternatives 1 through 5 are  
34    similar to irrigated acreage under the No Action Alternative and the Second Basis  
35    of Comparison. Therefore, changes in CVP and SWP operations would not  
36    change irrigated acreage and as a result they are not analyzed in this EIS.

37    **14.4.1.3   Effects Related to Water Transfers**

38    Historically water transfer programs have been developed on an annual basis.  
39    The demand for water transfers is dependent upon the availability of water  
40    supplies to meet water demands. Water transfer transactions have increased over  
41    time as CVP and SWP water supply availability has decreased, especially during  
42    drier water years.

1 Parties seeking water transfers generally acquire water from sellers who have  
 2 available surface water who can make the water available through releasing  
 3 previously stored water; pumping groundwater instead of using surface water  
 4 (groundwater substitution); idle crops; or substitute crops that use less water in  
 5 order to reduce normal consumptive use of surface water.

6 Water transfers using CVP and SWP Delta pumping plants and south of Delta  
 7 canals generally occur when there is unused capacity in these facilities. These  
 8 conditions generally occur during drier water year types when the flows from  
 9 upstream reservoirs plus unregulated flows are adequate to meet the Sacramento  
 10 Valley water demands and the CVP and SWP export allocations. In non-wet  
 11 years, the CVP and SWP water allocations would be less than full contract  
 12 amounts; therefore, capacity may be available in the CVP and SWP conveyance  
 13 facilities to move water from other sources.

14 Projecting future visual conditions related to water transfer activities is difficult  
 15 because specific water transfer actions required to make the water available,  
 16 convey the water, and/or use the water would change each year due to changing  
 17 hydrological conditions, CVP and SWP water availability, specific local agency  
 18 operations, and local cropping patterns. Reclamation recently prepared a long-  
 19 term regional water transfer environmental document which evaluated potential  
 20 changes in conditions related to water transfer actions (Reclamation 2014c).  
 21 Results from this analysis were used to inform the impact assessment of potential  
 22 effects of water transfers under the alternatives as compared to the No Action  
 23 Alternative and the Second Basis of Comparison.

#### 24 **14.4.2 Conditions in Year 2030 without Implementation of** 25 **Alternatives 1 through 5**

26 This EIS includes two bases of comparison, as described in Chapter 3,  
 27 Description of Alternatives: the No Action Alternative and the Second Basis of  
 28 Comparison. Both of these bases are evaluated at 2030 conditions. Changes that  
 29 would occur over the next 15 years without implementation of the alternatives are  
 30 not analyzed in this EIS. However, the changes to visual resources that are  
 31 assumed to occur by 2030 under the No Action Alternative and the Second Basis  
 32 of Comparison are summarized in this section. Many of the changed conditions  
 33 would occur in the same manner under both the No Action Alternative and the  
 34 Second Basis of Comparison.

##### 35 **14.4.2.1 Common Changes in Conditions under the No Action Alternative** 36 **and Second Basis of Comparison**

37 Conditions in 2030 would be different than existing conditions due to:

- 38 • Climate change and sea-level rise
- 39 • General plan development throughout California, including increased water  
 40 demands in portions of Sacramento Valley
- 41 • Implementation of reasonable and foreseeable water resources management  
 42 projects to provide water supplies

1 It is anticipated that climate change would result in more short-duration high-  
2 rainfall events and less snowpack in the winter and early spring months. The  
3 reservoirs would be full more frequently by the end of April or May by 2030 than  
4 in recent historical conditions. However, as the water is released in the spring,  
5 there would be less snowpack to refill the reservoirs. This condition would  
6 reduce reservoir storage and available water supplies to downstream uses in the  
7 summer. The reduced end-of-September storage would also reduce the ability to  
8 release stored water to downstream regional reservoirs. These conditions would  
9 occur for all reservoirs in the California foothills and mountains, including non-  
10 CVP and SWP reservoirs.

11 These changes would result in a decline of the long-term average CVP and SWP  
12 water supply deliveries by 2030 as compared to recent historical long-term  
13 average deliveries under the No Action Alternative and the Second Basis of  
14 Comparison. However, the CVP and SWP water deliveries would be less under  
15 the No Action Alternative as compared to the Second Basis of Comparison, as  
16 described in Chapter 5, Surface Water Resources and Water Supplies, which  
17 could result in more crop-idling.

18 Under the No Action Alternative and the Second Basis of Comparison, land uses  
19 in 2030 would occur in accordance with adopted general plans. Development  
20 under the general plans would change visual resources, especially near municipal  
21 areas.

22 The No Action Alternative and the Second Basis of Comparison assumes  
23 completion of water resources management and environmental restoration  
24 projects that would have occurred without implementation of Alternatives 1  
25 through 5, including regional and local recycling projects, surface water and  
26 groundwater storage projects, conveyance improvement projects, and desalination  
27 projects, as described in Chapter 3, Description of Alternatives. The No Action  
28 Alternative and the Second Basis of Comparison also assumes implementation of  
29 actions included in the 2008 U.S. Fish and Wildlife Service (USFWS) Biological  
30 Opinion (BO) and 2009 National Marine Fisheries Service (NMFS) BO that  
31 would have been implemented without the BOs by 2030, as described in Chapter  
32 3, Description of Alternatives. These projects would include several projects that  
33 would affect visual resources, including:

- 34 • Restoration of more than 10,000 acres of intertidal and associated subtidal  
35 wetlands in Suisun Marsh and Cache Slough; and at least 17,000 to  
36 20,000 acres of seasonal floodplain restoration in Yolo Bypass
- 37 • Restoration of Battle Creek
- 38 • Implementation of Red Bluff Pumping Plant

### 39 **14.4.3 Evaluation of Alternatives**

40 Alternatives 1 through 5 have been compared to the No Action Alternative; and  
41 the No Action Alternative and Alternatives 1 through 5 have been compared to  
42 the Second Basis of Comparison.

1 During review of the numerical modeling analyses used in this EIS, an error was  
 2 determined in the CalSim II model assumptions related to the Stanislaus River  
 3 operations for the Second Basis of Comparison, Alternative 1, and Alternative 4  
 4 model runs. Appendix 5C includes a comparison of the CalSim II model run  
 5 results presented in this chapter and CalSim II model run results with the error  
 6 corrected. Appendix 5C also includes a discussion of changes in the comparison  
 7 of groundwater conditions for the following alternative analyses.

- 8 • No Action Alternative compared to the Second Basis of Comparison
- 9 • Alternative 1 compared to the No Action Alternative
- 10 • Alternative 3 compared to the Second Basis of Comparison
- 11 • Alternative 5 compared to the Second Basis of Comparison

12 **14.4.3.1 No Action Alternative**

13 The No Action Alternative is compared to the Second Basis of Comparison.

14 **14.4.3.1.1 Trinity River Region**

15 *Potential Changes in Visual Resources at Reservoirs that Store CVP and*  
 16 *SWP Water*

17 Changes in CVP water supplies and operations under the No Action Alternative  
 18 as compared to the Second Basis of Comparison would result in similar end-of-  
 19 September reservoir elevations (changes within 5 percent) and related visual  
 20 resources at Trinity Lake in all water year types, as described in Chapter 5,  
 21 Surface Water Resources and Water Supplies.

22 **14.4.3.1.2 Central Valley Region**

23 *Potential Changes in Visual Resources at Reservoirs that Store CVP and*  
 24 *SWP Water*

25 Changes in CVP water supplies and operations under the No Action Alternative  
 26 as compared to the Second Basis of Comparison would result in similar end-of-  
 27 September reservoir elevations and related visual resources at Shasta Lake, Lake  
 28 Oroville, Folsom Lake, and New Melones Reservoir in all water year types; and  
 29 at San Luis Reservoir in above-normal, below-normal, and dry years, as described  
 30 in Chapter 5, Surface Water Resources and Water Supplies. Changes in visual  
 31 resources at San Luis Reservoir would be reduced in wet year and critical dry  
 32 years because the end-of-September surface water elevations would be reduced by  
 33 6.2 percent in wet and critical dry years.

34 *Effects Related to Cross Delta Water Transfers*

35 Potential effects to visual resources could be similar to those identified in a recent  
 36 environmental analysis conducted by Reclamation for long-term water transfers  
 37 from the Sacramento to San Joaquin valleys (Reclamation 2014c). Potential  
 38 effects to visual resources were identified as changes in reservoir surface water  
 39 elevations, streams, irrigated acreage, and water elevations in canals that would  
 40 convey transferred water. The analysis indicated that these potential impacts  
 41 would not be substantial because the conditions with and without the water  
 42 transfers would be similar.

1 Under the No Action Alternative, the timing of cross Delta water transfers would  
2 be limited to July through September and include annual volumetric limits, in  
3 accordance with the 2008 USFWS BO and 2009 NMFS BO. Under the Second  
4 Basis of Comparison, water could be transferred throughout the year without an  
5 annual volumetric limit. Overall, the potential for cross Delta water transfers  
6 would be less under the No Action Alternative than under the Second Basis of  
7 Comparison.

8 **14.4.3.1.3 San Francisco Bay Area, Central Coast, and Southern California**  
9 **Regions**

10 *Potential Changes in Visual Resources at Reservoirs that Store CVP and*  
11 *SWP Water*

12 Changes in visual resources at reservoirs that store CVP and SWP water supplies  
13 are assumed to be related to changes in water deliveries over long-term conditions  
14 for this EIS analysis. Monthly deliveries are not necessarily indicative of  
15 reservoir storage because all or a portion of the water deliveries could be directly  
16 conveyed to water users in any specific month. Therefore, annual deliveries are  
17 considered to be relatively proportional to the amount of water that could be  
18 stored over all water year types. In the San Francisco Bay Area Region, values  
19 for the CVP municipal and industrial water deliveries and the SWP south of the  
20 Delta water deliveries (without Article 21 deliveries) were considered; and SWP  
21 south of the Delta water deliveries (without Article 21 deliveries) were considered  
22 for the Central Coast and Southern California regions. Under the No Action  
23 Alternative as compared to the Second Basis of Comparison CVP water deliveries  
24 would be reduced by 10 percent and SWP water deliveries would be reduced by  
25 18 percent. Therefore, for this EIS analysis, it is assumed that visual resources  
26 related to surface water elevations in reservoirs that store CVP and SWP water  
27 supplies would be reduced by 10 to 18 percent in the San Francisco Bay Area  
28 Region and 18 percent in the Central Coast and Southern California regions.

29 **14.4.3.2 Alternative 1**

30 Alternative 1 is identical to the Second Basis of Comparison. Alternative 1 is  
31 compared to the No Action Alternative and the Second Basis of Comparison.  
32 However, because visual resource conditions under Alternative 1 are identical to  
33 visual resource conditions under the Second Basis of Comparison; Alternative 1 is  
34 only compared to the No Action Alternative.

35 **14.4.3.2.1 Alternative 1 Compared to the No Action Alternative**

36 *Trinity River Region*

37 *Potential Changes in Visual Resources at Reservoirs that Store CVP and*  
38 *SWP Water*

39 Changes in CVP water supplies and operations under Alternative 1 as compared  
40 to the No Action Alternative would result in similar end-of-September reservoir  
41 elevations and related visual resources at Trinity Lake in all water year types, as  
42 described in Chapter 5, Surface Water Resources and Water Supplies.

1 *Central Valley Region*

2 *Potential Changes in Visual Resources at Reservoirs that Store CVP and*  
 3 *SWP Water*

4 Changes in CVP water supplies and operations under Alternative 1 as compared  
 5 to the No Action Alternative would result in similar end-of-September reservoir  
 6 elevations and related visual resources at Shasta Lake, Lake Oroville, Folsom  
 7 Lake, and New Melones Reservoir in all water year types; and at San Luis  
 8 Reservoir in above-normal, below-normal, and dry years, as described in Chapter  
 9 5, Surface Water Resources and Water Supplies. Changes in visual resources at  
 10 San Luis Reservoir would be reduced in wet year and critical dry years because  
 11 the end-of-September surface water elevations would be increased by 6.6 percent  
 12 in wet and critical dry years.

13 *Effects Related to Cross Delta Water Transfers*

14 Potential effects to visual resources could be similar to those identified in a recent  
 15 environmental analysis conducted by Reclamation for long-term water transfers  
 16 from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described  
 17 above under the No Action Alternative compared to the Second Basis of  
 18 Comparison. For the purposes of this EIS, it is anticipated that similar conditions  
 19 would occur during implementation of cross Delta water transfers under  
 20 Alternative 1 and the No Action Alternative, and that impacts on visual resources  
 21 would not be substantial in the seller's service area due to implementation  
 22 requirements of the transfer programs.

23 Under Alternative 1, water could be transferred throughout the year without an  
 24 annual volumetric limit. Under the No Action Alternative, the timing of cross  
 25 Delta water transfers would be limited to July through September and include  
 26 annual volumetric limits, in accordance with the 2008 USFWS BO and 2009  
 27 NMFS BO. Overall, the potential for cross Delta water transfers would be  
 28 increased under Alternative 1 as compared to the No Action Alternative.

29 *San Francisco Bay Area, Central Coast, and Southern California Regions*

30 *Potential Changes in Visual Resources at Reservoirs that Store CVP and*  
 31 *SWP Water*

32 Changes in visual resources at reservoirs that store CVP and SWP water supplies  
 33 are assumed to be related to changes in water deliveries over long-term conditions  
 34 for this EIS analysis, as described above under the No Action Alternative as  
 35 compared to the Second Basis of Comparison. Therefore, under Alternative 1 as  
 36 compared to the No Action Alternative, visual resources related to surface water  
 37 elevations in reservoirs that store CVP and SWP water supplies would be  
 38 increased by 11 to 21 percent in the San Francisco Bay Area Region and  
 39 21 percent in the Central Coast and Southern California regions.

40 **14.4.3.2.2 Alternative 1 Compared to the Second Basis of Comparison**

41 Alternative 1 is identical to the Second Basis of Comparison.



1    **14.4.3.3    Alternative 2**

2    The CVP and SWP operations under Alternative 2 are identical to the CVP and  
3    SWP operations under the No Action Alternative; therefore, Alternative 2 is only  
4    compared to the Second Basis of Comparison.

5    **14.4.3.3.1    Alternative 2 Compared to the Second Basis of Comparison**

6    The CVP and SWP operations under Alternative 2 are identical to the CVP and  
7    SWP operations under the No Action Alternative. Therefore, changes to visual  
8    resources conditions under Alternatives 2 as compared to the Second Basis of  
9    Comparison would be the same as the impacts described in Section 14.4.3.1, No  
10   Action Alternative.

11   **14.4.3.4    Alternative 3**

12   As described in Chapter 3, Description of Alternatives, CVP and SWP operations  
13   under Alternative 3 are similar to the Second Basis of Comparison with modified  
14   Old and Middle River flow criteria and New Melones Reservoir operations. As  
15   described in Chapter 4, Approach to Environmental Analysis, Alternative 3 is  
16   compared to the No Action Alternative and the Second Basis of Comparison.

17   **14.4.3.4.1    Alternative 3 Compared to the No Action Alternative**

18    *Trinity River Region*

19        *Potential Changes in Visual Resources at Reservoirs that Store CVP and*  
20        *SWP Water*

21   Changes in CVP water supplies and operations under Alternative 3 as compared  
22   to the No Action Alternative would result in similar end-of-September reservoir  
23   elevations and related visual resources at Trinity Lake in all water year types, as  
24   described in Chapter 5, Surface Water Resources and Water Supplies.

25    *Central Valley Region*

26        *Potential Changes in Visual Resources at Reservoirs that Store CVP and*  
27        *SWP Water*

28   Changes in CVP water supplies and operations under Alternative 3 as compared  
29   to the No Action Alternative would result in similar end-of-September reservoir  
30   elevations and related visual resources at Shasta Lake, Lake Oroville, Folsom  
31   Lake, and New Melones Reservoir in all water year types; and at San Luis  
32   Reservoir in below-normal, dry, and critical dry years, as described in Chapter 5,  
33   Surface Water Resources and Water Supplies. Changes in visual resources at San  
34   Luis Reservoir would be reduced in wet year and critical dry years because the  
35   end-of-September surface water elevations would be increased by 7.9 percent in  
36   wet years and 5.7 percent in above-normal years.

37        *Effects Related to Cross Delta Water Transfers*

38   Potential effects to visual resources could be similar to those identified in a recent  
39   environmental analysis conducted by Reclamation for long-term water transfers  
40   from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described  
41   above under the No Action Alternative compared to the Second Basis of

1 Comparison. For the purposes of this EIS, it is anticipated that similar conditions  
 2 would occur during implementation of cross Delta water transfers under  
 3 Alternative 3 and the No Action Alternative, and that impacts on visual resources  
 4 would not be substantial in the seller’s service area due to implementation  
 5 requirements of the transfer programs.

6 Under Alternative 3, water could be transferred throughout the year without an  
 7 annual volumetric limit. Under the No Action Alternative, the timing of cross  
 8 Delta water transfers would be limited to July through September and include  
 9 annual volumetric limits, in accordance with the 2008 USFWS BO and 2009  
 10 NMFS BO. Overall, the potential for cross Delta water transfers would be  
 11 increased under Alternative 3 as compared to the No Action Alternative.

12 *San Francisco Bay Area, Central Coast, and Southern California Regions*

13 *Potential Changes in Visual Resources at Reservoirs that Store CVP and*  
 14 *SWP Water*

15 Changes in visual resources at reservoirs that store CVP and SWP water supplies  
 16 are assumed to be related to changes in water deliveries over long-term conditions  
 17 for this EIS analysis, as described above under the No Action Alternative as  
 18 compared to the Second Basis of Comparison. Therefore, under Alternative 3 as  
 19 compared to the No Action Alternative, visual resources related to surface water  
 20 elevations in reservoirs that store CVP and SWP water supplies would be  
 21 increased by 9 to 17 percent in the San Francisco Bay Area Region and 17 percent  
 22 in the Central Coast and Southern California regions.

23 **14.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison**

24 *Trinity River Region*

25 *Potential Changes in Visual Resources at Reservoirs that Store CVP and*  
 26 *SWP Water*

27 Changes in CVP water supplies and operations under Alternative 3 as compared  
 28 to the Second Basis of Comparison would result in similar end-of-September  
 29 reservoir elevations and related visual resources at Trinity Lake in all water year  
 30 types, as described in Chapter 5, Surface Water Resources and Water Supplies.

31 *Central Valley Region*

32 *Potential Changes in Visual Resources at Reservoirs that Store CVP and*  
 33 *SWP Water*

34 Changes in CVP water supplies and operations under Alternative 3 as compared  
 35 to the Second Basis of Comparison would result in similar end-of-September  
 36 reservoir elevations and related visual resources at Shasta Lake, Lake Oroville,  
 37 Folsom Lake, New Melones Reservoir, and San Luis Reservoir in all water year  
 38 types, as described in Chapter 5, Surface Water Resources and Water Supplies.

39 *Effects Related to Cross Delta Water Transfers*

40 Potential effects to visual resources could be similar to those identified in a recent  
 41 environmental analysis conducted by Reclamation for long-term water transfers  
 42 from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described

1 above under the No Action Alternative compared to the Second Basis of  
2 Comparison. For the purposes of this EIS, it is anticipated that similar conditions  
3 would occur during implementation of cross Delta water transfers under  
4 Alternative 3 and the Second Basis of Comparison, and that impacts on visual  
5 resources would not be substantial in the seller's service area due to  
6 implementation requirements of the transfer programs.

7 Under Alternative 3 and the Second Basis of Comparison, water could be  
8 transferred throughout the year without an annual volumetric limit. Overall, the  
9 potential for cross Delta water transfers would be similar under Alternative 3 and  
10 the Second Basis of Comparison.

11 *San Francisco Bay Area, Central Coast, and Southern California Regions*

12 *Potential Changes in Visual Resources at Reservoirs that Store CVP and*  
13 *SWP Water*

14 Changes in visual resources at reservoirs that store CVP and SWP water supplies  
15 are assumed to be related to changes in water deliveries over long-term conditions  
16 for this EIS analysis, as described above under the No Action Alternative as  
17 compared to the Second Basis of Comparison. Therefore, under Alternative 3 as  
18 compared to the Second Basis of Comparison, visual resources related to surface  
19 water elevations in reservoirs that store CVP and SWP water supplies would be  
20 similar (changes within 5 percent).

#### 21 **14.4.3.5 Alternative 4**

22 The visual resources conditions under Alternative 4 would be identical to the  
23 conditions under the Second Basis of Comparison; therefore, Alternative 4 is only  
24 compared to the No Action Alternative.

#### 25 **14.4.3.5.1 Alternative 4 Compared to the No Action Alternative**

26 The CVP and SWP operations under Alternative 4 are identical to the CVP and  
27 SWP operations under the Second Basis of Comparison and Alternative 1.  
28 Therefore, changes in visual resources conditions under Alternative 4 as  
29 compared to the No Action Alternative would be the same as the impacts  
30 described in Section 14.4.3.2.1, Alternative 1 Compared to the No Action  
31 Alternative.

#### 32 **14.4.3.6 Alternative 5**

33 As described in Chapter 3, Description of Alternatives, CVP and SWP operations  
34 under Alternative 5 are similar to the No Action Alternative with modified Old  
35 and Middle Rivers (OMR) flow criteria and New Melones Reservoir operations.  
36 As described in Chapter 4, Approach to Environmental Analysis, Alternative 5 is  
37 compared to the No Action Alternative and the Second Basis of Comparison.

1 **14.4.3.6.1 Alternative 5 Compared to the No Action Alternative**

2 *Trinity River Region*

3 *Potential Changes in Visual Resources at Reservoirs that Store CVP and*  
 4 *SWP Water*

5 Changes in CVP water supplies and operations under Alternative 5 as compared  
 6 to the No Action Alternative would result in similar end-of-September reservoir  
 7 elevations and related visual resources at Trinity Lake in all water year types, as  
 8 described in Chapter 5, Surface Water Resources and Water Supplies.

9 *Central Valley Region*

10 *Potential Changes in Visual Resources at Reservoirs that Store CVP and*  
 11 *SWP Water*

12 Changes in CVP water supplies and operations under Alternative 5 as compared  
 13 to the No Action Alternative would result in similar end-of-September reservoir  
 14 elevations and related visual resources at Shasta Lake, Lake Oroville, Folsom  
 15 Lake, New Melones Reservoir, and San Luis Reservoir in all water year types, as  
 16 described in Chapter 5, Surface Water Resources and Water Supplies.

17 *Effects Related to Cross Delta Water Transfers*

18 Potential effects to visual resources could be similar to those identified in a recent  
 19 environmental analysis conducted by Reclamation for long-term water transfers  
 20 from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described  
 21 above under the No Action Alternative compared to the Second Basis of  
 22 Comparison. For the purposes of this EIS, it is anticipated that similar conditions  
 23 would occur during implementation of cross Delta water transfers under  
 24 Alternative 5 and the No Action Alternative, and that impacts on visual resources  
 25 would not be substantial in the seller’s service area due to implementation  
 26 requirements of the transfer programs.

27 Under Alternative 5 and the No Action Alternative, the timing of cross Delta  
 28 water transfers would be limited to July through September and include annual  
 29 volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO.  
 30 Overall, the potential for cross Delta water transfers would be similar under  
 31 Alternative 5 and the No Action Alternative.

32 *San Francisco Bay Area, Central Coast, and Southern California Region*

33 *Potential Changes in Visual Resources at Reservoirs that Store CVP and*  
 34 *SWP Water*

35 Changes in visual resources at reservoirs that store CVP and SWP water supplies  
 36 are assumed to be related to changes in water deliveries over long-term conditions  
 37 for this EIS analysis, as described above under the No Action Alternative as  
 38 compared to the Second Basis of Comparison. Therefore, under Alternative 5 as  
 39 compared to the No Action Alternative, visual resources would be similar.

1 **14.4.3.6.2 Alternative 5 Compared to the Second Basis of Comparison**

2 *Trinity River Region*

3 *Potential Changes in Visual Resources at Reservoirs that Store CVP and*  
4 *SWP Water*

5 Changes in CVP water supplies and operations under Alternative 5 as compared  
6 to the Second Basis of Comparison would result in similar end-of-September  
7 reservoir elevations and related visual resources at Trinity Lake in all water year  
8 types, as described in Chapter 5, Surface Water Resources and Water Supplies.

9 *Central Valley Region*

10 *Potential Changes in Visual Resources at Reservoirs that Store CVP and*  
11 *SWP Water*

12 Changes in CVP water supplies and operations under Alternative 5 as compared  
13 to the Second Basis of Comparison would result in similar end-of-September  
14 reservoir elevations and related visual resources at Shasta Lake, Lake Oroville,  
15 Folsom Lake, and New Melones Reservoir in all water year types; and at San Luis  
16 Reservoir in wet, above-normal, and below-normal years, as described in Chapter  
17 5, Surface Water Resources and Water Supplies. Changes in visual resources at  
18 San Luis Reservoir would be reduced in dry year and critical dry years because  
19 the end-of-September surface water elevations would be decreased by 6.2 percent  
20 in dry years and 8.5 percent in critical dry years.

21 *Effects Related to Cross Delta Water Transfers*

22 Potential effects to visual resources could be similar to those identified in a recent  
23 environmental analysis conducted by Reclamation for long-term water transfers  
24 from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described  
25 above under the No Action Alternative compared to the Second Basis of  
26 Comparison. For the purposes of this EIS, it is anticipated that similar conditions  
27 would occur during implementation of cross Delta water transfers under  
28 Alternative 5 and the Second Basis of Comparison, and that impacts on visual  
29 resources would not be substantial in the seller's service area due to  
30 implementation requirements of the transfer programs.

31 Under Alternative 5, the timing of cross Delta water transfers would be limited to  
32 July through September and include annual volumetric limits, in accordance with  
33 the 2008 USFWS BO and 2009 NMFS BO. Under the Second Basis of  
34 Comparison, water could be transferred throughout the year without an annual  
35 volumetric limit. Overall, the potential for cross Delta water transfers would be  
36 reduced under Alternative 5 as compared to the Second Basis of Comparison.

37 *San Francisco Bay Area, Central Coast, and Southern California Regions*

38 *Potential Changes in Visual Resources at Reservoirs that Store CVP and*  
39 *SWP Water*

40 Changes in visual resources at reservoirs that store CVP and SWP water supplies  
41 are assumed to be related to changes in water deliveries over long-term conditions  
42 for this EIS analysis, as described above under the No Action Alternative as  
43 compared to the Second Basis of Comparison. Therefore, under Alternative 5 as

1 compared to the Second Basis of Comparison, visual resources related to surface  
 2 water elevations in reservoirs that store CVP and SWP water supplies would be  
 3 reduced by 10 to 18 percent in the San Francisco Bay Area Region and 18 percent  
 4 in the Central Coast and Southern California regions.

5 **14.4.3.7 Summary of Impact Assessment**

6 The results of the impact assessment of implementation of Alternatives 1 through  
 7 5 as compared to the No Action Alternative and the Second Basis of Comparison  
 8 are presented in Tables 14.1 and 14.2.

9 **Table 14.1 Comparison of Alternatives 1 through 5 to No Action Alternative**

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	Visual resources would be similar at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir in all water year types; and at San Luis Reservoir in above-normal, below-normal, and dry years. Visual resources would be increased by 6 percent in wet and critical dry years at San Luis Reservoir, by 11 to 21 percent in the San Francisco Bay Area Region, and by 21 percent in the Central Coast and Southern California regions.	None needed.
Alternative 2	No effects on visual resources.	None needed.
Alternative 3	Visual resources would be similar at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir in all water year types; and at San Luis Reservoir in above-normal, below-normal, and dry years. Visual resources would be increased by 8 percent in wet years and 6 percent in above-normal years at San Luis Reservoir, by 9 to 17 percent in the San Francisco Bay Area Region, and by 17 percent in the Central Coast and Southern California regions.	None needed.
Alternative 4	Same effects as described for Alternative 1 compared to the No Action Alternative.	None needed.
Alternative 5	Visual resources would be similar at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, San Luis Reservoir, and other reservoirs that store CVP and SWP water in the San Francisco Bay Area, Central Coast, and Southern California regions.	None needed.

10 Note: Due to the limitations and uncertainty in the CalSim II monthly model and other  
 11 analytical tools, incremental differences of 5 percent or less between alternatives and the  
 12 Second Basis of Comparison are considered to be “similar.”

1 **Table 14.2 Comparison of No Action Alternative and Alternatives 1 through 5 to**  
 2 **Second Basis of Comparison**

Alternative	Potential Change	Consideration for Mitigation Measures
No Action Alternative	Visual resources would be similar at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir in all water year types; and at San Luis Reservoir in above-normal, below-normal, and dry years. Visual resources would be reduced by 6 percent in wet and critical dry years at San Luis Reservoir, by 10 to 18 percent in the San Francisco Bay Area Region, and by 18 percent in the Central Coast and Southern California regions.	Not considered for this comparison.
Alternative 1	No effects on visual resources.	Not considered for this comparison.
Alternative 2	Same effects as described for No Action Alternative as compared to the Second Basis of Comparison.	Not considered for this comparison.
Alternative 3	Visual resources would be similar at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, San Luis Reservoir, and other reservoirs that store CVP and SWP water in the San Francisco Bay Area, Central Coast, and Southern California regions.	Not considered for this comparison.
Alternative 4	No effects on visual resources.	Not considered for this comparison.
Alternative 5	Visual resources would be similar at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir in all water year types; and at San Luis Reservoir in above-normal, below-normal, and dry years. Visual resources would be reduced by 6 percent in dry years and 9 percent in critical dry years at San Luis Reservoir, by 10 to 18 percent in the San Francisco Bay Area Region, and by 18 percent in the Central Coast and Southern California regions.	Not considered for this comparison.

3 Note: Due to the limitations and uncertainty in the CalSim II monthly model and other  
 4 analytical tools, incremental differences of 5 percent or less between alternatives and the  
 5 Second Basis of Comparison are considered to be “similar.”

6 **14.4.3.8 Potential Mitigation Measures**

7 Mitigation measures are presented in this section to avoid, minimize, rectify,  
 8 reduce, eliminate, or compensate for adverse environmental effects of  
 9 Alternatives 1 through 5 as compared to the No Action Alternative. Mitigation  
 10 measures were not included to address adverse impacts under the alternatives as

1 compared to the Second Basis of Comparison because this analysis was included  
 2 in this EIS for information purposes only.

3 Changes in CVP and SWP operations under Alternatives 1 through 5, as  
 4 compared to the No Action Alternative, would not result in changes in visual  
 5 resources. Therefore, there would be no adverse impacts to visual resources and  
 6 no mitigation measures are required.

7 **14.4.3.9 Cumulative Effects Analysis**

8 As described in Chapter 3, the cumulative effects analysis considers projects,  
 9 programs, and policies that are not speculative and are based upon known or  
 10 reasonably foreseeable long-range plans, regulations, operating agreements, or  
 11 other information that establishes them as reasonably foreseeable.

12 The cumulative effects analysis for Alternatives 1 through 5 for Visual Resources  
 13 are summarized in Table 14.3.

14 **Table 14.3 Summary of Cumulative Effects on Visual Resources with**  
 15 **Implementation of Alternatives 1 through 5 as Compared to the No Action**  
 16 **Alternative**

Scenarios	Actions	Cumulative Effects of Actions
Past & Present, and Future Actions included in the No Action Alternative in All Alternatives in Year 2030	Consistent with Affected Environment conditions plus: Actions in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives), including climate change and sea level rise Actions not included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives): <ul style="list-style-type: none"> <li>- Implementation of Federal and state policies and programs, including Clean Water Act (e.g., Total Maximum Daily Loads); Safe Drinking Water Act; Clean Air Act; and flood management programs</li> <li>- General plans for 2030.</li> <li>- Trinity River Restoration Program.</li> <li>- Central Valley Project Improvement Act programs</li> <li>- Folsom Dam Water Control Manual Update</li> <li>- FERC Relicensing for the Middle Fork of the American River Project</li> <li>- Lower Mokelumne River Spawning Habitat Improvement Project</li> </ul>	<u>These effects would be the same under all alternatives.</u> Climate change and sea level rise, development under the general plans, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce end of September storage in CVP and SWP reservoirs compared to past conditions, and to reduce CVP and SWP water supply reliability which could result in less irrigated lands compared to past conditions. General plans would be completed for projected conditions by 2030, as described in Chapter 13, Land Use. Restoration plans for the ongoing programs would be completed which would change visual resources of the restored lands.



Scenarios	Actions	Cumulative Effects of Actions
	<ul style="list-style-type: none"> <li>- Dutch Slough Tidal Marsh Restoration</li> <li>- Suisun Marsh Habitat Management, Preservation, and Restoration Plan Implementation</li> <li>- Tidal Wetland Restoration: Yolo Ranch, Northern Liberty Island Fish Restoration Project, Prospect Island Restoration Project, and Calhoun Cut/Lindsey Slough Tidal Habitat Restoration Project</li> <li>- San Joaquin River Restoration Program</li> <li>- Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects with completed environmental documents)</li> </ul>	
<p>Future Actions considered as Cumulative Effects Actions in All Alternatives in Year 2030</p>	<p>Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives):</p> <ul style="list-style-type: none"> <li>- Bay-Delta Water Quality Control Plan Update</li> <li>- FERC Relicensing Projects</li> <li>- Bay Delta Conservation Plan (including the California WaterFix alternative)</li> <li>- Shasta Lake Water Resources, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations</li> <li>- El Dorado Water and Power Authority Supplemental Water Rights Project</li> <li>- Sacramento River Water Reliability Project</li> <li>- Semitropic Water Storage District Delta Wetlands</li> <li>- North Bay Aqueduct Alternative Intake</li> <li>- San Luis Reservoir Low Point Improvement Project</li> <li>- Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects that did not have completed environmental documents during preparation of the EIS)</li> </ul>	<p><u>These effects would be the same under all alternatives.</u></p> <p>Most of the future reasonably foreseeable actions are anticipated to reduce water supply impacts due to climate change, sea level rise, increased water allocated to improve habitat conditions, and future growth.</p> <p>Some of the future reasonably foreseeable actions related to improved water quality and habitat conditions (e.g., Water Quality Control Plan Update and FERC Relicensing Projects), could in further reductions in CVP and SWP water deliveries and associated extent of irrigated lands.</p>

Scenarios	Actions	Cumulative Effects of Actions
No Action Alternative with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO	<p>Climate change and sea level rise, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce end of September CVP and SWP reservoir storage as compared to past conditions.</p> <p>Community development would occur in accordance with general plan projections for 2030. Restoration plans for the ongoing programs would be completed.</p> <p>Future water supply projects are anticipated to both increase water supply reliability due to reduced surface water supplies and to accommodate planned growth in the general plans.</p>
Alternative 1 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternative 1 with future reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 2 with Associated Cumulative Effects Actions in Year 2030	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions</p> <p>No implementation of structural improvements or other actions that require further study to develop a more detailed action description.</p>	Implementation of Alternative 2 with future reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 3 with Associated Cumulative Effects Actions in Year 2030	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)</p> <p>Slight increase in positive Old and Middle River flows in the winter and spring months</p>	Implementation of Alternative 3 with future reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 4 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternative 4 with future reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 5 with Associated Cumulative Effects Actions in Year 20530	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO</p> <p>Positive Old and Middle River flows and increased Delta outflow in spring months</p>	Implementation of Alternative 5 with future reasonably foreseeable actions would result in similar changes as under the No Action Alternative with added actions.

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**Chapter 15****1 Recreation Resources****2 15.1 Introduction**

3 This chapter describes recreational resources in the study area; and potential  
4 changes that could occur as a result of implementing the alternatives evaluated in  
5 this Environmental Impact Statement (EIS). Implementation of the alternatives  
6 could affect recreation resources through potential changes in operation of the  
7 Central Valley Project (CVP) and State Water Project (SWP) and ecosystem  
8 restoration.

**9 15.2 Regulatory Environment and Compliance  
10 Requirements**

11 Potential actions that could be implemented under the alternatives evaluated in  
12 this EIS could affect recreational resources at reservoirs and lands served by CVP  
13 and SWP water supplies. Actions located on public agency lands; or  
14 implemented, funded, or approved by Federal and state agencies would need to be  
15 compliant with appropriate Federal and state agency policies and regulations, as  
16 summarized in Chapter 4, Approach to Environmental Analyses.

**17 15.3 Affected Environment**

18 This section describes recreational resources that could be potentially affected by  
19 the implementation of the alternatives considered in this EIS. Changes in  
20 recreation opportunities due to changes in CVP and SWP operations may occur in  
21 the Trinity River, Central Valley, San Francisco Bay Area, Central Coast, and  
22 Southern California regions. Recreational fishing in San Francisco Bay and along  
23 the Pacific Coast also may be affected by changes in CVP and SWP operations.

24 There are extensive recreational opportunities within this study area. However,  
25 the recreational opportunities that could be directly or indirectly affected through  
26 implementation of the alternatives analyzed in this EIS are related to water-related  
27 recreation activities at CVP and SWP reservoirs and in the rivers downstream of  
28 those reservoir, fishing opportunities in the Delta and the Pacific Ocean that are  
29 affected by the water flows managed by CVP and SWP operations, and bird  
30 watching, wildlife viewing, and hunting activities at wildlife refuges that use CVP  
31 water supplies. Therefore, the following description of the affected environment  
32 is limited to these recreational aspects. The wildlife refuges identified to receive  
33 CVP water supplies are shown on Figure 15.1.

1 **15.3.1 Trinity River Region**

2 The Trinity River Region includes the area along the Trinity River from Trinity  
 3 Lake to the confluence with the Klamath River; and along the lower Klamath  
 4 River from the confluence with the Trinity River to the Pacific Ocean. Major  
 5 recreational opportunities occur at Trinity Lake, Lewiston Reservoir, along the  
 6 Trinity River between Lewiston Reservoir and the confluence with the Klamath  
 7 River, and along the lower Klamath River.

8 **15.3.1.1 Trinity Lake**

9 Trinity Lake is a CVP facility on the Trinity River that is located approximately  
 10 50 miles northwest of Redding, as described in Chapter 5, Surface Water  
 11 Resources and Water Supplies. Trinity Lake is part of the Whiskeytown-Shasta-  
 12 Trinity National Recreation Area and part of the Shasta-Trinity National Forest.  
 13 Recreational facilities and activities at Trinity Lake are administered by the U.S.  
 14 Forest Service (USFS). When the water storage in the reservoir is at full capacity  
 15 (water elevation at 2370 feet mean sea level (msl), Trinity Lake has a surface area  
 16 of 17,222 acres and 147 miles of shoreline (USFS 2014).

17 Boating, windsurfing, and fishing primarily occur in the northern part of the lake  
 18 near Trinity Center. Houseboats, motorboats, water skiing primarily occur in the  
 19 southern part of the lake. There are six public boat ramps on Trinity Lake as  
 20 summarized in Table 15.1.

21 **Table 15.1 Trinity Lake Boat Ramps**

Location	Boat Ramp	Comments	Useable Elevations (feet, msl)
Trinity Lake	Bowerman	–	2,370 to 2,323
Trinity Lake	Clark Spring	–	2,370 to 2,313
Trinity Lake	Fairview	–	2,370 to 2,313
Trinity Lake	Minersville	–	2,305 to 2,170
Trinity Lake	Stuart Fork	–	2,370 to 2,338
Trinity Lake	Trinity Center	–	2,370 to 2,300

22 Source: USFS 2014

23 Three major marinas are located at Trinity Lake, as summarized in Table 15.2.  
 24 The USFS can permit up to 1,000 boat slips at the Trinity Lake marinas (USFS  
 25 2014). Many commercial houseboats are available for rent at the marinas.  
 26 Trinity Lake shoreline includes approximately 32 miles of prime houseboating  
 27 areas and 18.5 miles of secondary houseboating areas. The USFS issues permits  
 28 for houseboats and privately-owned recreational occupancy vehicles that use the  
 29 water overnight. At Trinity Lake, up to 99 permits for privately-owned vessels  
 30 and 85 permits for commercially-owned vessels may be issued each year.

1 **Table 15.2 Trinity Lake Marinas and Moorage Facilities**

Location	Marina and Moorage Facility	Number
Trinity Lake	Cedar Stock Resort & Marina	31 Commercial and 220 Private Slips, including 10 Commercial Houseboats
Trinity Lake	KOA Campground	15 Commercial and 110 Private Slips
Trinity Lake	Pinewood Cove Docks	52 Private Slips
Trinity Lake	Trinity Alps Marina	31 Commercial and 63 Private Slips, including 25 Commercial Houseboats
Trinity Lake	Trinity Center Marina	80 Private Slips

2 Source: USFS 2014

3 The Trinity Unit of the Whiskeytown-Shasta-Trinity National Recreation Area  
 4 includes many campground sites, including campgrounds for group camping  
 5 opportunities (USFS 2014), as summarized in Table 15.3. There are other  
 6 campgrounds within the upper elevations of the Trinity Lake watershed that are  
 7 not directly or indirectly affected by changes in surface water elevations.

8 **Table 15.3 Trinity Lake Major Campgrounds**

Location	Campground	Comments	Number of Campsites
Trinity Lake	Alpine View	–	53
Trinity Lake	Bushytail	–	11
Trinity Lake	Captain’s Point	Boat-In Campground	3
Trinity Lake	Clark Springs	–	21
Trinity Lake	Fawn	Group Campground	60
Trinity Lake	Hayward Flat	–	98
Trinity Lake	Jackass Springs	–	10
Trinity Lake	Mariner’s Roost	Boat-In Campground	7
Trinity Lake	Minersville	–	14
Trinity Lake	Ridgeville	Boat-In Campground	10
Trinity Lake	Ridgeville Island	Boat-In Campground	3
Trinity Lake	Stoney Creek	Group Campground	10
Trinity Lake	Stoney Point	–	15
Trinity Lake	Tannery Gulch	–	82

9 Source: USFS 2014

1 Trinity Lake recreational areas also include day use areas for picnicking,  
 2 swimming, and other recreational opportunities, as summarized in Table 15.4.  
 3 The locations for shoreline day use areas are limited due to the steep and rocky  
 4 elevations at the shorelines. To develop two swimming beaches at Trinity Lake,  
 5 the rocky shorelines were covered with sand and/or decomposed granite at a  
 6 specific elevation. Uses of these locations are less desirable when the water  
 7 elevations decline.

8 **Table 15.4 Trinity Lake Major Day Use Areas**

Location	Day Use Area	Comments	Number
Trinity Lake	Clark Springs Day Use and Beach	Picnic and Swimming	34 picnic sites
Trinity Lake	North Shore Vista	Vistas and Interpretative Site	–
Trinity Lake	Osprey Info Site	Vistas and Interpretative Site	–
Trinity Lake	Stoney Creek	Picnic and Swimming	4 picnic sites
Trinity Lake	Tanbark Picnic	Picnic and Swimming	8 picnic sites
Trinity Lake	Trail of Trees	Interpretative Trail at Tannery Gulch Campground	0.5 miles
Trinity Lake	Trinity Lakeshore Trail	Trail	4 miles
Trinity Lake	Trinity Vista	Vistas and Interpretative Site	–

9 Source: USFS 2014

10 Trinity Lake fishing opportunities include Smallmouth Bass, Largemouth Bass,  
 11 Rainbow Trout, Brown Trout, Chinook Salmon, and Kokanee Salmon (USFS  
 12 2014). White Catfish, Brown Bullhead, Green Sunfish, Bluegill, Klamath  
 13 Smallscale Sucker, and Pacific Lamprey also are present but are not generally  
 14 considered as part of the recreational fishing opportunities. Wildlife viewing  
 15 opportunities extend throughout the Trinity Lake area, including viewing of Bald  
 16 Eagles, Black-tailed Deer, Black Bear, Gray Squirrel, rabbit, turkey, and  
 17 California Quail.

18 **15.3.1.2 Lewiston Reservoir**

19 Lewiston Reservoir is a CVP facility on the Trinity River that is located  
 20 immediately downstream of the Trinity Dam, as described in Chapter 5, Surface  
 21 Water Resources and Water Supplies. Lewiston Reservoir is part of the  
 22 Whiskeytown-Shasta-Trinity National Recreation Area and part of the Shasta-  
 23 Trinity National Forest. Recreational facilities and activities are administered by  
 24 the USFS. When the water storage in the reservoir is at full capacity (water

1 elevation at 1,874 feet msl), the reservoir has a surface area of 759 acres and  
 2 15 miles of shoreline (USFS 2014).  
 3 The water elevation is generally stable in Lewiston Reservoir because it is used as  
 4 regulating reservoir for releases to downstream uses. Water is diverted from the  
 5 lower outlets in Trinity Lake to Lewiston Reservoir to provide cold water to  
 6 Trinity River and Whiskeytown Lake. Therefore, recreational opportunities in  
 7 Lewiston Reservoir include boating and fishing; however, there are fewer  
 8 opportunities for swimming and water skiing. Lewiston Reservoir does not  
 9 support houseboats. There is one primary boat ramp and two marinas in Lewiston  
 10 Reservoir, as summarized in Tables 15.5 and 15.6.

11 **Table 15.5 Lewiston Reservoir Boat Ramps**

Location	Boat Ramp	Comments	Useable Elevations (feet, msl)
Lewiston Lake	Pine Cove	Open all year	Around 1870

12 Source: USFS 2014

13 **Table 15.6 Lewiston Lake Marinas and Moorage Facilities**

Location	Marina and Moorage Facility	Number
Lewiston Lake	Lakeview Terrace Docks	14 Commercial and 7 Private Slips
Lewiston Lake	Pine Cove Marina	20 Commercial and 34 Private Slips

14 Source: USFS 2014

15 The Whiskeytown-Shasta-Trinity National Recreation Area includes campground  
 16 sites near the Lewiston Reservoir shoreline, including campgrounds for group  
 17 camping opportunities (USFS 2014), as summarized in Table 15.7. Lewiston  
 18 Reservoir recreational areas also include day use areas for picnicking, swimming,  
 19 and other recreational opportunities, as summarized in Table 15.8. Because the  
 20 water surface elevations are more stable in Lewiston Reservoir than Trinity Lake,  
 21 the day use areas have more vegetation along the shoreline.

22 **Table 15.7 Lewiston Lake Major Campgrounds**

Location	Campground	Comments	Number of Campsites
Lewiston Lake	Ackerman	–	51
Lewiston Lake	Cooper Gulch	–	5
Lewiston Lake	Mary Smith	–	17
Lewiston Lake	Tunnel Rock	–	6

23 Source: USFS 2014

1 **Table 15.8 Lewiston Major Lake Day Use Areas**

Location	Day Use Area	Comments	Number
Lewiston Lake	Baker Gulch Trail	Trail	0,2 miles
Lewiston Lake	Lewiston Vista	Vistas and Interpretative Site	–
Lewiston Lake	North Lakeshore Trail	Trail	2 miles
Lewiston Lake	Pine Cove	Picnic	2 picnic sites
Lewiston Lake	South Lakeshore Trail	Trail	1 mile

2 Source: USFS 2014

3 Lewiston Reservoir fishing opportunities include Smallmouth Bass, Rainbow  
4 Trout, Brown Trout, Three-spine Stickleback, Golden Shiner, and Kokanee  
5 Salmon (USFS 2014). Klamath Smallscale Sucker, and Pacific Lamprey also are  
6 present but are not generally considered as part of the recreational fishing  
7 opportunities. Wildlife viewing opportunities extend throughout the Lewiston  
8 Reservoir area, including viewing of Bald Eagles, Black-tailed Deer, River Otter,  
9 ring-tailed cats, raccoon, and California Quail. Waterfowl use Lewiston  
10 Reservoir throughout the year with increased populations in the winter.

### 11 **15.3.1.3 Trinity River from Lewiston Dam to the Klamath River**

12 The Trinity River flows approximately 112 miles from Lewiston Dam to the  
13 Klamath River (NCRWQCB et al. 2009) through Trinity, Humboldt, and Del  
14 Norte counties.

15 The first mile of the river below the Lewiston Dam is located within the  
16 Whiskeytown-Shasta-Trinity National Recreation Area. Portions of the Trinity  
17 River downstream of Lewiston Dam and Junction City to the confluence with  
18 North Fork Trinity River are under the jurisdiction of the Department of the  
19 Interior, Bureau of Land Management (BLM) (USFWS et al. 1999). Between the  
20 confluence with the North Fork Trinity River and the confluence of New River,  
21 the area along the Trinity River is located within the USFS Shasta-Trinity  
22 National Forest. Between the confluence with the New River and the Hoopa  
23 Indian Reservation, most of the area along the Trinity River is located within the  
24 USFS Six Rivers National Forest. The remaining portions of the Trinity River to  
25 the confluence with the Klamath River are located within the Hoopa Indian  
26 Reservation.

27 On January 19, 1981, the Secretary of the Interior designated the Trinity River  
28 starting 100 yards downstream of the Lewiston Dam to the confluence with the  
29 Klamath River as part of the National Wild and Scenic Rivers System. The  
30 designation also included portions of the South Fork, North Fork, and New River  
31 (BLM et al 2012). However, because the flows in the South Fork, North Fork,  
32 and New River are not affected by the alternatives considered in this EIS, these  
33 rivers are not evaluated in this EIS.

1 There are approximately 35 developed recreation sites and more than 200 access  
 2 points along the Trinity River corridor within a half mile of the river, and  
 3 numerous river access sites between Lewiston Dam and Weitchpec (NCRWQCB  
 4 et al. 2009; USFWS et al. 1999).

5 Recreation occurs year-round in the Trinity River area. Water-related activities  
 6 include boating, kayaking, canoeing, whitewater rafting, inner tubing, fishing,  
 7 swimming, wading, gold panning, camping, and picnicking (NCRWQCB et al.  
 8 2009). Fishing opportunities include steelhead, Rainbow Trout, Brown Trout, and  
 9 Chinook Salmon.

#### 10 **15.3.1.4 Lower Klamath River from Trinity River Confluence to the** 11 **Pacific Ocean**

12 The Klamath River continues for 43.5 miles from the Trinity River confluence to  
 13 the Pacific Ocean (NCRWQCB et al. 2009).

14 Downstream of the Trinity River, the Klamath River flows through the Hoopa  
 15 Indian Reservation, Yurok Indian Reservation, and Resighini Indian Reservation  
 16 as well as lands owned by local agencies and private entities (DOI and DFG  
 17 2012). Near the confluence with the Pacific Ocean, the Klamath River flows  
 18 through the Redwood National Park. These reaches are primarily within  
 19 Humboldt and Del Norte counties.

20 The portion of the Klamath River from the confluence with the Trinity River to  
 21 the Pacific Ocean is part of the Klamath River designated by the Secretary of the  
 22 Interior to be part of the National Wild and Scenic Rivers System on January 19,  
 23 1981. The State of California also designated this reach of Klamath River as wild  
 24 and scenic under Public Resources Code sections 5093.54 and 5093.545.

25 Recreation along the Klamath River downstream of the Trinity River is limited  
 26 (DOI and DFG 2012). Canoeing, kayaking, and whitewater boating occurs along  
 27 this reach. Whitewater rafting generally requires a minimum flow of 1,800 cfs in  
 28 this portion of the Klamath River. Four campgrounds, picnic areas, and water  
 29 access at public lands are located along the Klamath River near the confluence  
 30 with the Pacific Ocean. Fishing opportunities in the lower Klamath River are  
 31 primarily related to Chinook Salmon. Del Norte County operates two public boat  
 32 ramps along the Klamath River. The Redwood National and State Parks operate  
 33 Lagoon Creek near the confluence of the Klamath River and the Pacific Ocean  
 34 (RNSP 2013; Del Norte County 2003). There are other trails near the Pacific  
 35 Ocean, including the California Coastal Trail which is generally located along the  
 36 northern and eastern banks of the Klamath River at the Pacific Ocean (California  
 37 Coastal Trail 2014).

#### 38 **15.3.2 Central Valley Region**

39 The Central Valley Region extends from above Shasta Lake to the Tehachapi  
 40 Mountains, and includes the Sacramento Valley, San Joaquin Valley, Delta, and  
 41 Suisun Marsh.



1 **15.3.2.1 Sacramento Valley**

2 Recreational opportunities in the Sacramento Valley upstream of the Delta that  
 3 are influenced by CVP and SWP operations occur at Shasta Lake, Keswick  
 4 Reservoir, Whiskeytown Lake, Clear Creek, Sacramento River between Keswick  
 5 Dam and the Delta, Lake Oroville and Thermalito Afterbay, Yuba River from  
 6 between New Bullards Bar and Feather River, Bear River between Camp Far  
 7 West Reservoir and Feather River, Feather River between Thermalito Dam and  
 8 the Sacramento River, Folsom Lake and Lake Natoma, American River between  
 9 Nimbus Dam and the Sacramento River, and refuges that use CVP water supplies.

10 **15.3.2.1.1 Shasta Lake**

11 Shasta Lake is a CVP facility on the Sacramento River that is located near  
 12 Redding, as described in Chapter 5, Surface Water Resources and Water Supplies.  
 13 Shasta Lake is part of the Whiskeytown-Shasta-Trinity National Recreation Area  
 14 and part of the Shasta-Trinity National Forest. Recreational facilities and  
 15 activities at Shasta Lake are administered by the USFS. When the water storage  
 16 in the lake is at full capacity (water elevation at 1067 feet msl), Shasta Lake has a  
 17 surface area of approximately 30,000 acres and 365 miles of shoreline  
 18 (Reclamation 2013a; USFS 2014).

19 Boating, water skiing, other water sports, and fishing occur in many locations in  
 20 the lake. Many types of boats are used, including fishing boats, deck boats,  
 21 houseboats, cabin cruisers, pontoon boats, personal watercraft, runabouts, and ski  
 22 boats (Reclamation 2013a; USFS 2014). There are seven public boat ramps on  
 23 Shasta Lake, as summarized in Table 15.9.

24 **Table 15.9 Shasta Lake Boat Ramps**

Location	Boat Ramp	Comments	Useable Elevations (feet, msl)
Shasta Lake	Antlers	–	1,067 to 992
Shasta Lake	Bailey Cove	–	1,067 to 1,017
Shasta Lake	Centimudi	–	1,067 to 857
Shasta Lake	Hirz Bay	–	1,067 to 972
Shasta Lake	Jones Valley	–	1,067 to 857
Shasta Lake	Packers Bay	–	1,067 to 952
Shasta Lake	Sugar Loaf	–	992 to 907

25 Source: USFS 2014

26 A boating safety issue that arises with fluctuations in water level is the associated  
 27 fluctuation of the pattern of submerged obstacles. When the water level  
 28 decreases, many rocks, shoals, and islands are much closer to the water surface,  
 29 and can be easily struck by boats. When the water level rises, debris and  
 30 obstacles that were previously easily visible may be dangerously out of sight and  
 31 struck by boats (Reclamation 2013a).

1 Nine major marinas are located at Shasta Lake, as summarized in Table 15.10.  
 2 The USFS can permit up to 3,000 boat slips at the Shasta Lake marinas (USFS  
 3 2014). Many commercial houseboats are available for rent at the marinas. Shasta  
 4 Lake shoreline includes approximately 109 miles of prime houseboating areas and  
 5 153 miles of secondary houseboating areas. The USFS issues permits for  
 6 houseboats and privately-owned recreational occupancy vehicles that use the  
 7 water overnight. At Shasta Lake, up to 613 permits for privately-owned vessels  
 8 and 450 permits for commercially-owned vessels may be issued each year.

9 **Table 15.10 Shasta Lake Marinas and Moorage Facilities**

Location	Marina and Moorage Facility	Number
Shasta Lake	Antlers Resort and Marina	101 Commercial and 200 Private Slips, including 35 Commercial Houseboats
Shasta Lake	Bridge Bay Resort	140 Commercial and 7,773 Private Slips, including 92 Commercial Houseboats
Shasta Lake	Digger Bay Marina	75 Commercial and 145 Private Slips, including 50 Commercial Houseboats
Shasta Lake	Holiday Harbor	95 Commercial and 330 Private Slips, including 70 Commercial Houseboats
Shasta Lake	Jones Valley Marina	90 Commercial and 99 Private Slips, including 64 Commercial Houseboats
Shasta Lake	Packers Bay Marina	51 Commercial Slips, including 26 Commercial Houseboats
Shasta Lake	Shasta Lake RV Resort	22 Private Slips
Shasta Lake	Shasta Marina	54 Commercial and 139 Private Slips, including 24 Commercial Houseboats
Shasta Lake	Silverthorn Resort Marina	59 Commercial and 113 Private Slips, including 35 Commercial Houseboats
Shasta Lake	Sugarloaf Cottages	16 Private Slips
Shasta Lake	Sugarloaf Marina	41 Commercial and 40 Private Slips, including 21 Commercial Houseboats
Shasta Lake	Tsardi Resort	30 Private Slips

10 Source: USFS 2014

1 The Shasta Unit of the Whiskeytown-Shasta-Trinity National Recreation Area  
 2 includes many campground sites, including campgrounds for group camping  
 3 opportunities (USFS 2014), as summarized in Table 15.11. There are other  
 4 campgrounds within the upper elevations of the Shasta Lake watershed that are  
 5 not directly or indirectly affected by changes in surface water elevations.  
 6 Campers are also affected by declining water elevations because this increases the  
 7 distance from the campsites to the shoreline. Drawdown of the reservoir has an  
 8 aesthetic effect on users because the land exposed during drawdown is generally  
 9 composed of bare earth and rock.

10 **Table 15.11 Shasta Lake Major Campgrounds**

Location	Campground	Comments	Number of Campsites
Shasta Lake	Antlers	–	59
Shasta Lake	Arbuckle Flat	Boat-In Campground	11
Shasta Lake	Beehive	Shoreline Campground	No specified number
Shasta Lake	Bailey Cove	–	7
Shasta Lake	Dekkas Rock	Group Campground	60
Shasta Lake	Ellery Creek	–	19
Shasta Lake	Gooseneck Cove	Boat-In Campground	8
Shasta Lake	Green's Creek	Boat-In Campground	9
Shasta Lake	Gregory Creek	Shoreline Campground	18
Shasta Lake	Hirz Bay	Individual and Group Campground	48 Individual Sites and 200 Group Sites
Shasta Lake	Jones Valley (Upper & Lower)	Includes Shoreline Campground at Inlet	21
Shasta Lake	Lakeshore East	–	26
Shasta Lake	Lower Salt Creek	Shoreline Campground	No specified number
Shasta Lake	Mariners Point	Shoreline Campground	No specified number
Shasta Lake	McCloud Bridge	–	14
Shasta Lake	Moore Creek	Individual and Group Campground	12 Individual Sites and 90 Group Sites
Shasta Lake	Nelson Point	Individual and Group Campground	8 Individual Sites and 60 Group Sites
Shasta Lake	Oak Grove	–	45
Shasta Lake	Pine Point	Individual and Group Campground	14 Individual Sites and 100 Group Sites
Shasta Lake	Ski Island	Boat-In Campground	23

11 Source: USFS 2014

1 Shasta Lake recreational areas also include day use areas for picnicking,  
 2 swimming, and other recreational opportunities, as summarized in Table 15.12.  
 3 The locations for shoreline day use areas are limited due to the steep and rocky  
 4 elevations at the shorelines. Uses of these locations are less desirable when the  
 5 water elevations decline.

6 **Table 15.12 Shasta Lake Day Use Areas**

Location	Day Use Area	Comments	Number
Shasta Lake	Bailey Cove	Picnic and Trail	9 picnic sites 3.1 miles
Shasta Lake	Clikapudi	Trail	8 miles with 1 mile advanced trail
Shasta Lake	Dekkas Rock	Picnic	5 picnic sites
Shasta Lake	Dry Fork Creek	Trail	4.7 miles
Shasta Lake	Fisherman's Point	Picnic and Trail	7 picnic sites 0.5 miles
Shasta Lake	Hirz Bay	Trail	1.6 miles
Shasta Lake	McCloud Bridge	Picnic	5 picnic sites
Shasta Lake	Packers Bay	Trail	Four Trails: 0.4 to 2.8 miles
Shasta Lake	Potem Falls	Trail	0.3 miles
Shasta Lake	Samwel Cave Nature Trail	Interpretative Trail	1 mile
Shasta Lake	Sugarloaf	Trail	1 mile

7 Source: USFS 2014

8 Additional recreational opportunities are provided at the Shasta Dam Visitors  
 9 Center.

10 Fishing is also popular at Shasta Lake, performed mostly by boat as opposed to  
 11 from the shoreline. Anglers can catch warmwater and coldwater fish species  
 12 year-round due to the summer stratification of the lake into a warm layer above a  
 13 coldwater pool (Reclamation 2013a). Shasta Lake warm water fishing  
 14 opportunities include Black Bass, Smallmouth Bass, Largemouth Bass, Spotted  
 15 Bass, Black Crappie, Channel Catfish, and Bluegill (USFS 2014). There are  
 16 many bass tournaments at Shasta Lake each summer. The cooler water strata  
 17 supports fishing for Rainbow Trout and Chinook Salmon.

18 **15.3.2.1.2 Keswick Reservoir**

19 Keswick Reservoir is a CVP afterbay that extends 9 miles along the Sacramento  
 20 River from Shasta Dam to Keswick Dam, as described in Chapter 5, Surface  
 21 Water Resources and Water Supplies. Recreational facilities and activities at  
 22 Keswick Reservoir are administered by BLM, Shasta County, and U.S. Forest  
 23 Service for the Department of the Interior, Bureau of Reclamation (Reclamation).  
 24 The maximum water storage elevation at the top of the Keswick Dam spillway is

1 587 feet msl (Reclamation 2009). The water level fluctuates frequently in  
2 Keswick Reservoir, depending on the operations of Shasta Dam.

3 Water-related activities include boating, fishing, and water sports. The Keswick  
4 Boat Launch, operated by BLM, is located on the western shoreline at the south  
5 end of the reservoir (BLM 2005).

6 There are several trails along Keswick Reservoir and areas for off highway  
7 vehicles (OHVs) with camping allowed at one of the locations (BLM 2005; BLM  
8 2011). The Sacramento Rail Trail extends from Moccasin Creek below Shasta  
9 Dam to Redding along the western shoreline of Keswick Reservoir and the  
10 Sacramento River downstream of Keswick Dam. The Fisherman Trail extends  
11 along the shoreline from the lower Sacramento Rail Trail to Keswick Dam. The  
12 F.B. Trail extends from the Ribbon Bridge downstream of the Keswick Dam to  
13 Walker Mine Road along the eastern side of the Keswick Reservoir. There are  
14 several other trails at higher elevations above Keswick Reservoir, including the  
15 Hornbeck Tail, Upper and Lower Sacramento Ditch Trails, Flanagan Trail, and  
16 Chamise Peak Trail.

17 The Chappie-Shasta OHV Area provides over 200 miles of roads in  
18 approximately 52,000 acres (Reclamation 2013a). The area is accessed at two  
19 staging areas. The Chappie-Shasta OHV Staging Area and Shasta Campground  
20 includes a staging area for day use activities, including picnics, and 22 campsites  
21 (BLM 2005). This site is located along the western shoreline of Keswick  
22 Reservoir at the trailhead of the Sacramento Rail Trail at Moccasin Creek. The  
23 Copley Mountain OHV Staging Area is located along the western shoreline of  
24 Keswick Reservoir about midway between Shasta and Keswick dams. This site  
25 also provides a staging area for day use activities, including picnics.

26 Fishing opportunities are primarily for German Brown Trout and Rainbow Trout.

### 27 **15.3.2.1.3 Whiskeytown Lake**

28 Whiskeytown Lake is a CVP facility on Clear Creek that is located approximately  
29 8 miles west of Redding on the eastern slope of the Coast Range, as described in  
30 Chapter 5, Surface Water Resources and Water Supplies. Whiskeytown Lake is  
31 part of the Whiskeytown-Shasta-Trinity National Recreation Area. Recreational  
32 facilities and activities administered by the National Park Service (NPS). When  
33 the water storage in the reservoir is at full capacity (water elevation at  
34 1210 feet msl), Whiskeytown Lake has a surface area of 3,250 acres and 36 miles  
35 of shoreline (Reclamation 1997).

36 Boating, water skiing, sailing, kayaking, and canoeing, swimming, and fishing  
37 occur in many locations in the lake. Boat launches are available at Oak Bottom,  
38 Brandy Creek, and Whiskey Creek and at marinas at Oak Bottom and Brandy  
39 Creek (NPS 2012), as summarized in Table 15.13.

1 **Table 15.13 Whiskeytown Lake Boat Ramps**

Location	Boat Ramp	Comments	Useable Elevations (feet, msl)
Whiskeytown Lake	Brandy Creek	–	1210 to 1190
Whiskeytown Lake	Oak Bottom	–	1210 to 1195
Whiskeytown Lake	Oak Bottom Marina	–	1210 to 1198
Whiskeytown Lake	Whiskey Creek	–	1210 to 1195

2 Sources: NPS 2012; Reclamation 1997

3 The lake level is relatively stable and do not reduce the ability for boat launching  
 4 until late summer or early fall.

5 The Whiskeytown Unit of the Whiskeytown-Shasta-Trinity National Recreation  
 6 Area includes many campground sites, including campgrounds for group camping  
 7 opportunities (NPS 2012), as summarized in Table 15.14.

8 **Table 15.14 Whiskeytown Lake Major Campgrounds**

Location	Campground	Comments	Number of Campsites
Whiskeytown Lake	Brandy Creek RV	–	37 RV Sites
Whiskeytown Lake	Brandy Creek	Primitive Campground	2 Sites
Whiskeytown Lake	Coggins Park	Primitive Campground	1 Site
Whiskeytown Lake	Crystal Creek	Primitive Campground near Crystal Creek	2 Sites
Whiskeytown Lake	Dry Creek	Group Campground	100 people
Whiskeytown Lake	Horse Camp	Primitive Campground	2 Sites
Whiskeytown Lake	Oak Bottom Tent and Recreation Vehicle (RV)	–	98 Tent Sites and 22 RV Sites
Whiskeytown Lake	Peltier Bridge	Primitive Campground near Clear Creek	9 Sites
Whiskeytown Lake	Sheep Camp	Primitive Campground	4 Sites

9 Source: NPS 2012

1 Whiskeytown Lake recreational areas also include day use areas for picnicking,  
 2 swimming, and other recreational opportunities, as summarized in Table 15.15.  
 3 Shoreline day use areas are limited at some locations due to the steep and rocky  
 4 elevations at the shorelines.

5 **Table 15.15 Whiskeytown Lake Day Use Areas**

Location	Day Use Area	Comments	Number
Whiskeytown Lake	Boulder Creek Falls	Trail	1 mile with 2.75-mile advanced trail
Whiskeytown Lake	Brandy Creek Beach and Falls	Picnic, Swimming, and Trails	1.6 and 1.5 miles
Whiskeytown Lake	Buck Hollow	Trail	1 mile
Whiskeytown Lake	Camden Water Ditch	Trail	1.1 miles
Whiskeytown Lake	Clear Creek Canal and Vista	Picnic and Trails	2.4 and 4.5 miles
Whiskeytown Lake	Crystal Creek Water Ditch and Falls	Picnic and Trails	0.75 and 0.3 miles
Whiskeytown Lake	Davis Gulch	Trail	3.3 miles
Whiskeytown Lake	East Beach	Swimming	–
Whiskeytown Lake	Guardian Rock	Trail	0.25 miles
Whiskeytown Lake	James K. Carr Trail	Trail	1.7 miles
Whiskeytown Lake	Judge Francis Carr Powerhouse	Picnic	–
Whiskeytown Lake	Kanaka Peak	Trail	3.6 miles
Whiskeytown Lake	Logging Camp	Trail	1 mile
Whiskeytown Lake	Mill Creek	Trail	6.1 miles
Whiskeytown Lake	Mt. Shasta Mine	Trail	3.5 miles
Whiskeytown Lake	Mule Mountain Pass	Trail	4.4 miles
Whiskeytown Lake	Oak Bottom Beach	Picnic and Swimming	–
Whiskeytown Lake	Oak Bottom Ditch	Trail	2.75 miles
Whiskeytown Lake	Papoose Pass	Trail	5.5 miles
Whiskeytown Lake	Peltier	Trail	1.75 miles
Whiskeytown Lake	Rich Gulch	Trail	1.8 miles
Whiskeytown Lake	Salt Creek	Trail	1.8 miles
Whiskeytown Lake	Salt Gulch	Trail	1.6 miles
Whiskeytown Lake	Shasta Divide Nature Trail	Trail	0.4 miles
Whiskeytown Lake	Whiskey Creek	Group Picnic Area and Swimming	–

6 Source: NPS 2012

1 Additional recreational opportunities are provided at the Whiskeytown Visitors  
2 Center.

3 Fishing opportunities at Whiskeytown Lake include Brown Trout and Rainbow  
4 Trout; Kokanee Salmon; Smallmouth Bass, Largemouth Bass, and Spotted Bass;  
5 Bluegill; crappie; and Sacramento Pikeminnow (NPS No Date).

#### 6 **15.3.2.1.4 Clear Creek from Whiskeytown Dam to the Sacramento River**

7 Whiskeytown Lake is operated to release most of the water through the Spring  
8 Creek Power Conduit into Keswick Reservoir, as described in Chapter 5, Surface  
9 Water Resources and Water Supplies. Flows are also released from Whiskeytown  
10 Lake to Clear Creek to be consistent with federal and state requirements. During  
11 high flow events, additional flows may be released into Clear Creek.

12 The initial reaches of Clear Creek downstream of the Whiskeytown Dam are  
13 located within the Whiskeytown-Shasta-Trinity National Recreation Area. The  
14 remaining portions of Clear Creek flow to the Sacramento River through lands  
15 owned by BLM and private owners. All of these reaches are located within  
16 Shasta County and the most eastern reaches are within the City of Redding.

17 BLM has established the Clear Creek Greenway along a large portion of the lower  
18 Clear Creek from within the Whiskeytown-Shasta-Trinity National Recreation  
19 Area to the Sacramento River (BLM n.d.). The area also includes the Horsetown-  
20 Clear Creek Preserve which is a private-public partnership recreation area.

21 Hiking, picnicking, kayaking, swimming, fishing, and gold panning occur along  
22 the lower Clear Creek (SRWP 2010). The Clear Creek Greenway includes ten  
23 trails and eight picnic areas (BLM n.d.). Hunting is allowed in the Swasey and  
24 Muletown Road areas of the Clear Creek Greenway. Fishing opportunities  
25 include steelhead, Chinook Salmon, carp, suckers, Bluegill, bass, and Sacramento  
26 Pikeminnow (SRWP 2010).

#### 27 **15.3.2.1.5 Sacramento River from Keswick Dam to the Delta**

28 The Sacramento River from Keswick Dam to the Sacramento-San Joaquin Delta  
29 (Delta) is divided into three reaches for discussion in this section: Keswick  
30 Reservoir to Red Bluff, Red Bluff to the Feather River, and Feather River  
31 confluence to the Delta (near the City of West Sacramento).

##### 32 *Sacramento River from Keswick Dam to Red Bluff*

33 The upper reach of the Sacramento River flows for approximately 60 miles from  
34 Keswick Dam to Red Bluff (Reclamation 1997). Water-related recreational  
35 activities include boating, picnicking, camping, and wildlife viewing. Boating  
36 opportunities include motor-boating, jet-skiing, kayaking, canoeing, and  
37 whitewater rafting in some locations (Reclamation 2013a, Reclamation et al.  
38 2002). River flows can increase for short-term periods when water is being  
39 released from the CVP facilities and during and following storm events in the  
40 upper Sacramento River watershed. Flows in the late fall months may decrease to  
41 levels that are not favorable for boating. Water temperatures in this reach are  
42 generally cold throughout the year.



1 Much of the land along the Sacramento River between Balls Ferry and Red Bluff  
2 is owned and managed by BLM (Reclamation 2013a). Public access points are  
3 provided by the cities of Redding and Anderson and the BLM. Lake Redding  
4 Park, Turtle Bay, and the Anderson River Park are some of the prominent access  
5 areas. Boat launching can occur at eight public boat ramps and two smaller  
6 launch facilities, including at Turtle Bay, Caldwell Park, and South Bonneyview  
7 in the City of Redding; Ball Ferry; Battle Creek confluence with the Sacramento  
8 River; Bend Bridge; and Red Bluff River Park in the City of Red Bluff.

9 There are two whitewater river reaches, including between Keswick Dam and the  
10 Anderson-Cottonwood Irrigation District Diversion Dam and between Anderson  
11 River Park and William B. Ide Adobe State Historic Park.

12 Camping facilities include public campgrounds along the Sacramento River at  
13 Lake Red Bluff Recreation Area (Reclamation 2013a).

14 There are trails or trail access and picnicking facilities with access to the river in  
15 this reach of the Sacramento River (Reclamation 2013a). The trails include the  
16 13-mile Sacramento River Trail between Keswick Dam to Turtle Bay Park in the  
17 City of Redding. Many of the picnicking locations are managed by local  
18 municipalities, including the cities of Redding, Anderson, and Red Bluff.  
19 Coleman National Fish Hatchery, located along Battle Creek near the Sacramento  
20 River, provides recreational and educational opportunities.

21 Fishing opportunities along the upper Sacramento River include Chinook Salmon,  
22 steelhead, Rainbow Trout, sunfish, and bass (Reclamation 2013a). Fishing can  
23 occur from boats along the Sacramento River and at four public fishing access  
24 points, including Turtle Bay East, Kapusta Property, Deschutes Road, Reading  
25 Island, Diestlehorst Pasture River Access, Jellys Ferry, and Sacramento River  
26 Island.

27 The Mouth of Cottonwood Creek Wildlife Area is operated by California  
28 Department of Fish and Wildlife (DFW). This area provides viewing  
29 opportunities for Swainson's Hawk, Bald Eagle, ringtail cat, River Otter, and  
30 other birds and wildlife (Reclamation 2013a). Hunting opportunities on BLM  
31 land occur at Inks Creek, Massacre Flat, Perry Rifle, Paynes Creek, Bald Hill and  
32 Iron Canyon. Commonly hunted game includes quail, dove, waterfowl, deer, pig,  
33 turkey, and bear (Reclamation 2013a).

#### 34 *Sacramento River from Red Bluff to Feather River*

35 The middle reach of the Sacramento River flows approximately 160 miles from  
36 Red Bluff to the confluence with the Feather River (Reclamation 1997).

37 Water-dependent activities along the middle reach include boating, swimming,  
38 and fishing (Reclamation 2005a). Water-contact activities are popular in this  
39 section of the river due to relatively warm water. Public access points are  
40 provided along this reach by California Department of Parks and Receptions  
41 (State Parks); and Tehama, Glenn, Colusa, and Sutter counties (Reclamation  
42 2005a; Reclamation 1997). River access in this reach is primarily provided at  
43 private fishing access points, marinas, and resorts.

1 The three major State Parks properties along the middle reach include the  
 2 Woodson Bridge State Recreation Area, the Bidwell-Sacramento River State  
 3 Park, and the Colusa-Sacramento River State Recreation area (DFG 2004;  
 4 Reclamation 2013a). Public access for fishing, hunting, and wildlife viewing also  
 5 is provided at the DFW Fremont Weir Wildlife Area (DFW 2014a).

6 Fishing opportunities include Chinook Salmon, steelhead, trout, American Shad,  
 7 sturgeon, catfish, and Striped Bass (Reclamation 2005a).

8 Seasonal game includes Ring-necked Pheasants, California Quail, various species  
 9 of ducks and geese, Mourning Doves, and Mule Deer (Reclamation 2013a).

#### 10 *Sacramento River from Feather River to the Northern Delta Boundary*

11 The lower reach of the Sacramento River flows for approximately 20 river miles  
 12 between the confluence with Feather River and immediately downstream of the  
 13 confluence with the American River (USACE 1991). The major portion of this  
 14 reach of the Sacramento River flows along private property.

15 Water-related activities in this reach include boating, swimming and beach use,  
 16 picnicking, biking, sightseeing, and fishing. Public access is provided by Yolo  
 17 County at Elkhorn Regional Park (Yolo County ); Sacramento County and the  
 18 City of Sacramento at Discovery Park and Miller Park, respectively (Sacramento  
 19 County 2012; Reclamation 2005a); and by the City of West Sacramento at  
 20 Broderick Boat Ramp (West Sacramento 2000).

21 Fishing opportunities in this area include Chinook Salmon, steelhead, American  
 22 Shad, sturgeon, catfish, and Striped Bass (Reclamation 1997, 2005a).

#### 23 **15.3.2.1.6 Sacramento Valley Wildlife Refuges**

24 Wildlife refuges in the Sacramento Valley that rely upon CVP water supplies  
 25 include the Sacramento National Wildlife Refuge (NWR) Complex include  
 26 Sacramento, Delevan, Colusa, and Sutter NWRs and Gray Lodge Wildlife Area,  
 27 as described in Chapter 5, Surface Water Resources and Water Supplies, and  
 28 Chapter 10, Terrestrial Biological Resources (Reclamation 2012). Water-related  
 29 activities include wildlife viewing, hiking along the refuge wetlands, and  
 30 waterfowl hunting. Shoreline fishing opportunities at Gray Lodge Wildlife Area  
 31 include bass, sunfish, perch, catfish, and carp (DFW 2014b)

#### 32 **15.3.2.1.7 Feather River Watershed**

33 Antelope Lake, Lake Davis, and Frenchman Lake located in the Upper Feather  
 34 River; Lake Oroville and Thermalito Forebay and Afterbay; and the lower Feather  
 35 River are located within areas in the Feather River watershed that could be  
 36 affected by changes in CVP and/or SWP operations.

#### 37 *Upper Feather River Lakes*

38 The Upper Feather River Lakes, including Antelope Lake, Lake Davis, and  
 39 Frenchman Lake, are SWP facilities on the upper Feather River upstream of Lake  
 40 Oroville. These lakes are part of the Plumas National Forest (DWR 2013a).

1 Recreational facilities and activities at all three lakes are managed by private  
2 concessionaires under contract with the Plumas National Forest.

3 For Antelope Lake, when the water storage in the lake is at full capacity (water  
4 elevation at 5,002 feet), the lake has a surface area of 930 acres and 15 miles of  
5 shoreline (DWR 2013a; USFS 2011). Water related activities include boating,  
6 water skiing, swimming, fishing, camping, and picnicking. There is a boat  
7 launching ramp, three fishing access sites, and a picnic area. There are three  
8 campgrounds at Antelope Lake, including Boulder Creek, Lone Rock, and Long  
9 Point. There are approximately 194 campsites and 4 group campsites at the three  
10 campgrounds for use between May through October. Fishing opportunities in  
11 Antelope Lake include Rainbow Trout, Brook Trout, crappie, Channel Catfish,  
12 and Smallmouth Bass, Largemouth Bass. Hunting opportunities around Antelope  
13 Lake include Mule Deer and Black-tailed Deer.

14 For Lake Davis, when the water storage in the lake is at full capacity (water  
15 elevation at 5,785 feet), the lake has a surface area of 4,030 acres and 32 miles of  
16 shoreline (DWR 2013a; USFS 2006a). Water related activities include boating,  
17 fishing, camping, and picnicking. There are boat launching ramps at Lightning  
18 and Honker Cove, car-top boat ramp at Mallard Cove, a fishing access site, and a  
19 picnic area. There are three campgrounds at Lake Davis, including Grizzly,  
20 Grasshopper, and Lightning Tree. There are approximately 180 campsites at the  
21 three campgrounds for use between May through October. Fishing opportunities  
22 in Lake Davis include Rainbow Trout, German Brown Trout, Eagle Lake trout,  
23 Brown Bullhead, and Largemouth Bass. Hunting opportunities around Lake  
24 Davis include Mule Deer and Black-tailed Deer.

25 For Frenchman Lake, when the water storage in the lake is at full capacity (water  
26 elevation at 5,588 feet), the lake has a surface area of 1,580 acres and 21 miles of  
27 shoreline (DWR 2013a; USFS 2006b). Water related activities include boating,  
28 water skiing, swimming, fishing, camping, picnicking, and ice fishing. There are  
29 two boat launching ramps (Frenchman and Lunker Point), six fishing access sites,  
30 and a picnic area. There are five campgrounds at Frenchman Lake, including  
31 Chilcoot, Cottonwood Springs, Frenchman, Spring Creek, and Big Cove. There  
32 are approximately 209 campsites and 2 group campsites at the five campgrounds  
33 for use between May through October. Fishing opportunities in Frenchman Lake  
34 include Rainbow Trout, Brown Trout, Eagle Lake trout, and Smallmouth Bass.  
35 Hunting opportunities around Frenchman Lake include deer and waterfowl.

36 *Lake Oroville and Thermalito Forebay and Afterbay*

37 Lake Oroville and Thermalito Forebay and Afterbay are SWP facilities on the  
38 Feather River, as described in Chapter 5, Surface Water Resources and Water  
39 Supplies. The upper North Fork arm of Lake Oroville is part of the Lassen  
40 National Forest; and the upper Middle Fork and South Fork arms of Lake Oroville  
41 are part of Plumas National Forest. The Middle Fork Feather River (from  
42 Beckwourth downstream of Lake Davis to Lake Oroville) was designated as part  
43 of Public Law 90-542 (Wild and Scenic Rivers Act) to be part of the National  
44 Wild and Scenic Rivers System on October 2, 1968. Recreational facilities and  
45 activities at the Lake Oroville Complex (including Lake Oroville and Thermalito

1 Forebay and Afterbay) are managed by State Parks as part of the Lake Oroville  
 2 State Recreation Area. When the water storage in the lake is at full capacity  
 3 (water elevation at 900 feet msl), Lake Oroville has a surface area of 15,810 acres  
 4 and 167 miles of shoreline. Thermalito Forebay has a surface area of 630 acres.  
 5 Thermalito Afterbay has a surface area of 4,300 acres and 26 miles of shoreline  
 6 when the water elevation is at 136.5 feet msl (DWR 2007a, 2007c, 2013b).

7 Water-related activities include boating, whitewater boating, camping, picnicking,  
 8 and fishing (DWR 2007a). Boating includes kayaking, canoeing, and fishing  
 9 boats. Whitewater boating occurs on the Big Bend area of the North Fork Feather  
 10 River when Lake Oroville elevations are sufficiently low to expose several miles  
 11 of river. This portion of the North Fork Feather River forms the Upper North  
 12 Fork arm of Lake Oroville. Generally, this area is exposed in the late fall months.  
 13 Another whitewater area is located in the Bald Rock Canyon on the Middle Fork  
 14 Feather River. This whitewater area is located upstream of the Middle Fork arm  
 15 of Lake Oroville.

16 There are 11 boat ramps on Lake Oroville, as summarized in Table 15.16. Two of  
 17 the boat ramps are located at marinas (DWR 2007a).

18 **Table 15.16 Lake Oroville, Thermalito Forebay, and Thermalito Afterbay Boat**  
 19 **Ramps**

Location	Boat Ramp	Comments	Useable Elevations (feet, msl)
Lake Oroville	Bidwell Canyon	Day Use Area Marina with 280 berths and 400 mooring anchors	900 to 700
Lake Oroville	Dark Canyon	Car-Top Launching	900 to 765
Lake Oroville	Enterprise		900 to 835
Lake Oroville	Foreman Creek	Car-Top Launching	900 to approximately 800
Lake Oroville	Lime Saddle	Day Use Area Marina, including houseboat rentals	900 to 702
Lake Oroville	Loafer Creek	Boat-In Campground	900 to 775
Lake Oroville	Monument Hill	Day Use Area	900 to approximately 700
Lake Oroville	Nelson Bar	Car-Top Launching	900 to 825
Lake Oroville	Spillway	Day Use Area	900 to 695
Lake Oroville	Stringtown Creek	Car-Top Launching	900 to 866
Lake Oroville	Vinton Gulch	Car-Top Launching	900 to 825

Location	Boat Ramp	Comments	Useable Elevations (feet, msl)
Thermalito Forebay	North Thermalito Forebay	Day Use Area Also used by California State University, Chico	Water elevation does not vary substantially
Thermalito Forebay	South Thermalito Forebay	Day Use Area	Water elevation does not vary substantially
Thermalito Afterbay	Larkin Road	Car-Top Launching	Water elevation does not vary substantially
Thermalito Afterbay	Oroville Wildlife Area		Water elevation does not vary substantially
Thermalito Afterbay	Thermalito Afterbay Outlet		Water elevation does not vary substantially
Thermalito Afterbay	Wilbur Road		Water elevation does not vary substantially

1 Sources: DWR 2006, 2007a

2 There are 16 campgrounds at Oroville Lake and Thermalito complex (DWR  
3 2007a), as summarized in Table 15.17. Campers are affected by declining water  
4 elevations because this increases the distance from the campsites to the shoreline,  
5 and makes it difficult to access shoreline campgrounds at Bidwell Canyon, Lime  
6 Saddle, and Loafer Creek when water elevations are lower than 850 feet msl.

7 **Table 15.17 Lake Oroville, Thermalito Forebay, and Thermalito Afterbay Major**  
8 **Campgrounds**

Location	Campground	Comments	Number of Campsites
Lake Oroville	Bidwell Canyon	Campground	75
Lake Oroville	Bloomer Cove	Boat-In Campground	5
Lake Oroville	Bloomer Group	Boat-In Group Campground	75
Lake Oroville	Bloomer Knoll	Boat-In Campground	6
Lake Oroville	Bloomer Point	Boat-In Campground	25
Lake Oroville	Craig Saddle	Boat-In Campground	18
Lake Oroville	Floating Campsites	Boat-In Campground	10 Different Locations with approximately 15 sites per location
Lake Oroville	Foreman Creek	Boat-In Campground	26
Lake Oroville	Goat Ranch	Boat-In Campground	5
Lake Oroville	Lime Saddle	Campground and Group Campground	45

Location	Campground	Comments	Number of Campsites
Lake Oroville	Loafer Creek	Campground and Group Campground Horse Campground	137 6 15
Thermalito Forebay	North Thermalito Forebay "En Route"	Recreational Vehicle Campground	15
Thermalito Afterbay	Oroville Wildlife Area	Primitive Campground	Several

1 Sources: DWR 2006, 2007a

2 Lake Oroville recreational areas also include day use areas for picnicking,  
 3 swimming, and other recreational opportunities, as summarized in Table 15.18.  
 4 The locations for shoreline day use areas are limited due to the steep and rocky  
 5 elevations at the shorelines. Uses of these locations are less desirable when the  
 6 water elevations decline. It is difficult to access shoreline campgrounds at  
 7 Bidwell Canyon and Loafer Creek when water elevations are lower than  
 8 850 feet msl.

9 **Table 15.18 Lake Oroville, Thermalito Forebay, and Thermalito Afterbay Day**  
 10 **Use Areas**

Location	Day Use Area	Comments	Number
Lake Oroville	Bidwell Canyon With Saddle Dam trailhead	Trail and picnic	4.9 mile trail (hiking and bicycling) 21 picnic sites
Lake Oroville	Chaparral Trail	Interpretative Trail	0.2 miles
Lake Oroville	Dan Beebe Trail With Saddle Dam, Lakeland Boulevard, Oro Dam Boulevard, and visitor center trailheads	Trail	14.3 mile trail (equestrian and hiking)
Lake Oroville	Lake Oroville Visitors Center	Visitors Center and picnic	18 picnic sites
Lake Oroville	Lime Saddle	Picnic	13 picnic sites
Lake Oroville	Loafer Creek	Trail, swimming, and picnic	3.2 mile trail (equestrian and hiking) 1.7 mile trail (hiking and bicycling) 30 picnic sites
Lake Oroville	Model Aircraft Flying Facility	Aircraft staging and picnic	6 picnic sites

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<b>Location</b>	<b>Day Use Area</b>	<b>Comments</b>	<b>Number</b>
Lake Oroville	Oroville Dam Overlook and Spillway Day Use Area	Trail, picnic, and shoreline fishing	1 mile along Oroville Dam crest 8 picnic sites
Lake Oroville	Potter's Ravine	Trail	5.5 miles
Lake Oroville	Roy Rogers Trail	Trail	4 miles (equestrian and hiking)
Lake Oroville	Sewim Bo Trail	Trail and picnic	0.5 miles (equestrian and hiking) 1 picnic site
Lake Oroville	Wyk Island Trail	Trail	0.2 miles
Feather River downstream of Oroville Dam	Feather River Fish Hatchery	Hatchery and picnic	1 picnic site
Oroville Dam Crest, Diversion Pool, Thermalito Forebay, and Thermalito Afterbay	Brad Freeman Trail Diversion Pool access road, East Hamilton Road, Powerhouse Road, Toland Road, and Tres Vias Road trailheads	Trail Loop	41 miles
Thermalito Forebay	North Thermalito Forebay	Picnic, swimming, and shoreline fishing	117 picnic sites
Thermalito Forebay	South Thermalito Forebay	Picnic, swimming, and shoreline fishing	10 picnic sites
Thermalito Afterbay	Monument Hill	Picnic, swimming, and shoreline fishing	10 picnic sites
Oroville Wildlife Area	Rabe Road Shooting Range	Range and target shooting and picnic	7 picnic sites
Oroville Wildlife Area	Clay Pit State Vehicular Recreation Area	Off-highway vehicle riding	-
Thermalito Afterbay	Thermalito Afterbay Outlet and Oroville Wildlife Area	Trail, picnic, shoreline fishing, and hunting	Several trails and day use areas

1 Sources: DWR 2006, 2007a

2 Fishing is popular at the Lake Oroville complex and is performed by boat and  
 3 from the shoreline (DWR 2007a). Fishing opportunities in Lake Oroville include  
 4 Smallmouth Bass, Largemouth Bass, Spotted Bass, red-eye bass, Black Crappie,

1 Bluegill, Green Sunfish, Channel Catfish, and White Catfish, Coho Salmon,  
 2 Rainbow Trout, and Brown Trout. In Thermalito Forebay, fish species include  
 3 Brook Trout, Brown Trout, Rainbow Trout, and Chinook Salmon. In Thermalito  
 4 Afterbay, fishing opportunities include Smallmouth Bass, Largemouth Bass, trout,  
 5 Channel Catfish, White Catfish, and carp. Downstream in the Feather River,  
 6 fishing opportunities include steelhead, Chinook Salmon, American Shad,  
 7 Smallmouth Bass, Largemouth Bass, and White Sturgeon.

8 Hunting opportunities occur around Thermalito Afterbay and/or Oroville Wildlife  
 9 Area for turkey (in the spring), dove, quail, waterfowl, pheasant, deer, squirrel,  
 10 and rabbit.

11 *Feather River from Thermalito Afterbay/Oroville Wildlife Area to Sacramento*  
 12 *River*

13 The Feather River flows from the Thermalito Dam to approximately 40 miles  
 14 downstream to the confluence with the Sacramento River (Reclamation 1997).  
 15 The Feather River Wildlife Area, managed by DFW, is located along the Feather  
 16 River near the confluence with the Bear River. The Feather River Wildlife Area  
 17 includes the Abbott Lake, Star Bend, O'Connor Lakes, Lake of the Woods, and  
 18 Nelson Slough units; and Bobelaine Audubon Ecological Reserve (DFG 2008a).  
 19 The southern boundary of the wildlife area is located adjacent to the Sutter  
 20 Bypass. In Sutter County, water-related recreation opportunities along the  
 21 Feather River also include public access at Donahue Road Park, Tisdale Boat  
 22 Ramp, Boyd's Pump boat launch, Feather River parkway, Yuba City Boat Ramp,  
 23 Riverfront Park in Marysville, and Live Oak Park and Recreation Area (Sutter  
 24 County 2010). There are several private facilities that offer camping, boating, and  
 25 river access.

26 **15.3.2.1.8 Yuba River Watershed**

27 Portions of the Yuba River watershed along the North Yuba River between New  
 28 Bullards Bar Reservoir and Englebright Lake and along the Lower Yuba River  
 29 between Englebright Lake and the Feather River could be affected by operation of  
 30 the Lower Yuba River Water Accord (DWR et al. 2007), as described in  
 31 Chapter 5, Surface Water Resources and Water Supplies. New Bullards Bar Dam  
 32 and Reservoir are owned and operated by the Yuba County Water Agency to  
 33 provide flood control, water storage, and hydroelectric generation. The Harry L.  
 34 Englebright Dam and Reservoir were constructed by the California Debris  
 35 Commission downstream of New Bullards Bar Reservoir to trap and store  
 36 sediment from historical hydraulic mining sites in the upper watershed, and  
 37 provide recreation and hydroelectric generation opportunities (USACE 2013).  
 38 Following decommissioning of the California Debris Commission in 1986,  
 39 administration of Englebright Dam and Reservoir (Lake) was assumed by the  
 40 U.S. Army Corps of Engineers.

41 Portions of the watershed along the Middle Yuba River between New Bullards  
 42 Bar Reservoir and Englebright Reservoir are within the Plumas and Tahoe  
 43 national forests. There are also lands owned and managed by the Bureau of Land  
 44 Management and U.S. Army Corps of Engineers along this reach of the river.



1 This reach also includes the confluence with the South Yuba River. Portions of  
2 the Lower South Yuba River are designated as a California Wild and Scenic River  
3 (USFS et al. No Date). Portions of the South Yuba River State Park located near  
4 the confluence along the South Yuba River and Yuba River provide recreational  
5 opportunities for swimming, fishing, bird watching, and gold panning (State  
6 Parks 2009).

7 *New Bullards Bar Reservoir*

8 The New Bullards Bar Reservoir has a storage capacity of 966,103 acre-feet when  
9 the water elevation is at 1,956 feet. When full, the lake has a surface area of  
10 4,790 acres and 71.9 miles of shoreline (YCWA 2012). Recreational facilities  
11 and activities are the responsibility of Yuba County Water Agency. Water related  
12 activities include boating, fishing, camping from May through September, and  
13 picnicking (DWR et al. 2007). There are several campgrounds adjacent to the  
14 lake, including Schoolhouse and Dark Day campgrounds along the shoreline and  
15 Madrone Cove and Garden Point that are only accessed by boat. Boat access is  
16 provided at Emerald Cove Resort and Marina, Cottage Creek, and Dark Day. The  
17 Cottage Creek and Dark Day boat ramps are not useable when the lake elevation  
18 declines below 1,822 and 1,798 feet, respectively. Fishing opportunities include  
19 Rainbow Trout, Brown Trout, Kokanee Salmon, Bluegill, crappie, Bullhead,  
20 Smallmouth Bass, and Largemouth Bass.

21 *Englebright Reservoir*

22 The Englebright Reservoir has a storage capacity of approximately 70,000 acre-  
23 feet when the water elevation is at 527 feet (USACE 2012, 2013, 2014). When  
24 full, the lake has a surface area of 815 acres and 24 miles of shoreline.  
25 Recreational facilities and activities are the responsibility of U.S. Army Corps of  
26 Engineers. Water related activities include boating, water-skiing, fishing, boat-  
27 access camping, and picnicking. There are 96 boat-access only camping sites.  
28 There are two boat ramps to provide access to the lower part of the lake. The  
29 upper portion of the lake is characterized by narrow canyons and sharp bends  
30 which limit boat access. Fishing opportunities include Rainbow Trout, Brown  
31 Trout, Kokanee Salmon, sunfish, catfish, Smallmouth Bass, and  
32 Largemouth Bass.

33 *Lower Yuba River*

34 Hiking and boating opportunities occur along the 24 miles of the Lower Yuba  
35 River between Englebright Reservoir and the Feather River (DWR et al. 2007).  
36 Public river access is provided at several locations to support fishing, picnicking,  
37 rafting, kayaking, tubing, and swimming. Fishing opportunities include American  
38 Shad, Chinook Salmon, steelhead, Smallmouth Bass, and Striped Bass.

39 **15.3.2.1.9 American River Watershed**

40 Folsom Lake and Lake Natoma on the American River and the lower American  
41 River are located within areas in the American River watershed that could be  
42 affected by changes in CVP and/or SWP operations.

1 *Folsom Lake and Lake Natoma*  
 2 Folsom Lake is a CVP facility on the American River, as described in Chapter 5,  
 3 Surface Water Resources and Water Supplies. The El Dorado National Forest is  
 4 located in the upper American River watershed upstream of Folsom Lake. The  
 5 State of California designated the North Fork American River from the source to  
 6 Iowa Hill Bridge upstream of Folsom Lake as wild and scenic. Recreational  
 7 facilities and activities in the Folsom Lake area are within the Folsom Lake State  
 8 Recreation Area or the Folsom Powerhouse State Historic Park that are managed  
 9 by State Parks. Recreational activities upstream of Folsom Lake occur on or  
 10 adjacent to many lands owned by the Bureau of Land Management, State Parks,  
 11 and El Dorado County. When the water storage in the lake is at full capacity  
 12 (466 feet msl), Folsom Lake has a surface area of 11,450 acres and 75 miles of  
 13 shoreline (State Parks and Reclamation 2003, 2007).

14 The upper extent of Lake Natoma is located about 1 mile downstream of Folsom  
 15 Dam. Lake Natoma continues from the Rainbow Bridge to Nimbus Dam, about a  
 16 4-mile distance (State Parks and Reclamation 2003, 2007). Recreational facilities  
 17 and activities at the Lake Natoma area are part of the Folsom Lake State  
 18 Recreation Area and managed by State Parks. When the water storage in the  
 19 reservoir is at full capacity (132 feet msl), Lake Natoma has a surface area of  
 20 540 acres and 14 miles of shoreline.

21 Water-related activities at Folsom Lake include boating, jet skiing, water skiing,  
 22 wind surfing, rafting, sailing, canoeing, kayaking, swimming, and fishing  
 23 (Reclamation 2005b; State Parks and Recreation 2003, 2007). White water  
 24 rafting occurs along the South Fork American River upstream of Folsom Lake  
 25 and at Skunk Hollow and Salmon Falls.

26 Water-related activities at Lake Natoma generally only includes paddling, rowing,  
 27 and fishing due to a 5 miles/hour speed limit for motorized watercraft. California  
 28 State University Sacramento operates an aquatic center at Lake Natoma  
 29 (Reclamation et al. 2006).

30 Folsom Lake Marina at Brown’s Ravine is the only marina at Folsom Lake.  
 31 There are six boat launch facilities at Folsom Lake and three boat launch facilities  
 32 at Lake Natoma, as summarized in Table 15.19.

33 **Table 15.19 Folsom Lake and Lake Natoma Boat Ramps**

Location	Boat Ramp	Comments	Useable Elevations (feet, msl)
Folsom Lake	Beal’s Point	Day Use Area Informal Boat Ramp	465 to 420
Folsom Lake	Brown’s Ravine	Day Use Area Folsom Lake Marina with 685 wet slips and 175 dry storage slips	466 to 395
Folsom Lake	Folsom Point	–	466 to 406

Location	Boat Ramp	Comments	Useable Elevations (feet, msl)
Folsom Lake	Granite Bay	Day Use Area Largest Boat Launch Facility at Folsom Lake	466 to 360
Folsom Lake	Hobie Cove	–	426 to 375
Folsom Lake	Peninsula	Day Use Area	466 to 410
Folsom Lake	Rattlesnake Bar	–	466 to 425
Lake Natoma	Negro Bar	–	121 to 115
Lake Natoma	Nimbus Flat	Main Boat Ramp Informal Boat Ramp	128 to 115 128 to 120
Lake Natoma	Willow Creek	Informal Boat Ramp	125 to 115

1 Sources: Reclamation et al. 2006; State Parks and Reclamation 2003, 2007

2 Campgrounds are located at Folsom Lake and Lake Natoma, as summarized in  
 3 Table 15.20. Campers are also affected by declining water elevations because this  
 4 increases the distance from the campsites to the shoreline. Drawdown of the  
 5 reservoir has an aesthetic effect on users because the land exposed during  
 6 drawdown is generally composed of bare earth and rock.

7 **Table 15.20 Folsom Lake and Lake Natoma Major Campgrounds**

Location	Campground	Comments	Number of Campsites
Folsom Lake	Beal's Point	–	49 Camp Sites 20 Recreation Vehicles
Folsom Lake	Peninsula	Campground Boat-In Campground	104 Camp Sites
Lake Natoma	Negro Bar	Group Campground	3 Major Camp Sites

8 Note: State Parks and Reclamation 2003, 2007; Reclamation et al. 2006

9 Folsom Lake and Lake Natoma recreational areas also include day use areas for  
 10 picnicking, swimming, and other recreational opportunities, as summarized in  
 11 Table 15.21. The locations for shoreline day use areas are limited due to the steep  
 12 and rocky elevations at the shorelines. Uses of these locations are less desirable  
 13 when the water elevations decline. The Jedediah Smith Memorial Trail begins at  
 14 Beal's Point and extends along Lake Natoma to the confluence of the American  
 15 River and Sacramento River downstream of Nimbus Dam. The Pioneer Express  
 16 Trail which extends from the Auburn State Recreation Area to Beal's Point is part  
 17 of the Western States Pioneer Express Trail (a National Recreation Trail).

1 **Table 15.21 Folsom Lake and Lake Natoma Day Use Areas**

<b>Location</b>	<b>Day Use Area</b>	<b>Comments</b>	<b>Number</b>
Folsom Lake	Beal's Point	Picnic and Swimming Trailhead for Jedediah Smith Memorial Trail	53 picnic sites in Day Use area 69 at campground
Folsom Lake	Brown's Ravine Trail	Trail (to Old Salmon Falls)	12 miles
Folsom Lake	Darrington Trail	Trail	9 miles
Folsom Lake	Doton's Point ADA Trail	Trail	1 mile
Folsom Lake	Folsom Point	Picnic and water skiing Trail (to Brown's Ravine Trail)	50 picnic sites 4 miles
Folsom Lake	Folsom Powerhouse	Historic Site and Museum Trail	10 picnic sites 1 mile
Folsom Lake	Folsom Reservoir River Access Areas	Whitewater rafting (South Fork)	40 commercial rafting outfitters with 67 permits No permits for private boats
Folsom Lake	Granite Bay	Trail Picnic, Swimming, fishing, equestrian, and hiking	Several trails: 1 to 5 miles 100 picnic sites
Folsom Lake	Los Lagos Trail	Trail	1.5 miles
Folsom Lake	Old Salmon Falls	Swimming, equestrian, and hiking Trailhead for Brown's Ravine and Sweetwater trails	–
Folsom Lake	Peninsula	Trail Picnic	1 mile 6 picnic sites in Day Use area 104 at campground
Folsom Lake	Pioneer Express Trail	Trail	21 miles
Folsom Lake	Rattlesnake Bar	Equestrian	–
Folsom Lake	Skunk Hollow and Salmon Falls	Whitewater rafting (South Fork)	–

Location	Day Use Area	Comments	Number
Folsom Lake	Sweetwater Creek	Trailhead for Sweetwater Trail	–
Folsom Lake	Sweetwater Trail	Trail	2 miles
Lake Natoma	Lake Natoma Trails	Trail	Several trails: 1 to 10 miles
Lake Natoma	Lake Overlook	Trailhead for Lake Natoma Trail	–
Lake Natoma	Negro Bar	Picnic, fishing, and equestrian Trailhead for Lake Natoma Trail	32 picnic sites in Day Use area 17 at campground
Lake Natoma	Nimbus Fish Hatchery	Hatchery	–
Lake Natoma	Nimbus Flat	California State University, Sacramento Aquatic Center Trailhead for Lake Natoma Trail	37 picnic sites
Lake Natoma	Willow Creek	Trailhead for Lake Natoma Trail	4 picnic sites

1 Sources: Reclamation et al. 2006; State Parks and Reclamation 2003, 2007

2 Fishing is also popular at Folsom Lake and Lake Natoma from boats and the  
 3 shoreline. Anglers can catch warmwater and coldwater fish species due to the  
 4 summer stratification of the lake into a warm layer above a coldwater pool  
 5 especially in Folsom Lake (State Parks and Reclamation 2007). Warm water  
 6 fishing opportunities include Smallmouth Bass, Largemouth Bass, Spotted Bass,  
 7 and black and White Crappie. The cooler water strata support fishing for  
 8 Rainbow Trout, Brown Trout, and Chinook Salmon.

9 *American River from Nimbus Dam to the Confluence with Sacramento River*

10 The American River flows 14 miles between Nimbus Dam and the confluence  
 11 with the Sacramento River was designated by the Secretary of the Interior to be  
 12 part of the National Wild and Scenic Rivers System on January 19, 1981. The  
 13 State of California also designated the Lower American River as wild and scenic  
 14 under Public Resources Code sections 5093.54 and 5093.545.

15 The Jedediah Smith Memorial Trail (also known as the American River Bike  
 16 Trail) continues along the American River from Beal’s Point at Folsom Lake,  
 17 along Folsom Lake and Lake Natoma, and along the Lower American River  
 18 through Discovery Park to the confluence with the Sacramento River  
 19 (Reclamation 2005b).

1 The American River Parkway is a 26-mile green space designated and managed  
 2 by Sacramento County Parks and Recreation along the Lower American River  
 3 from Nimbus Dam to the confluence with the Sacramento River at Discovery  
 4 Park. This parkway provides extensive recreational opportunities, including  
 5 boating rafting, kayaking, canoeing, swimming, and fishing (Reclamation 2005b;  
 6 Sacramento County 2008). Pedestrian access is provided at 87 locations along the  
 7 parkway. Bicycle access and equestrian access are provided at 65 and 37  
 8 locations, respectively. Boat launch ramps are provided at 7 locations and Car-  
 9 top Boat Launch opportunities are provided at 17 locations. Picnic locations are  
 10 located at numerous locations along the American River. Fishing opportunities  
 11 along the Lower American River include Chinook Salmon, steelhead, trout,  
 12 Striped Bass, American Shad, Largemouth Bass, Bluegill, crappie, sunfish, and  
 13 catfish (Sacramento County 2008).

14 *Sacramento Municipal Utility District – Rancho Seco Park and Lake*

15 Rancho Seco Park and Lake, operated by Sacramento Municipal Utility District,  
 16 is used to store CVP water (Reclamation 2005b). The lake has a surface area of  
 17 160 acres. Water-related activities include boating, camping, picnicking, bird  
 18 watching and fishing. Facilities available for these activities are two boat ramps  
 19 and a fish cleaning facility. Game fish species found at the lake include catfish,  
 20 Bluegill, crappie, and trout. Birds that use the area include ducks, geese, hawks,  
 21 Bald Eagles, blue heron, and migratory birds (SMUD 2013).

22 **15.3.2.2 San Joaquin Valley**

23 Recreational opportunities in the San Joaquin Valley upstream of the Delta that  
 24 are influenced by CVP and SWP operations occur at Millerton Lake, San Joaquin  
 25 River between Friant Dam and the Delta, New Melones Reservoir, Stanislaus  
 26 River between Tulloch Dam and San Joaquin River, San Luis Reservoir complex,  
 27 recreation areas along Delta Mendota Canal and California Aqueduct, and refuges  
 28 that use CVP water supplies.

29 **15.3.2.2.1 Millerton Lake**

30 Millerton Lake is a CVP facility on the San Joaquin River, as described in  
 31 Chapter 5, Surface Water Resources and Water Supplies. Millerton Lake is part  
 32 of the Millerton State Recreation Area. Recreational facilities and activities at  
 33 Millerton Lake are administered by State Parks. When the water storage in the  
 34 lake is at full capacity (water elevation at 580.6 feet msl), Millerton Lake has a  
 35 surface area of approximately 4,900 acres and 44 miles of shoreline (Reclamation  
 36 and DWR 2011).

37 Boating, sailing, water skiing, jetskiing, swimming, tournament and recreational  
 38 fishing, camping, and picnicking (Reclamation and DWR 2011; Reclamation and  
 39 State Parks 2010). Whitewater rafting opportunities occur upstream of Millerton  
 40 Lake. There are six public boat ramps on Millerton Lake, as summarized in  
 41 Table 15.22.

1 **Table 15.22 Millerton Lake Boat Ramps**

Location	Boat Ramp	Comments	Useable Elevations (feet, msl)
Millerton Lake	Crow's Nest	On South Shore	580 to 487
Millerton Lake	Grange Cove	On South Shore	Several Boat Ramps: 580 to 500
Millerton Lake	McKenzie Point	On South Shore	580 to 472
Millerton Lake	North Shore	On North Shore	580 to 470
Millerton Lake	South Bay	On South Shore	580 to 500

2 Sources: Reclamation and DWR 2011; Reclamation and State Parks 2010

3 The marina at Millerton Lake is located at Winchell Cove on the South Shore  
 4 (Reclamation and State Parks 2010). The marina includes 500 boat slips. There  
 5 are also eight boat slips at Crow's Nest.

6 Campgrounds are located along the Millerton Lake North Shore, as summarized  
 7 in Table 15.23. Many of these campsites are located along the shoreline. These  
 8 campsites are affected by declining water elevations because this increases the  
 9 distance from the campsites to the shoreline.

10 **Table 15.23 Millerton Lake Major Campgrounds**

Location	Campground	Comments	Number of Campsites
Millerton Lake	Dumna Strand	–	10
Millerton Lake	Fort Miller	Shoreline Campground	36
Millerton Lake	Group Campsites	Group Campground Amphitheater	Two sites with total of 120 sites
Millerton Lake	Meadows	Campsites Equestrian Campsites	59 4 corrals and campsites
Millerton Lake	Mono	–	16
Millerton Lake	North Fine Gold Campground	Boat-In Campground	15
Millerton Lake	Rocky Point	–	21
Millerton Lake	Temperance Flat Boat	Boat-In Campground	25
Millerton Lake	Valley Oak	–	6

11 Source: Reclamation and State Parks 2010

12 Millerton Lake recreational areas also include day use areas for picnicking,  
 13 swimming, and other recreational opportunities, as summarized in Table 15.24  
 14 (Reclamation and State Parks 2010). The locations for shoreline day use areas are  
 15 less desirable when the water elevations decline.

1 **Table 15.24 Millerton Lake Day Use Areas**

Location	Day Use Area	Comments	Number
Millerton Lake	Blue Oak	Picnic and Trail along the South Shore	3 sites 4 miles
Millerton Lake	Buzzard’s Roost Trail	Picnic and Trail	2 sites 0.5 miles
Millerton Lake	Crow’s Nest	Picnic	13 sites
Millerton Lake	Eagle’s Nest	Picnic and Trailhead	2 sites
Millerton Lake	Fort Miller	Trail	0.25 miles
Millerton Lake	Grange Grove	Picnic	74 sites
Millerton Lake	La Playa	Picnic and Swimming	95 sites
Millerton Lake	McKenzie Point	Picnic	–
Millerton Lake	Meadows	Picnic	10 sites
Millerton Lake	Millerton Courthouse	Historic Site and Picnic	3 sites
Millerton Lake	San Joaquin River Trail	Portions along the Millerton Lake shoreline	14 miles
Millerton Lake	South Bay	Picnic	9 sites
Millerton Lake	South Fine Gold	Picnic and Trail	10 sites 11 miles

2 Sources: Reclamation and State Parks 2010; State Parks 2008

3 Fishing is also popular at Millerton Lake from boats and shoreline. Fishing  
 4 opportunities include Striped Bass, Black Bass, Largemouth Bass, Green Sunfish,  
 5 and American Shad (Reclamation and State Parks 2010).

6 **15.3.2.2.2 San Joaquin River from Friant Dam to the Delta**

7 The San Joaquin River flows 100 miles from Friant Dam to the Delta.  
 8 Downstream of Friant Dam, the San Joaquin River flows 23 miles through lands  
 9 within the San Joaquin River Parkway which includes parks, trails, and ecological  
 10 reserve areas between Friant Dam and State Route 145 managed by the San  
 11 Joaquin River Parkway and Conservation Trust (Reclamation and DWR 2011).

12 Water-related recreational activities include boating, canoeing, kayaking,  
 13 whitewater rafting, camping, picnicking, fishing, and hunting (Reclamation and  
 14 DWR 2011). Access and facilities for these activities are available at several  
 15 locations along and adjacent to the San Joaquin River.

16 Between Friant Dam and the confluence with the Merced River, whitewater  
 17 rafting occurs between Friant Dam to Skaggs Bridge Park at State Route 145.  
 18 Public access locations are generally located within the San Joaquin River



1 Parkway. Seven boat launching locations along the San Joaquin River Parkway  
2 that are managed by the San Joaquin River Parkway and Conservation Trust  
3 and/or DFW, Fresno County, or private operators. Lost Lake Park, managed by  
4 the San Joaquin River Parkway and Conservation Trust and DFW, provides a  
5 non-powered car-top boat launch. Sycamore Island Park, managed by San  
6 Joaquin River Parkway and Conservation Trust offers a boat ramp for small boats.  
7 River access also is available at Skaggs Bridge Park, managed by Fresno County.  
8 Picnicking is provided at most of the public access locations and at several other  
9 locations within the parkway. Camping is provided at Scout Island and Lost Lake  
10 Park managed by Fresno County and the private Fort Washington Beach. Trails  
11 include the 5-mile long Lewis S. Eaton Trail.

12 Downstream of State Route 145, major recreational areas include the 85-acre  
13 Mendota Pool in Mendota; Dunkle and Maldonado parks in the City of Firebaugh;  
14 and Las Palmas Fishing Access and Laird Park in Stanislaus County. Public  
15 access is provided at all of these sites. A boat ramp is located upstream of  
16 Mendota Dam.

17 The majority of these areas permit fishing. Fishing opportunities in the San  
18 Joaquin River include sunfish, crappie, Bluegill, Striped Bass, Largemouth Bass,  
19 and catfish (Reclamation and DWR 2011).

#### 20 **15.3.2.2.3 San Joaquin Valley Refuges**

21 Wildlife refuges in the San Joaquin Valley that rely upon CVP water supplies  
22 include the San Luis NWR (including the San Luis Unit, West Bear Creek Unit,  
23 East Bear Creek Unit, Freitas Unit, and Kesterson Unit); Merced NWR; Los  
24 Banos Wildlife Area; Volta Wildlife Area; Mendota Wildlife Area; North  
25 Grasslands Wildlife Area (including China Island Unit and Salt Slough Unit); and  
26 Grasslands Resource Conservation District, as described in Chapter 5, Surface  
27 Water Resources and Water Supplies, and Chapter 10, Terrestrial Biological  
28 Resources (Reclamation 2012). Water-related activities include wildlife viewing,  
29 and hunting. Hunting opportunities include waterfowl, shorebirds, and pheasants  
30 (Reclamation and DWR 2011).

31 Several wildlife areas along the San Joaquin River could be affected by CVP  
32 operations of Millerton Lake, including the West Hilmar Wildlife Area  
33 downstream of the confluence with the Merced River and the San Joaquin River  
34 NWR located between the Tuolumne and Stanislaus rivers (Reclamation and  
35 DWR 2011). West Hilmar Wildlife Area includes 340 acres of wildlife area  
36 accessible by boat. The San Joaquin River NWR includes over 7,000 acres of  
37 riparian woodlands, wetlands, and grasslands for native wildlife with limited  
38 access at Pelican Trail.

39 In the southern San Joaquin Valley, the Kern and Pixley NWRs provide wildlife  
40 viewing opportunities.

1 **15.3.2.2.4 Stanislaus River Watershed**

2 New Melones Reservoir and Tulloch Reservoir on the Stanislaus River and the  
 3 lower Stanislaus River are located within areas in the Stanislaus River watershed  
 4 that could be affected by changes in CVP operations.

5 *New Melones Reservoir*

6 New Melones Reservoir is a CVP facility on the Stanislaus River, as described in  
 7 Chapter 5, Surface Water Resources and Water Supplies. Recreation activities  
 8 and facilities at New Melones Reservoir area are managed by Reclamation.

9 When the water storage in the reservoir is at full capacity, New Melones  
 10 Reservoir has a surface area of approximately 12,500 acres and 105 miles of  
 11 shoreline at a surface elevation of 1,088 feet msl (Reclamation 1997, 2010a).

12 Water-related activities include boating, waterskiing, camping, picnicking,  
 13 wildlife viewing, spelunking, rock climbing, gold panning, and fishing  
 14 (Reclamation 2010a). Float planes can land within the North, Middle, and South  
 15 Bays of the reservoir. A model airplane club operates an airstrip near New  
 16 Melones Dam. Cave exploration occurs in the Stanislaus River Canyon. Rock  
 17 climbing occurs on Table Mountain. In years when the reservoir elevation is low,  
 18 whitewater rafters launch at the Old Camp Nine Bridge.

19 There are five boat ramps at New Melones Reservoir, as summarized in  
 20 Table 15.25.

21 **Table 15.25 New Melones Reservoir Boat Ramps**

Location	Boat Ramp	Comments	Useable Elevations (feet, msl)
New Melones Reservoir	Angels Creek	–	1,088 to 975
New Melones Reservoir	Glory Hole	Location of New Melones Lake Marina	Several Boat Ramps: 1,088 to 860
New Melones Reservoir	Mark Twain	Unimproved Ramp	1,088 to 760
New Melones Reservoir	Parrotts Ferry	Unimproved Ramp	Several Boat Ramps: 1,088 to 900

22 Source: Reclamation 2010a

23 The New Melones Marina is the only location with mooring facilities and  
 24 houseboat rentals (Reclamation 2010a). Up to 50 private houseboats on mooring  
 25 balls, 38 private houseboats in slips, and 20 rental houseboats may be maintained  
 26 on the reservoir.

27 Campgrounds are located at Glory Hole and Tuttle town, as summarized in  
 28 Table 15.26 (Reclamation 2010a). Some of the campsites are located along the  
 29 shoreline. These campsites are affected by declining water elevations because  
 30 this increases the distance from the campsites to the shoreline.

1 **Table 15.26 New Melones Reservoir Major Campgrounds**

Location	Campground	Comments	Number of Campsites
New Melones Reservoir	Glory Hole	Two campgrounds	144
New Melones Reservoir	Tuttletown	Three campgrounds Two Group campgrounds	161 16

2 Source: Reclamation 2010a

3 New Melones Reservoir recreational areas also include day use areas for  
 4 picnicking, swimming, and other recreational opportunities, as summarized in  
 5 Table 15.27 (Reclamation 2010a). The locations for shoreline day use areas are  
 6 less desirable when the water elevations decline.

7 **Table 15.27 New Melones Reservoir Day Use Areas**

Location	Day Use Area	Comments	Number
New Melones Reservoir	Glory Hole	Picnic and Trails	61 sites Several trails: 0.25 to 2.5 miles
New Melones Reservoir	Mark Twain	Picnic and Norwegian Gulch Trail	0.5 miles
New Melones Reservoir	Natural Bridges	Trail	0.7 miles
New Melones Reservoir	Shoreline	Swimming and Recreational Gold Panning	–
New Melones Reservoir	Table Mountain	Trail	Several trails: 1.5 to 4.0 miles
New Melones Reservoir	New Melones Lake Visitor	Visitor Center	–
New Melones Reservoir	Tuttletown	Picnic and Trail	52 sites Several trails: 0.4 to 1.7 miles

8 Sources: Reclamation 2010a, 2010b, 2014

9 *Tulloch Reservoir*

10 Tulloch Reservoir is a reservoir owned and operated by the Oakdale and South  
 11 San Joaquin Irrigation Districts on the Stanislaus River downstream of New  
 12 Melones Reservoir, as described in Chapter 5, Surface Water Resources and  
 13 Water Supplies. When the water storage in the reservoir is at full capacity (water  
 14 elevation at 510 feet msl), the reservoir has a surface area of 1,260 acres and  
 15 55 miles of shoreline (CBC 2013; Tri-Dam Project 2002).

1 Water-related activities include boating, sailing, windsurfing, jet and water skiing,  
 2 camping, picnicking, and fishing. Most of the shoreline is privately owned with  
 3 shoreline access and more than 400 private docks for residents (Tri-Dam Project  
 4 2012). Public access is provided at a DFW marina and campground with a boat  
 5 ramp at South Shore.

6 *Stanislaus River from Tulloch Dam to the San Joaquin River*

7 Downstream of Tulloch Dam, the Stanislaus River flows to Goodwin Dam, and  
 8 then continues approximately 40 miles to the confluence with the San Joaquin  
 9 River. Water-related activities along the lower portion of the Stanislaus River  
 10 include whitewater rafting, camping, picnicking, swimming, and fishing.  
 11 Whitewater rafting begins at Goodwin Dam and continues almost 4 miles to  
 12 Knights Ferry (Reclamation 1997). Downstream of Knights Ferry, there are  
 13 seven parks, including Caswell Memorial State Park, a 258-acre park managed by  
 14 State Parks (Stanislaus County 1987; State Parks 2006a). Fishing opportunities  
 15 on the lower Stanislaus River include bass, catfish, and crappie.

16 **15.3.2.2.5 San Luis Reservoir State Recreation Area**

17 The San Luis Reservoir complex includes CVP and SWP offstream storage  
 18 facilities located south of the Delta, as described in Chapter 5, Surface Water  
 19 Resources and Water Supplies. The San Luis Reservoir complex includes San  
 20 Luis Reservoir, O'Neill Forebay, and Los Banos Creek Reservoir. The San Luis  
 21 Reservoir complex is located within the San Luis Reservoir State Recreation  
 22 Area, and the recreational facilities are operated by State Parks (State Parks  
 23 2003). Los Banos Creek Reservoir is a flood detention basin to protect the  
 24 community of Los Banos and San Luis Canal/California Aqueduct. This reservoir  
 25 and a similar flood management reservoir that is not within the San Luis  
 26 Reservoir State Recreation Area (Little Panoche Creek Reservoir) are not affected  
 27 by CVP and SWP operations. Therefore, Los Banos Creek Reservoir and Little  
 28 Panoche Creek Reservoir are not considered in detail in this EIS.

29 When the water storage in the San Luis Reservoir is at full capacity (water  
 30 elevation at 540 feet msl), the reservoir has a surface area of 12,700 acres and  
 31 65 miles of shoreline (Reclamation and State Parks 2013; State Parks 2010).

32 The O'Neill Forebay is east of the San Luis Reservoir downstream of the San  
 33 Luis Dam. When the water storage in the forebay is at full capacity (water  
 34 elevation of 230 feet msl), the reservoir has a surface area of 2,210 acres and  
 35 14 miles of shoreline (Reclamation and State Parks 2013; State Parks 2010).

36 Water-related activities include boating, camping, picnicking, wildlife and scenic  
 37 viewing, fishing, and hunting occur throughout the San Luis Reservoir State  
 38 Recreation Area (Reclamation 2005c; State Parks 2010; Reclamation and State  
 39 Parks 2013). Boat ramps are located at all three reservoirs, as summarized below.

- 40 • San Luis Reservoir: Boat ramps at Basalt Area and Dinosaur Point  
 41 (operational to 340 feet and 360 feet msl, respectively).

- 1 • O'Neill Forebay: Boat ramps at Group Campground and Medeiros  
2 Campground.
  - 3 • Los Banos Creek Reservoir: Boat ramp at Los Banos Creek Campground.
- 4 Camping occurs at Basalt Area at San Luis Reservoir (79 sites), O'Neill Forebay  
5 (50 sites), San Luis Creek Area (53 sites and two group campsites with 90 sites),  
6 and Los Banos Creek Area (14 sites) (Reclamation and State Parks 2013). Picnic  
7 sites, swimming, and/or trails occur at Basalt Area, Medeiros Area, and Los  
8 Banos Creek Area (Reclamation 2005c; State Parks 2010; Reclamation and State  
9 Parks 2013).
- 10 Fishing opportunities include Striped Bass, American Shad, and catfish  
11 (Reclamation and State Parks 2013). Hunting opportunities occur at San Luis  
12 Reservoir for waterfowl, deer, and wild pig (Reclamation 2005c; Reclamation and  
13 State Parks 2013).

#### 14 **15.3.2.2.6 Delta Mendota Canal**

15 Delta Mendota Canal is a CVP facility, as described in Chapter 5, Surface Water  
16 Resources and Water Supplies. The Delta-Mendota Canal includes two fishing  
17 sites: one in Stanislaus County and the other in Fresno County (Reclamation  
18 2005c). Fishing opportunities include Striped Bass and catfish (Reclamation  
19 1997).

#### 20 **15.3.2.2.7 California Aqueduct/San Luis Canal**

21 The California Aqueduct is a SWP facility, as described in Chapter 5, Surface  
22 Water Resources and Water Supplies. A portion of the canal is also co-located  
23 with the CVP San Luis Canal. Fishing is permitted at 12 sites along the  
24 California Aqueduct between Bethany Reservoir and Perris Lake in Southern  
25 California. Fishing opportunities include Striped Bass, Largemouth Bass, catfish,  
26 crappie, Green Sunfish, Bluegill, and starry flounder (Reclamation 1997).

#### 27 **15.3.2.3 Delta**

28 The Delta is located at the terminus of the Sacramento River and the San Joaquin  
29 River. Water-related activities in the Delta include boating, sailing, water skiing,  
30 canoeing, kayaking, picnicking, fishing, and hunting. Recreational opportunities  
31 exist in many areas of the Delta; however, the analysis in this EIS is related to  
32 areas that could be affected by changes in CVP and/or SWP water supply  
33 operations and restoration in the Yolo Bypass. The following discussion  
34 describes recreation throughout the Delta followed by more specific discussions  
35 of recreation within the Yolo Bypass and Cache Slough.

#### 36 **15.3.2.3.1 Delta Recreational Opportunities**

37 The primary recreational activities in the Delta are related to boating and fishing  
38 (DPC 2012). Public recreation facilities are limited within the Delta. Most  
39 recreational opportunities are provided by private enterprises, including marinas,  
40 restaurants, hunting venues, and wineries and farm visits. Public access is  
41 provided at DFW and U.S. Fish and Wildlife Service (USFWS) sites.

1 The most recent survey of boating opportunities in the Delta was completed in  
 2 2002 by the California Department of Boating and Waterways (DBW 2014; DPC  
 3 2012). The survey indicated that of the 95 marinas surveyed, three were  
 4 publically-owned and 92 were privately-owned (including 87 that were open to  
 5 the public and five that were for members). The survey indicated that within the  
 6 Delta there were over 11,600 boat slips, 55 boat launches, 2,182 campsites, and  
 7 324 picnic sites.

8 Public access sites for boating and wildlife and scenic viewing in the Delta  
 9 include:

- 10 • USFWS: Stone Lakes NWR, Antioch Dunes NWR.
- 11 • DFW: Calhoun Cut Ecological Reserve, Decker Island Wildlife Area, Lower  
 12 Sherman Island Wildlife Area, Miner Slough Wildlife Area, Rhode Island  
 13 Wildlife Area, White Slough Wildlife Area, Woodbridge Ecological Reserve,  
 14 Fremont Weir Wildlife Area, Sacramento Bypass Wildlife Area, and Yolo  
 15 Bypass Wildlife Area.
- 16 • State Parks: Brannan Island-Franks Tract State Recreation Areas, Delta  
 17 Meadows State Recreation Area.
- 18 • Department of Water Resources: Clifton Court Forebay.
- 19 • The Nature Conservancy/DFW: Cosumnes River Preserve.
- 20 • Solano Land Trust: Jepson Prairie Preserve.
- 21 • East Bay Regional Park District: Big Break Regional Shoreline,  
 22 Antioch/Oakley Regional Shoreline, Browns Island Regional Preserve, Bay  
 23 Point Regional Shoreline, Martinez Regional Shoreline, Carquinez Strait  
 24 Regional Shoreline-Crockett Hills Regional Park, and Contra Costa Canal  
 25 Trail.
- 26 • Municipal Marinas, Boat Launching, and Fishing Access Facilities: City of  
 27 Antioch Marina and Municipal Boat Ramp; City of Pittsburg Riverview Park;  
 28 Sacramento County Cliffhouse, Georgiana Slough Fishing Access, Hogback  
 29 Island Access, and Sherman Island Public Access Facility; City of Sacramento  
 30 Garcia Bend Park; several public and private marinas in Sacramento County;  
 31 12 public and private marinas with over 900 boat slips and boat access within  
 32 the City of Stockton; San Joaquin County Dos Reis Regional Park, Mossdale  
 33 Crossing Regional Park, and Westgate Landing Regional Park; and Yolo  
 34 County Clarksburg River Access.

35 Several of these sites include launch sites for boats, canoes, and kayaks and  
 36 numerous trails (DPC 2012; DSC 2011; DFG 2008b, 2008d, 2009; EBRPD  
 37 2013a; Antioch 2003; Pittsburg 2001; Sacramento County 2014; Sacramento  
 38 2005; Stockton 2007; Yolo County 2009).

39 One of the larger bodies of water in the Delta is the SWP Clifton Court Forebay.  
 40 Fishing is the only recreational opportunity that occurs within the Clifton Court  
 41 Forebay; and the opportunities are limited (DWR 2013c). Public access is

1 restricted near the radial gate along West Canal. However, boat access occurs at a  
2 boat dock along West Canal to the east of the radial gate and by a trail from  
3 Clifton Court Road.

4 Fishing opportunities in the Delta generally include Striped Bass, Smallmouth  
5 Bass, Largemouth Bass, Spotted Bass, American Shad, Black Crappie, Chinook  
6 Salmon, steelhead, catfish, sunfish, Tule Perch, Warmouth, and White Sturgeon  
7 (DPC 2006).

8 Hunting opportunities for waterfowl, shorebirds, doves, and pheasants occur in  
9 many areas of the Delta on privately-owned land. Hunting also occurs at several  
10 publically-owned sites within the Delta, including:

- 11 • USFWS: Stone Lakes NWR.
- 12 • DFW: Decker Island Wildlife Area, Lower Sherman Island Wildlife Area,  
13 Miner Slough Wildlife Area, Rhode Island Wildlife Area, White Slough  
14 Wildlife Area, Yolo Bypass Wildlife Area; and on some lands owned by  
15 DWR (including Sherman and Twitchell islands and Clifton Court Forebay).

16 The Delta Protection Commission identified several physical constraints to Delta  
17 recreational opportunities that could be affected by CVP and SWP operations,  
18 including changes in water quality and operation of the CVP or SWP water  
19 facilities (Delta Cross Channel, South Delta Temporary Barriers, and Montezuma  
20 Slough Salinity Gates) (DPC 2012).

### 21 **15.3.2.3.2 Yolo Bypass and Cache Slough Recreational Opportunities**

22 The primary recreational activities in the Yolo Bypass and Cache Slough areas are  
23 related to wildlife viewing and hunting. Many recreational hunting opportunities  
24 occur on private lands, including private hunting clubs. Areas within Yolo  
25 Bypass and Cache Slough that provide public access for wildlife viewing or  
26 hunting within the Yolo Bypass and Cache Slough area, include:

- 27 • Fremont Weir Wildlife Area (DFW 2014a).
  - 28 – Wildlife viewing and fishing.
  - 29 – Hunting for pheasant, waterfowl, Mourning Dove, deer, quail, rabbit, and  
30 turkey.
- 31 • Sacramento Bypass Wildlife Area (DFW 2014c).
  - 32 – Wildlife viewing and fishing, including for White Sturgeon, White  
33 Catfish, and Black Crappie in the Tule Canal; and Largemouth Bass,  
34 Bluegill, and White Catfish in the borrow pits.
  - 35 – Hunting for pheasant and Mourning Dove.
- 36 • Yolo Bypass Wildlife Area (DFG 2008c, 2010).
  - 37 – Wildlife viewing and hiking.
  - 38 – Fishing for sturgeon, Striped Bass, Black Bass, and catfish.

- 1       – Hunting for waterfowl, coots, Moorhens, Snipe, pheasants, and Mourning
- 2       Doves.
- 3       – Educational and interpretative programs.
- 4       • Calhoun Cut Ecological Reserve (DFG 2008d).
- 5       – Waterfowl hunting and fishing from a boat.

6 There are other publically-owned lands within the Yolo Bypass and Cache Slough  
7 that provide habitat or will be restored to provide habitat. However, these lands  
8 are generally not available for public access to protect fragile ecosystems.

#### 9 **15.3.2.4 Suisun Marsh**

10 Suisun Marsh is 106,511 acres of wetlands located between the Delta and the  
11 San Francisco Bay. Water-related activities at Suisun Marsh include waterfowl  
12 hunting, boating, kayaking, hiking, wildlife viewing, fishing, and hunting  
13 (Reclamation et al. 2011). Water-related recreation occurs within the two major  
14 channels, Montezuma and Suisun sloughs; and several moderately sized channels,  
15 Cordelia, Denverton, Nurse, and Hill sloughs.

16 The DFW manages several areas within the Suisun Marsh for public access, as  
17 described in Chapter 10, Terrestrial Biological Resources. These areas include  
18 (Reclamation et al. 2011):

- 19       • Grizzly Island Wildlife Area
  - 20           – Wildlife viewing, hiking, and fishing (February through July, and late
  - 21           September).
  - 22           – Hunting (August through mid-September, and October through January).
- 23       • Hill Slough Wildlife Area
  - 24           – Wildlife viewing and fishing.
- 25       • Peytonia Slough Ecological Preserve
  - 26           – Kayaking.
  - 27           – Wildlife viewing and fishing.
- 28       • Belden's Landing Water Access Facility
  - 29           – Boat launch ramp and fishing pier.

30 Suisun City Marina and Solano Yacht Club, Suisun City Boat Launch, and  
31 McAvoy Yacht Harbor and Club also provide boat launch ramp facilities  
32 (Reclamation et al. 2011). Pier fishing opportunities are provided at Suisun City  
33 Boat Launch.

34 The Solano Land Trust's Rush Ranch also provides opportunities for hiking and  
35 picnicking in the wetlands and upland areas near Potrero Hills (Reclamation et al.  
36 2010).



1 Fishing opportunities within Suisun Marsh include Striped Bass, White Sturgeon,  
2 catfish, and carp (Reclamation et al. 2011). Occasionally, Chinook Salmon,  
3 steelhead, and Largemouth Bass are caught in Suisun Marsh near Grizzly Island.  
4 Duck hunting generates the most frequent recreational visits in Suisun Marsh  
5 (Reclamation et al. 2011). About 37,500 acres of Suisun Marsh are owned and  
6 operated by private duck clubs. DFW manages about 15,300 acres of public lands  
7 in Grizzly Island Wildlife Area for hunting of waterfowl, Snipe, coots, Moorhens,  
8 Mourning Doves, pheasants, rabbits, and Tule Elk.  
9 There are other publically-owned lands within Suisun Marsh that provide habitat  
10 or will be restored to provide habitat. However, these lands are generally not  
11 available for public access to protect fragile ecosystems.

### 12 **15.3.3 San Francisco Bay Area Region**

13 The San Francisco Bay Area Region includes portions of Contra Costa, Alameda,  
14 Santa Clara, San Benito, and Napa counties that are within the CVP and SWP  
15 service areas. This section describes reservoirs in the San Francisco Bay Area  
16 Region that could be affected by CVP and SWP operations, including the CVP  
17 Contra Loma and San Justo reservoirs; the SWP Bethany Reservoir and Lake Del  
18 Valle; the Contra Costa Water District Los Vaqueros Reservoir; and the East Bay  
19 Municipal Utility District Upper San Leandro, San Pablo, Briones, and Lafayette  
20 reservoirs and Lake Chabot. CVP and SWP are generally not stored in reservoirs  
21 within Santa Clara County (SCVWD 2010).

#### 22 **15.3.3.1 Contra Loma Reservoir**

23 The Contra Loma Reservoir is a CVP facility in Contra Costa County that  
24 provides offstream storage along the Contra Costa Canal, as described in  
25 Chapter 5, Surface Water Resources and Water Supplies. The recreation facilities  
26 are managed by East Bay Regional Park District. The 80 acre reservoir is part of  
27 661-acre Contra Loma Regional Park and Antioch Community Park (Reclamation  
28 2014a). Water-related activities include boating, wind surfing, kayaking,  
29 picnicking, and fishing. No bodily contact is to occur in Contra Loma Reservoir;  
30 therefore, a large swimming pool was constructed for the visitors by the East Bay  
31 Regional Park District. There is one boat launch at the reservoir. Contra Loma  
32 Reservoir accommodates fishing all year-round. Fishing opportunities include  
33 catfish, Black Bass, Striped Bass, Largemouth Bass, Bluegill, crappie, trout, and  
34 Redear Sunfish (EBRPD 2013c).

#### 35 **15.3.3.2 San Justo Reservoir**

36 The San Justo Reservoir is a CVP facility in San Benito County that provides  
37 offstream storage as part of the San Felipe Division, as described in Chapter 5,  
38 Surface Water Resources and Water Supplies. San Justo Reservoir recreation  
39 facilities have been closed to the public since 2009 due to an infestation by the  
40 zebra mussel. Previously, the recreation facilities were managed by San Benito  
41 County Water District (SBCWD 2014).

1     **15.3.3.3   Bethany Reservoir**

2     Bethany Reservoir is a SWP facility located between the California Aqueduct and  
3     South Bay Aqueduct in Alameda County, as described in Chapter 5, Surface  
4     Water Resources and Water Supplies. The recreation facilities are part of the  
5     Bethany Reservoir State Recreation Area and are managed by State Parks. When  
6     the water storage in the reservoir is at full capacity (water elevation at  
7     243 feet msl), Bethany Reservoir has 161 acres of surface area and 6 miles of  
8     shoreline (DWR 2001). Water-related activities include boating, windsurfing,  
9     picnicking, and fishing. There is one boat launch at the reservoir (State Parks  
10    2013a). Fishing opportunities include Striped Bass, Smallmouth Bass,  
11    Largemouth Bass, Spotted Bass, White Bass, catfish, crappie, and trout.

12    **15.3.3.4   Lake Del Valle**

13    Lake Del Valle is a SWP facility located along the South Bay Aqueduct in  
14    Alameda County, as described in Chapter 5, Surface Water Resources and Water  
15    Supplies. The recreation facilities are managed by East Bay Regional Park  
16    District as part of the Del Valle Regional Park. When the water storage in the  
17    reservoir is at full capacity (water elevation at 703 feet msl), Lake Del Valle has  
18    708 acres of surface area and 16 miles of shoreline (DWR 2001). Water-related  
19    activities include boating, windsurfing, camping, swimming, and fishing (DWR  
20    2001). There is a boat launch at the lake (EBRPD 2014). Boating hazards can  
21    occur along the variable shoreline when the surface water elevation declines to  
22    678 feet msl. There are seven group campsites for up to 475 and a family  
23    campground (DWR 2001; EBRPD 2014). Fishing opportunities include trout,  
24    catfish, Largemouth Bass, and Smallmouth Bass, Striped Bass, and Panfish  
25    (EBRPD 2014).

26    **15.3.3.5   Los Vaqueros Reservoir**

27    Los Vaqueros Reservoir is a Contra Costa Water District offstream storage  
28    facility in Contra Costa County, as described in Chapter 5, Surface Water  
29    Resources and Water Supplies. Recreation facilities are managed by Contra  
30    Costa Water District. Water-related activities include boating using rented  
31    electrical boats, and fishing (CCWD 2014). The Los Vaqueros recreation  
32    facilities include a marina, four fishing piers, 55 miles of trails, several individual  
33    and group picnic areas, and an interpretative center. Fishing opportunities include  
34    Rainbow Trout, Brown Bullhead, White Catfish, Channel Catfish, sunfish, White  
35    Crappie, Largemouth Bass, Striped Bass, Chinook Salmon, Kokanee Salmon,  
36    Green Sunfish, and Sacramento Perch (EBRPD 2014).

37    **15.3.3.6   San Pablo Reservoir, Lafayette Reservoir, Lake Chabot, and East  
38    Bay Municipal Utility District Trails**

39    The East Bay Municipal Utility District reservoirs in Alameda and Contra Costa  
40    County are used to store water within and near the East Bay Municipal Utility  
41    District service area. Water stored in these reservoirs includes water from local  
42    watersheds, the Mokelumne River watershed, and CVP water supplies, as  
43    described in Chapter 5, Surface Water Resources and Water Supplies. Recreation  
44    is allowed within the waters of San Pablo and Lafayette reservoirs and Lake

1 Chabot (EBMUD 2011). Recreation is not allowed within the waters of Upper  
2 San Leandro and Briones reservoir. East Bay Municipal Utility District maintains  
3 trails within the watersheds of the reservoirs.

4 Recreation facilities at San Pablo Reservoir are managed by East Bay Municipal  
5 Utility District. Water-related activities at San Pablo Reservoir include boating,  
6 picnicking, and fishing (EBMUD 2014a). There is a boat launch at the reservoir.  
7 There are individual sites and nine group picnic areas that can accommodate up to  
8 100 people at each site. Hiking can occur in the San Pablo Reservoir watershed  
9 on 8.7 miles of trails which connect to about 13 miles of trails in the Briones  
10 Reservoir watershed (EBMUD 2007a). The surface water of the reservoirs can be  
11 viewed from many locations along these trails. Fishing opportunities at San Pablo  
12 Reservoir include Rainbow Trout, catfish, Black Bass, Bluegill, and crappie  
13 (EBMUD 2014a).

14 Recreation facilities at Lafayette Reservoir are managed by East Bay Municipal  
15 Utility District. Water-related activities at Lafayette Reservoir include boating,  
16 picnicking, and fishing (EBMUD 2014b). There is a private car-top boat launch  
17 at the reservoir. There are 125 picnic sites around the reservoir. Hiking can occur  
18 in the Lafayette Reservoir watershed on 7.4 miles of trails. Fishing opportunities  
19 at Lafayette Reservoir include Rainbow Trout, catfish, Black Bass, and sunfish.

20 There are no water-related activities within or adjacent to Upper San Leandro  
21 Reservoir. However, East Bay Municipal Utility District maintains over 26 miles  
22 of trails within the Upper San Leandro Reservoir watershed. The surface water of  
23 the reservoirs can be viewed from many locations along these trails (EBMUD  
24 2007b).

25 Recreation facilities at Lake Chabot are managed by East Bay Regional Park  
26 District as part of the Lake Chabot Regional Park (EBRPD 2011). Water-related  
27 activities at Lake Chabot include boating, camping, picnicking, and fishing.  
28 There is a boat launch at the reservoir and boat rides are offered on the *Chabot*  
29 *Queen*. Individual campsites and group campsites are located near the southern  
30 portion of the park. Picnic sites are located near the Lake Chabot Marina. Hiking  
31 can occur along the shoreline on over 9 miles of trails which connect to more than  
32 17 miles of other trails in the watershed (EBRPD 2011, 2013d). Other  
33 recreational activities, including equestrian trails and a marksmanship range, are  
34 located in the upper Lake Chabot watershed. Fishing opportunities at Lake  
35 Chabot include Rainbow Trout, catfish, Black Bass, crappie, Bluegill, and carp.

#### 36 **15.3.4 Central Coast Region**

37 The Central Coast Region includes portions of San Luis Obispo and Santa  
38 Barbara counties served by the SWP. The SWP water supplies generally are  
39 conveyed to Central Coast municipal, industrial, and agricultural water users in  
40 pipelines and closed reservoirs. Water is delivered to southern Santa Barbara  
41 County communities through Cachuma Lake. Therefore, in the Central Coast  
42 Region, the only recreational opportunities that may be affected by changes in  
43 SWP operations would be Cachuma Lake in Santa Barbara County (CCWA  
44 2014).

1     **15.3.4.1   Cachuma Lake**

2     Cachuma Lake is a facility owned and operated by Reclamation in Santa Barbara  
3     County, as described in Chapter 5, Surface Water Resources and Water Supplies.  
4     Recreation facilities are managed by Santa Barbara County Parks Department.  
5     Water-related activities include boating, and fishing within the lake and along the  
6     lake shoreline (Reclamation 2010c). Cachuma Lake recreation facilities include a  
7     marina with 87 rental boats and a public boat launch, 94 private boat slips,  
8     520 campsites, equestrian campsites, family center, amphitheater, and trails that  
9     range from 0.25 to 9 miles in length. Fishing opportunities include trout, catfish,  
10    crappie, bass, Redear Perch, and Bluegill.

11    **15.3.5     Southern California Region**

12    The Southern California Region includes portions of Ventura, Los Angeles,  
13    Orange, San Diego, Riverside, and San Bernardino counties served by the SWP.  
14    The SWP water supplies generally are conveyed to Southern California  
15    municipal, industrial, and agricultural water users in canals and pipelines. There  
16    are six SWP reservoirs along the main canal, West Branch, and East Branch of the  
17    California Aqueduct and many other reservoirs owned and operated by regional  
18    and local agencies. The Metropolitan Water District of Southern California's  
19    Diamond Valley Lake and Lake Skinner primarily store water from the SWP.  
20    Other reservoirs that store SWP water, include United Water Conservation  
21    District's Lake Piru; City of Escondido's Dixon Lake; City of San Diego's San  
22    Vicente, El Capitan, Lower Otay, Hodges, and Murray reservoirs; Helix Water  
23    District's Lake Jennings; and Sweetwater Authority's Sweetwater Reservoir.

24    This section does not include reservoirs that do not provide recreational  
25    opportunities, such as Vail Lake in Riverside County or Olivenhain Reservoir in  
26    San Diego County, or reservoirs that do not store SWP water supplies, such as  
27    Lake Mathews in Riverside County which is used to store Colorado River water  
28    (RCWD 2011; SDCWA 2015; Riverside County 2000).

29    **15.3.5.1   Quail Lake**

30    Quail Lake is a SWP facility in Los Angeles County, as described in Chapter 5,  
31    Surface Water Resources and Water Supplies. Recreation facilities are managed  
32    by DWR (DWR 2014a). Water-related activities include fishing within the lake  
33    and along the shoreline. Fishing opportunities include Channel Catfish, Striped  
34    Bass, Blackfish, Tule Perch, Threadfin Shad, and Hitch.

35    **15.3.5.2   Pyramid Lake**

36    Pyramid Lake is a SWP facility located in Los Angeles County and upstream of  
37    Castaic Lake on the West Branch of the California Aqueduct, as described in  
38    Chapter 5, Surface Water Resources and Water Supplies. Recreation facilities are  
39    managed by the U.S. Forest Service (DWR 2000, 2014b). Water-related activities  
40    include boating, camping, water skiing, swimming, and fishing. Boat launch  
41    facilities are available at Vaqueros Beach and Emigrant Landing. A marina and  
42    picnic sites are available at Emigrant Landing. Four picnic and viewing sites are  
43    accessible only by boat. Family and group camping are available at two sites.

1 Fishing opportunities include largemouth, smallmouth, and Striped Bass; catfish,  
2 blue gill; crappie; and trout. Reservoir elevations can vary substantially on a daily  
3 basis because the lake provides short-term storage for the downstream Castaic  
4 Powerplant.

5 **15.3.5.3 Castaic Lake**

6 Castaic Lake is a SWP facility located in Los Angeles County at the terminal end  
7 of the West Branch of the California Aqueduct, as described in Chapter 5, Surface  
8 Water Resources and Water Supplies. Recreation facilities are managed by the  
9 Los Angeles County Department of Parks (DWR 2007b). Water-related activities  
10 include boating, water skiing, jet skiing, wakeboarding, camping, picnicking,  
11 swimming at the lagoon/afterbay, and fishing. Fishing opportunities include  
12 trout, Largemouth Bass, Striped Bass, catfish, and crappie (DWR 2014c).

13 **15.3.5.4 Silverwood Lake**

14 Silverwood Lake is a SWP facility located in San Bernardino County along the  
15 East Branch of the California Aqueduct, as described in Chapter 5, Surface Water  
16 Resources and Water Supplies. Recreation facilities are managed by State Parks  
17 as part of the Silverwood Lake State Recreational Area (State Parks 2006b).  
18 Water-related activities include boating, water skiing, camping, picnicking,  
19 swimming, and fishing. Facilities available for boating include a boat ramp,  
20 marina, and waterskiing area. Camping facilities include 136 family sites, seven  
21 walk-in sites, and several group sites for up to 120 people. The park includes two  
22 swimming beaches and 13 miles of trails. Fishing opportunities include  
23 Largemouth Bass, Striped Bass, Bluegill, crappie, and catfish.

24 **15.3.5.5 Crafton Hills Reservoir**

25 Crafton Hills Reservoir is a SWP facility located in the City of Yucaipa within  
26 San Bernardino County, as described in Chapter 5, Surface Water Resources and  
27 Water Supplies. Recreation facilities are managed by DWR (DWR 2009).  
28 Recreation activities in vicinity of the reservoir are associated with hiking trails in  
29 the open space within the Crafton Hills watershed. The surface water of the  
30 reservoirs can be viewed from many locations along these trails.

31 **15.3.5.6 Lake Perris**

32 Lake Perris is a SWP facility located in Riverside County at the terminal end of  
33 the East Branch of the California Aqueduct, as described in Chapter 5, Surface  
34 Water Resources and Water Supplies. Recreation facilities are managed by State  
35 Parks as part of the Lake Perris State Recreational Area (State Parks 2013b; DWR  
36 2010). Water-related activities include boating, camping, swimming, picnicking,  
37 and fishing. Boating facilities include a marina and three boat launch ramps.  
38 Other recreational facilities include two swimming beaches, family campground,  
39 seven equestrian camp sites, boat-in picnic sites on Alessandro Island, and the  
40 Ya'i Hek'i Regional Indian Museum. Fishing opportunities include Largemouth  
41 Bass, catfish, crappie, carp, Bluegill, and Redear Sunfish.

**15.3.5.7 Diamond Valley Lake**

Diamond Valley Lake is an offstream storage facility located in Riverside County owned and operated by Metropolitan Water District of Southern California, as described in Chapter 5, Surface Water Resources and Water Supplies (MWD 2013). The lake is used to store SWP water. Water-related activities include boating, and fishing. Boating facilities include a marina with boat rentals. Other recreational facilities include a visitor center, Western Science Center, and the Valley-Wide Recreation and Park District Regional Aquatic Center and Community Park. Fishing opportunities include Black Bass, Bluegill, redear sunfish, Rainbow Trout, blue catfish, and Channel Catfish (DVM 2014).

**15.3.5.8 Lake Skinner**

Lake Skinner is an offstream storage facility located in Riverside County owned and operated by Metropolitan Water District of Southern California, as described in Chapter 5, Surface Water Resources and Water Supplies. Recreation facilities are managed by Riverside County Parks (Riverside County 2014). The lake is used to store SWP water. Water-related activities include boating, camping, and fishing. Other recreational facilities include an amphitheater and Splash Pad. Fishing opportunities include Striped Bass, Largemouth Bass, Bluegill, Rainbow Trout, catfish, and carp.

**15.3.5.9 Lake Piru**

Lake Piru is located on Piru Creek, a tributary of the Santa Clara River, in Ventura County (UWCD 2014). The lake is owned and operated by United Water Conservation District, as described in Chapter 5, Surface Water Resources and Water Supplies. Lake Piru is located within Los Padres National Forest (PMC 2014). The lake is used to store SWP water.

Recreation facilities are managed by a private concessionaire for the district (UWCD 2014; PMC 2014). Water-related activities include boating, camping, and picnicking. The marina includes a boat launch and private boat slips. There are over 220 campsites, including several group campsites.

**15.3.5.10 Dixon Lake**

Dixon Lake is located in the hills above the City of Escondido in San Diego County (Escondido 2014a). The lake is owned and operated by the City of Escondido, as described in Chapter 5, Surface Water Resources and Water Supplies. The lake is used to store SWP water.

Recreation facilities are managed by the City of Escondido (Escondido 2014b). Water-related activities include camping, picnicking, and fishing. Boats are allowed on the lake for fishing. There are 45 campsites and 22 picnic sites (Escondido 2014 n.d.; Escondido 2014c). Fishing opportunities include trout, bass, Bluegill, carp, catfish, and crappie.

1     **15.3.5.11 San Vicente, El Capitan, Lower Otay, Hodges, and Murray**  
2             **Reservoirs**

3 San Vicente Reservoir, El Capitan, Lower Otay, Hodges, and Murray reservoirs  
4 are located in San Diego County (San Diego 2011). The reservoirs are owned and  
5 operated by the City of San Diego, as described in Chapter 5, Surface Water  
6 Resources and Water Supplies. The reservoirs are used to store SWP water.

7 Recreation facilities are managed by the City of San Diego (San Diego 2014a,  
8 2015a, 2015b). Water-related activities at the reservoirs include boating,  
9 picnicking, and fishing (San Diego 2014b, 2015a, 2015b). There are 16 picnic  
10 sites at Lower Otay Reservoir. Fishing opportunities at Lower Otay Reservoir  
11 include Largemouth Bass, Bluegill, black and White Crappie, Channel Catfish,  
12 blue catfish, White Catfish, and bullhead. Recreational activities at San Vicente  
13 Reservoir are temporarily closed during construction to raise the dam (San Diego  
14 2014c). Fishing opportunities at El Capitan Reservoir include Largemouth Bass,  
15 Bluegill, crappie, Channel Catfish, Blue Catfish, Green Sunfish, and carp (San  
16 Diego 2014d). Hodges Reservoir provides recreational opportunities including  
17 boating, boardsailing, and fishing for bass, catfish, crappie, Bluegill, Bullhead,  
18 and carp (San Diego 2015a). Murray Reservoir provides recreational  
19 opportunities for boating, floating, swimming, and fishing for Largemouth Bass,  
20 Bluegill, Channel Catfish, Black Crappie, and trout (San Diego 2015b).

21     **15.3.5.12 Lake Jennings**

22 Lake Jennings is located in San Diego County (HWD 2014). The lake is owned  
23 and operated by Helix Water District, as described in Chapter 5, Surface Water  
24 Resources and Water Supplies. The lake is used to store SWP water.

25 Recreation facilities are managed by Helix Water District (HWD 2014). Water-  
26 related activities include boating, camping, picnicking, and fishing. There are  
27 96 campsites. There are a variety of picnic sites at Lake Jennings including:  
28 Cloister Cover, Siesta Point, Hermit Cove, and Eagle Point. Bird watchers at  
29 Lake Jennings can see Loons, Grebes, Cormorants, Herons, Swans, Geese,  
30 Eagles, Hawks, Thrushes, Warblers, and many others. Hikers at Lake Jennings  
31 have access to a variety of different trails near the lake including a 5.5 mile loop  
32 around the lake. Fishing opportunities include trout, bass, and catfish.

33     **15.3.5.13 Sweetwater Reservoir**

34 Sweetwater Reservoir is located in San Diego County (Sweetwater Authority  
35 2014). The lake is owned and operated by Sweetwater Authority, as described in  
36 Chapter 5, Surface Water Resources and Water Supplies. The reservoir is used to  
37 store SWP water. Recreation facilities are managed by Sweetwater Authority.  
38 Water-related activities include fishing.

39     **15.3.5.14 Lake Arrowhead**

40 Lake Arrowhead is located in San Bernardino County (LACSD 2014). The lake  
41 is owned and operated by Arrowhead Lake Association. The Lake Arrowhead  
42 Community Services District stores SWP water in the lake, as described in  
43 Chapter 5, Surface Water Resources and Water Supplies. Recreation facilities are

1 managed by the Arrowhead Lake Association. Water-related activities include  
2 boating, camping, and fishing (Lake Arrowhead 2014).

### 3 **15.3.6 Recreational Fishing in San Pablo and San Francisco Bays**

4 Recreational fishing for sturgeon, Striped Bass, steelhead, trout, and salmon in  
5 San Pablo and San Francisco bays could be affected by changes in populations  
6 that may occur due to implementation of the alternatives considered in this EIS.  
7 Of these species, the majority of recreational fishing in the San Francisco Bay  
8 Estuary is related to Striped Bass and sturgeon fishing, especially in San Pablo  
9 and Suisun bays.

10 Recreational fishing for White Sturgeon is limited to three sturgeons per person  
11 each year, with a daily bag limit of one fish/day and a size limitation of 40 to  
12 60 inches (from the nose tip to fork in the tail). In addition, White Sturgeon  
13 fishing is not allowed in San Francisco Bay from March 16 through December 31.  
14 Green sturgeon fishing is not allowed. Striped bass fishing occurs throughout the  
15 year with a daily bag limit two fish/day and a minimum size limitation of  
16 18 inches. Salmon sportfishing also occurs within the San Francisco Bay Estuary  
17 during periods specified by the National Marine Fisheries Service (NMFS).

### 18 **15.3.7 Recreational Salmon Fishing along Northern California** 19 **Coast**

20 Chinook Salmon, Coho Salmon, and steelhead are generally the primary species  
21 for recreational fishing that could be affected by changes in CVP and SWP  
22 operations along the Pacific Coast of Northern California from Pigeon Point to  
23 southern Oregon (near Elk River). The Pacific Coast salmon fisheries are  
24 managed by the Pacific Fishery Management Council (PFMC) in waters between  
25 the United States/Canada border to the United States/Mexico border between  
26 3 and 200 nautical miles offshore (PFMC 2014). The State DFW manages the  
27 salmon fisheries within 0 to 3 nautical miles offshore with regulations that are  
28 generally similar to the PFMC to the salmon fishing requirements. The PFMC  
29 analyzes the a fisheries evaluation each year; and defines the periods of time for  
30 the fishing season and minimum size fish to be caught for commercial,  
31 recreational, and tribal salmon fishing activities, as described in more detail for  
32 recreational and commercial salmon fishing in Chapter 19, Socioeconomics.

## 33 **15.4 Impact Analysis**

34 This section describes the potential mechanisms and analytical methods for  
35 change in recreation resources; results of the impact analysis; potential mitigation  
36 measures; and cumulative effects.

### 37 **15.4.1 Potential Mechanisms for Change and Analytical Methods**

38 As described in Chapter 4, Approach to Environmental Analysis, the impact  
39 analysis considers changes in recreational resources conditions related to changes



1 in CVP and SWP operations under the alternatives as compared to the No Action  
2 Alternative and Second Basis of Comparison.

3 As described in Section 15.3, Affected Environment, there are a wide range of  
4 recreational opportunities at the reservoirs and along the downstream rivers. This  
5 analysis focuses on the potential changes in these recreational opportunities and  
6 not specific recreational actions. For example, this analysis focuses on changes in  
7 surface water elevations at reservoirs which could affect boating, shoreline  
8 camping and picnicking, and use of trails. The changes in reservoir elevations  
9 would occur within the historical range of elevation changes; therefore, none of  
10 the recreational opportunities would be permanently reduced or expanded. The  
11 changes that would occur within the alternatives would change the potential for  
12 enjoyable recreational opportunities based upon changes in reservoir surface  
13 water elevations and river flows.

14 Changes in CVP and SWP operations under the alternatives as compared to the  
15 No Action Alternative and Second Basis of Comparison could change recreational  
16 opportunities at water bodies affected by CVP and SWP operations.

17 **15.4.1.1 Changes in Recreational Resources at Reservoirs that Store CVP**  
18 **and SWP Water**

19 Reservoirs that store CVP and SWP water provide a wide diversity of recreational  
20 experiences on the water surface, at shoreline campgrounds, and along shoreline  
21 trails. By the end of September, the surface water elevations can decline from  
22 higher elevations in the spring by up to 100 feet in Shasta Lake and Lake  
23 Oroville; and over 50 feet in Trinity and Folsom lakes and New Melones and San  
24 Luis reservoirs. As the water elevations declines, boat ramps become unavailable  
25 and the water surface recedes along steep slopes from shoreline campgrounds and  
26 trails. Changes in CVP and SWP operations under the alternatives could change  
27 the surface water elevations, especially in dry and critical dry years as compared  
28 to the No Action Alternative and Second Basis of Comparison.

29 The CalSim II model output includes monthly reservoir elevations for CVP and  
30 SWP reservoirs in the Central Valley and Trinity Lake. The end of September  
31 reservoir elevations generally indicate low reservoir elevations. To assess  
32 changes in recreational resources, changes in reservoir elevations for the end of  
33 September were compared between alternatives and the No Action  
34 Alternative and Second Basis of Comparison. The reservoir elevations at the end  
35 of September were compared to minimum allowable boat ramp elevations as a  
36 measure of surface water accessibility.

37 Reservoirs in the San Francisco Bay Area, Central Coast, and Southern California  
38 regions store water from multiple water supplies including CVP and SWP water;  
39 however, these reservoirs are not included in the CalSim II model simulation. For  
40 the purposes of this EIS analysis, changes in surface water elevations in these  
41 reservoirs were assumed to be related to changes in CVP and SWP water  
42 deliveries to the areas located to the south of the Delta.

1     **15.4.1.2   Changes in Recreational Resources along Rivers downstream of**  
2     **CVP and SWP Reservoirs**

3     Changes in CVP and SWP operations under the alternatives could change the  
4     river flows in Trinity, Sacramento, Feather, American, and Stanislaus rivers in a  
5     manner that would affect recreational opportunities including boating and  
6     swimming during the spring and summer months, especially in dry and critical  
7     dry years.

8     Results of the CalSim II model were used to assess changes in average monthly  
9     flows that could affect recreational opportunities under the alternatives, the No  
10    Action Alternative, and the Second Basis of Comparison. This analysis is focused  
11    on the Trinity, Sacramento, Feather, American, and Stanislaus rivers. Generally,  
12    flow in rivers downstream of San Luis Reservoir and the reservoirs in the San  
13    Francisco Bay Area, Central Coast, and Southern California that store CVP and  
14    SWP water are based upon minimum instream flow requirements except in high  
15    flow events because the reservoirs are operated primarily to provide water into  
16    downstream water distribution systems.

17    **15.4.1.3   Changes in Recreational Opportunities at Wildlife Refuges**

18    Changes in CVP and SWP operations under the alternatives would not change  
19    water supplies to wildlife refuges that use CVP water for Level 2 water demands,  
20    as described in Chapter 5, Surface Water Resources and Water Supplies.  
21    Therefore, these changes are not analyzed in this EIS.

22    **15.4.1.4   Effects Related to Water Transfers**

23    Historically water transfer programs have been developed on an annual basis.  
24    The demand for water transfers is dependent upon the availability of water  
25    supplies to meet water demands. Water transfer transactions have increased over  
26    time as CVP and SWP water supply availability has decreased, especially during  
27    drier water years.

28    Water transfers using CVP and SWP Delta pumping plants and south of Delta  
29    canals generally occur when there is unused capacity in these facilities. These  
30    conditions generally occur during drier water year types when the flows from  
31    upstream reservoirs plus unregulated flows are adequate to meet the Sacramento  
32    Valley water demands and the CVP and SWP export allocations. In non-wet  
33    years, the CVP and SWP water allocations would be less than full contract  
34    amounts; therefore, capacity may be available in the CVP and SWP conveyance  
35    facilities to move water from other sources.

36    Projecting future recreational conditions related to water transfer activities is  
37    difficult because specific water transfer actions required to make the water  
38    available, convey the water, and/or use the water would change each year due to  
39    changing hydrological conditions, CVP and SWP water availability, specific local  
40    agency operations, and local cropping patterns. Reclamation recently prepared a  
41    long-term regional water transfer environmental document which evaluated  
42    potential changes in conditions related to water transfer actions (Reclamation  
43    2014f). Results from this analysis were used to inform the impact assessment of

1 potential effects of water transfers under the alternatives as compared to the No  
2 Action Alternative and the Second Basis of Comparison.

3 **15.4.2 Conditions in Year 2030 without Implementation of**  
4 **Alternatives 1 through 5**

5 This EIS includes two bases of comparison, as described in Chapter 3,  
6 Description of Alternatives: the No Action Alternative and the Second Basis of  
7 Comparison. Both of these bases are evaluated at 2030 conditions. Changes that  
8 would occur over the next 15 years without implementation of the alternatives are  
9 not analyzed in this EIS. However, the changes to recreational resources that are  
10 assumed to occur by 2030 under the No Action Alternative and the Second Basis  
11 of Comparison are summarized in this section. Many of the changed conditions  
12 would occur in the same manner under both the No Action Alternative and the  
13 Second Basis of Comparison.

14 **15.4.2.1 Common Changes in Conditions under the No Action**  
15 **Alternative and Second Basis of Comparison**

16 Conditions in 2030 would be different than existing conditions due to:

- 17 • Climate change and sea level rise  
18 • General plan development throughout California, including increased water  
19 demands in portions of Sacramento Valley  
20 • Implementation of reasonable and foreseeable water resources management  
21 projects to provide water supplies

22 It is anticipated that climate change would result in more short-duration high-  
23 rainfall events and less snowpack in the winter and early spring months. The  
24 reservoirs would be full more frequently by the end of April or May by 2030 than  
25 in recent historical conditions. However, as the water is released in the spring,  
26 there would be less snowpack to refill the reservoirs. This condition would  
27 reduce reservoir storage and available water supplies to downstream uses in the  
28 summer. The reduced end of September storage also would reduce the ability to  
29 release stored water to downstream regional reservoirs. These conditions would  
30 occur for all reservoirs in the California foothills and mountains, including non-  
31 CVP and SWP reservoirs.

32 Under the No Action Alternative and the Second Basis of Comparison, land uses  
33 in 2030 would occur in accordance with adopted general plans. Development  
34 under the general plans would could increase demand for recreational resources.

35 The No Action Alternative and the Second Basis of Comparison assumes  
36 completion of water resources management and environmental restoration  
37 projects that would have occurred without implementation of Alternatives 1  
38 through 5, including regional and local recycling projects, surface water and  
39 groundwater storage projects, conveyance improvement projects, and desalination  
40 projects, as described in Chapter 3, Description of Alternatives. The No Action  
41 Alternative and the Second Basis of Comparison also assumes implementation of  
42 actions included in the 2008 USFWS Biological Opinion (BO) and 2009 NMFS

1 BO that would have been implemented without the BOs by 2030, as described in  
 2 Chapter 3, Description of Alternatives. These projects would include several  
 3 projects that would affect recreational resources, including restoration of more  
 4 than 10,000 acres of intertidal and associated subtidal wetlands in Suisun Marsh  
 5 and Cache Slough; and at least 17,000 to 20,000 acres of seasonal floodplain  
 6 restoration in Yolo Bypass.

### 7 **15.4.3 Evaluation of Alternatives**

8 Alternatives 1 through 5 have been compared to the No Action Alternative; and  
 9 the No Action Alternative and Alternatives 1 through 5 have been compared to  
 10 the Second Basis of Comparison.

11 During review of the numerical modeling analyses used in this EIS, an error was  
 12 determined in the CalSim II model assumptions related to the Stanislaus River  
 13 operations for the Second Basis of Comparison, Alternative 1, and Alternative 4  
 14 model runs. Appendix 5C includes a comparison of the CalSim II model run  
 15 results presented in this chapter and CalSim II model run results with the error  
 16 corrected. Appendix 5C also includes a discussion of changes in the comparison  
 17 of groundwater conditions for the following alternative analyses.

- 18 • No Action Alternative compared to the Second Basis of Comparison
- 19 • Alternative 1 compared to the No Action Alternative
- 20 • Alternative 3 compared to the Second Basis of Comparison
- 21 • Alternative 5 compared to the Second Basis of Comparison

#### 22 **15.4.3.1 No Action Alternative**

23 The No Action Alternative is compared to the Second Basis of Comparison.

##### 24 **15.4.3.1.1 Trinity River Region**

###### 25 *Potential Changes in Recreational Resources at Reservoirs that Store CVP and* 26 *SWP Water*

27 Changes in CVP water supplies and operations under the No Action  
 28 Alternative as compared to the Second Basis of Comparison would result in  
 29 similar end of September reservoir elevations (changes within 5 percent) and  
 30 related recreational resources at Trinity Lake in all water year types, as described  
 31 in Chapter 5, Surface Water Resources and Water Supplies.

32 There are several boat ramps at Trinity Lake that provide access at different  
 33 elevations. Boat ramps at Stuart Fork and Bowerman are not useable when the  
 34 water elevation is less than 2,323 feet which occurs approximately 80 percent of  
 35 the time under the No Action Alternative and Second Basis of Comparison. Boat  
 36 ramps at Clark Springs, Fairview, and Trinity Center are not useable when the  
 37 water elevation is lower than 2,300 feet which occurs approximately 62 percent of  
 38 the time under the No Action Alternative and Second Basis of Comparison. The  
 39 Minersville boat ramp is accessible until the elevation declines below 2,170 feet  
 40 which occurs approximately 5 percent of the time under the No Action  
 41 Alternative and Second Basis of Comparison.

1 *Potential Changes in Recreational Resources along Rivers Downstream of the*  
2 *CVP and SWP Reservoirs*

3 The following changes would occur on the Trinity River under the No Action  
4 Alternative as compared to the Second Basis of Comparison, as summarized in  
5 Chapter 5, Surface Water Resources and Water Supplies.

- 6 • Over long-term conditions, flows would be similar in March through  
7 November; and reduced in December through February (up to 9.5 percent).
- 8 • In wet years, flows would be similar in April through November; and reduced  
9 in December through March (up to 11.2 percent).
- 10 • In dry years, flows would be similar in all months.

11 Flows in Trinity River would be similar during the recreation season (spring and  
12 summer months); therefore, recreational opportunities would be similar.

13 **15.4.3.1.2 Central Valley Region**

14 *Potential Changes in Recreational Resources at Reservoirs that Store CVP and*  
15 *SWP Water*

16 Changes in CVP water supplies and operations under the No Action  
17 Alternative as compared to the Second Basis of Comparison would result in  
18 similar end of September reservoir elevations and related recreational resources at  
19 Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir in all  
20 water year types; and at San Luis Reservoir in above normal, below normal, and  
21 dry years, as described in Chapter 5, Surface Water Resources and Water  
22 Supplies. Changes in recreational resources at San Luis Reservoir would be  
23 reduced in wet year and critical dry years because the end of September surface  
24 water elevations would be reduced by 6.2 percent in wet and critical dry years.

25 There are several boat ramps at each of the reservoirs that provide access at  
26 different elevations. At Shasta Lake, boat ramps at Antlers, Hirz Bay, Packers  
27 Bay, Sugar Loaf, and Centimundi and Jones Valley are not accessible  
28 approximately 55, 35, 20, 10, and 9 percent of the time, respectively, under the  
29 No Action Alternative; and approximately 55, 30, 15, 10, and 7 percent of the  
30 time, respectively, under the Second Basis of Comparison.

31 At Lake Oroville, boat ramps at Enterprise, Vinton Gulch, and Nelson Bar;  
32 Foreman Creek; Dark Canyon and Loafer Creek; and Bidwell Canyon, Lime  
33 Saddle, and Spillway are not accessible approximately 95, 87, 73, and 35 percent  
34 of the time, respectively, under the No Action Alternative; and approximately  
35 85, 75, 62, and 25 percent of the time, respectively, under the Second Basis of  
36 Comparison.

37 At Folsom Lake, boat ramps at Rattlesnake Bar, Beal's Point; Peninsula, Brown's  
38 Ravine, and Folsom Point; Hobie Cove; and Granite Bay are not accessible  
39 approximately 80, 65, 40, 10, and 7 percent of the time, respectively, under the  
40 No Action Alternative; and approximately 65, 40, 10, and 7 percent of the time,  
41 respectively, under the Second Basis of Comparison.

1 At New Melones Reservoir, the boat ramp at Angels Creek, Parrott's Ferry, Glory  
 2 Hole, and Mark Twain are not accessible approximately 65, 25, 18, and 5 percent  
 3 of the time, respectively, under the No Action Alternative; and approximately  
 4 30, 25, 15, 5 percent of the time, respectively, under the Second Basis of  
 5 Comparison.

6 At San Luis Reservoir, the boat ramps at Dinosaur Point and Basalt Area are not  
 7 useable approximately 50 and 10 percent of the time, respectively, under the No  
 8 Action Alternative; and approximately 20 and 5 percent of the time, respectively,  
 9 under the Second Basis of Comparison.

10 At all reservoirs, boating opportunities would be decreased, and shoreline  
 11 recreational opportunities would be similar or decreased under the No Action  
 12 Alternative as compared to the Second Basis of Comparison.

13 *Potential Changes in Recreational Resources along Rivers Downstream of the*  
 14 *CVP and SWP Reservoirs*

15 The recreational opportunities along the Sacramento, Feather, American, and  
 16 Stanislaus rivers would be affected by the following changes in river flows, as  
 17 described in Chapter 5.

- 18 • Sacramento River downstream of Keswick Dam
  - 19 – Over long-term conditions, similar flows would occur in October,  
 20 February through May, July, and August; increased flows in September  
 21 and November (up to 37.7 percent); and reduced flows in December,  
 22 January, and June (up to 7.8 percent).
  - 23 – In wet years, similar flows would occur in January through July; increased  
 24 flows in September through November (up to 77.7 percent); and reduced  
 25 flows in December and August (up to 14.6 percent).
  - 26 – In dry years, similar flows would occur in July through October,  
 27 December through March, and May; increased flows in November  
 28 (33.4 percent).
- 29 • Sacramento River at Freeport
  - 30 – Over long-term conditions, similar flows would occur in October,  
 31 December through May, and August; increased flows in September,  
 32 November, and July (up to 43.3 percent); and reduced flows in June  
 33 (11.4 percent).
  - 34 – In wet years, similar flows would occur in January through June and  
 35 October; increased flows in July through September and November (up to  
 36 90.3 percent); and reduced flows in December (10.7 percent).
  - 37 – In dry years, similar flows would occur in August through October and  
 38 December through April; increased flows in November and July (up to  
 39 15.8 percent); and reduced flows in May and June (up to 11.9 percent).

- 1 • Feather River downstream of the Thermalito Complex
  - 2 – Over long-term conditions, similar flows would occur in November and
  - 3 April; increased flows in July through September (up to 76.1 percent); and
  - 4 reduced flows in October, December through March, May, and June (up to
  - 5 27.2 percent).
  - 6 – In wet years, similar flows would occur in October through November and
  - 7 March through May; increased flows in July through September (up to
  - 8 184 percent) and reduced flows in December through February (up to
  - 9 26.0 percent).
  - 10 – In dry years, similar flows would occur in November through March;
  - 11 increased flows in April and July (up to 52.4 percent); and reduced flows
  - 12 in August through October and May and June (up to 27.6 percent).
- 13 • American River downstream of Nimbus Dam
  - 14 – Over long-term conditions, similar flows would occur in November
  - 15 through May and July; increased flows in September and October (up to
  - 16 44.7 percent); and reduced flows in June and August (up to 6.1 percent).
  - 17 – In wet years, similar flows would occur in October through November and
  - 18 January through July; increased flows in September (91.1 percent) and
  - 19 reduced flows in December and August (up to 10.7 percent).
  - 20 – In dry years, similar flows would occur in all months except October,
  - 21 February and July; increased flows in October (16.5 percent); and reduced
  - 22 flows in February and July (up to 7.3 percent).
- 23 • Stanislaus River downstream of Goodwin Dam
  - 24 – Over long-term conditions, similar flows would occur in May and July
  - 25 through September; increased flows in October, March, and April (up to
  - 26 148.7 percent); and reduced flows in November through February and
  - 27 June (up to 33.8 percent).
  - 28 – In wet years, similar flows would occur in February and April; increased
  - 29 flows in October, March, May, July, and August (up to 117.1 percent);
  - 30 and reduced flows in September, November through January, and June (up
  - 31 to 50.8 percent).
  - 32 – In dry years, similar flows would occur in July through September;
  - 33 increased flows in October and April (up to 154.3 percent); and reduced
  - 34 flows in November through March, May, and June (up to 35.7 percent).

35 During the spring and summer months, the changes in flow conditions between  
36 the No Action Alternative and the Second Basis of Comparison vary on a monthly  
37 basis in the Sacramento, Feather, American, and Stanislaus rivers within a water  
38 year type. For example, flows in the Sacramento River at Freeport would  
39 increase in several months under the No Action Alternative as compared to the  
40 Second Basis of Comparison by up to 90 percent, and decrease in several months  
41 up to 11 percent. The overall range of flows is within the historical operational

1 range; therefore, recreational opportunities still exist. However, the value of the  
 2 recreational opportunities would be both improved and reduced depending upon  
 3 the timing of the changes.

4 Overall, under the No Action Alternative and the Second Basis of Comparison,  
 5 recreational opportunities would be reduced on the Sacramento River downstream  
 6 of Keswick Dam; and both improved and reduced on the Sacramento River near  
 7 Freeport, Feather River downstream of Thermalito Complex, American River  
 8 downstream of Nimbus Dam, and the Stanislaus River downstream of Goodwin  
 9 Dam depending upon the month.

#### 10 *Effects Related to Cross Delta Water Transfers*

11 Potential effects to recreational resources could be similar to those identified in a  
 12 recent environmental analysis conducted by Reclamation for long-term water  
 13 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c).

14 Potential effects to recreational resources were identified as changes in reservoir  
 15 surface water elevations, streams, and the Delta. The analysis indicated that these  
 16 potential impacts would not be substantial because the conditions with and  
 17 without the water transfers would be similar.

18 Under the No Action Alternative, the timing of cross Delta water transfers would  
 19 be limited to July through September and include annual volumetric limits, in  
 20 accordance with the 2008 USFWS BO and 2009 NMFS BO. Under the Second  
 21 Basis of Comparison, water could be transferred throughout the year without an  
 22 annual volumetric limit. Overall, the potential for cross Delta water transfers  
 23 would be less under the No Action Alternative than under the Second Basis of  
 24 Comparison.

#### 25 **15.4.3.1.3 San Francisco Bay Area, Central Coast, and Southern California** 26 **Region**

##### 27 *Potential Changes in Recreational Resources at Reservoirs that Store CVP and* 28 *SWP Water*

29 Changes in recreational resources at reservoirs that store CVP and SWP water  
 30 supplies are assumed to be related to changes in water deliveries over long-term  
 31 conditions for this EIS analysis. Monthly deliveries are not necessarily indicative  
 32 of reservoir storage because all or a portion of the water deliveries could be  
 33 directly conveyed to water users in any specific month. Therefore, annual  
 34 deliveries are considered to be relatively proportional to the amount of water that  
 35 could be stored over all water year types. In the San Francisco Bay Area Region,  
 36 values for the CVP municipal and industrial water deliveries and the SWP south  
 37 of the Delta water deliveries (without Article 21 deliveries) were considered; and  
 38 SWP south of the Delta water deliveries (without Article 21 deliveries) were  
 39 considered for the Central Coast and Southern California regions. Under the No  
 40 Action Alternative as compared to the Second Basis of Comparison CVP water  
 41 deliveries would be reduced by 10 percent and SWP water deliveries would be  
 42 reduced by 18 percent. Therefore, for this EIS analysis, it is assumed that  
 43 recreational resources related to surface water elevations in reservoirs that store  
 44 CVP and SWP water supplies would be reduced by 10 to 18 percent in the



1 San Francisco Bay Area Region and 18 percent in the Central Coast and Southern  
2 California regions.

3 **15.4.3.2 Alternative 1**

4 Alternative 1 is identical to the Second Basis of Comparison. As described in  
5 Chapter 4, Approach to Environmental Analysis, Alternative 1 is compared to the  
6 No Action Alternative and the Second Basis of Comparison. However, because  
7 recreational resource conditions under Alternative 1 are identical to recreational  
8 resource conditions under the Second Basis of Comparison; Alternative 1 is only  
9 compared to the No Action Alternative.

10 **15.4.3.2.1 Alternative 1 Compared to the No Action Alternative**

11 *Trinity River Region*

12 *Potential Changes in Recreational Resources at Reservoirs that Store CVP*  
13 *and SWP Water*

14 Changes in CVP water supplies and operations under Alternative 1 as compared  
15 to the No Action Alternative would result in similar end of September reservoir  
16 elevations and related recreational resources at Trinity Lake in all water year  
17 types, as described in Chapter 5, Surface Water Resources and Water Supplies.

18 There are several boat ramps at Trinity Lake that provide access at different  
19 elevations. Boat ramps at Stuart Fork and Bowerman are not useable when the  
20 water elevation is less than 2,323 feet which occurs approximately 80 percent of  
21 the time under Alternative 1 and the No Action Alternative. Boat ramps at Clark  
22 Springs, Fairview, and Trinity Center are not useable when the water elevation is  
23 lower than 2,300 feet which occurs approximately 62 percent of the time under  
24 Alternative 1 and the No Action Alternative. The Minersville boat ramp is  
25 accessible until the elevation declines below 2,170 feet which occurs  
26 approximately 5 percent of the time under Alternative 1 and the No Action  
27 Alternative.

28 The potential for reduced recreational resources at Trinity Lake related to  
29 shoreline activities would be less under the No Action Alternative as compared to  
30 the Second Basis of Comparison.

31 *Potential Changes in Recreational Resources along Rivers Downstream of the*  
32 *CVP and SWP Reservoirs*

33 The following changes would occur on the Trinity River under Alternative 1 as  
34 compared to the No Action Alternative, as summarized in Chapter 5, Surface  
35 Water Resources and Water Supplies.

- 36 • Over long-term conditions, flows would be similar in March through  
37 November; and increased in December through February (up to 10.5 percent).
- 38 • In wet years, flows would be similar in April through November; and  
39 increased in December through March (up to 12.6 percent).
- 40 • In dry years, flows would be similar all months.

1 Flows in Trinity River would be similar during the recreation season (spring and  
2 summer months); therefore, recreational opportunities would be similar.

### 3 *Central Valley Region*

#### 4 *Potential Changes in Recreational Resources at Reservoirs that Store CVP* 5 *and SWP Water*

6 Changes in CVP water supplies and operations under Alternative 1 as compared  
7 to the No Action Alternative would result in similar end of September reservoir  
8 elevations and related recreational resources at Shasta Lake, Lake Oroville,  
9 Folsom Lake, and New Melones Reservoir in all water year types; and at San Luis  
10 Reservoir in above normal, below normal, and dry years, as described in  
11 Chapter 5, Surface Water Resources and Water Supplies. Changes in recreational  
12 resources at San Luis Reservoir would be reduced in wet year and critical dry  
13 years because the end of September surface water elevations would be increased  
14 by 6.6 percent in wet and critical dry years.

15 There are several boat ramps at each of the reservoirs that provide access at  
16 different elevations. At Shasta Lake, boat ramps at Antlers, Hirz Bay, Packers  
17 Bay, Sugar Loaf, and Centimundi and Jones Valley are not accessible  
18 approximately 55, 30, 15, 10, and 7 percent of the time, respectively, under  
19 Alternative 1; and approximately 55, 35, 20, 10, and 9 percent of the time,  
20 respectively, under the No Action Alternative.

21 At Lake Oroville, boat ramps at Enterprise, Vinton Gulch, and Nelson Bar;  
22 Foreman Creek; Dark Canyon and Loafer Creek; and Bidwell Canyon, Lime  
23 Saddle, and Spillway are not accessible approximately 85, 75, 62, and 25 percent  
24 of the time, respectively, under Alternative 1; and approximately 95, 87, 73, and  
25 35 percent of the time, respectively, under the No Action Alternative.

26 At Folsom Lake, boat ramps at Rattlesnake Bar, Beal's Point; Peninsula, Brown's  
27 Ravine, and Folsom Point; Hobie Cove; and Granite Bay are not accessible  
28 approximately 65, 40, 10, and 7 percent of the time, respectively, under  
29 Alternative 1; and approximately 80, 65, 40, 10, and 7 percent of the time,  
30 respectively, under the No Action Alternative.

31 At New Melones Reservoir, the boat ramp at Angels Creek, Parrott's Ferry, Glory  
32 Hole, and Mark Twain are not accessible approximately 30, 25, 15, 5 percent of  
33 the time, respectively, under Alternative 1 as compared to approximately 65, 25,  
34 18, and 5 percent of the time, respectively, under the No Action Alternative.

35 At San Luis Reservoir, the boat ramps at Dinosaur Point and Basalt Area are not  
36 useable approximately 20 and 5 percent of the time, respectively, under  
37 Alternative 1; and approximately 50 and 10 percent of the time, respectively,  
38 under the No Action Alternative.

39 At all reservoirs, boating opportunities would be increased, and shoreline  
40 recreational opportunities would be similar or increased under Alternative 1 as  
41 compared to the No Action Alternative.

1        *Potential Changes in Recreational Resources along Rivers Downstream of the*  
2        *CVP and SWP Reservoirs*

3        The recreational opportunities along the Sacramento, Feather, American, and  
4        Stanislaus rivers would be affected by the following changes in river flows, as  
5        described in Chapter 5.

- 6        • Sacramento River downstream of Keswick Dam
  - 7            – Over long-term conditions, similar flows would occur in October,  
8            February through May, July, and August; reduced flows in September and  
9            November (up to 27.4 percent); and increased flows in December,  
10           January, and June (up to 8.4 percent).
  - 11           – In wet years, similar flows would occur in January through July; reduced  
12           flows in September through November (up to 43.7 percent); and increased  
13           flows in December and August (up to 17.0 percent).
  - 14           – In dry years, similar flows would occur in July through October,  
15           December through March, and May; reduced flows in November  
16           (25.0 percent); and increased flows in April and June (up to 7.8 percent).
- 17        • Sacramento River at Freeport
  - 18           – Over long-term conditions, similar flows would occur in October,  
19           December through May, and August; reduced flows in September,  
20           November, and July (up to 30.2 percent); and increased flows in June  
21           (12.8 percent).
  - 22           – In wet years, similar flows would occur in January through June and  
23           October; reduced flows in July through September and November (up to  
24           47.4 percent); and increased flows in December (6.6 percent).
  - 25           – In dry years, similar flows would occur in August through October and  
26           December through April; reduced flows in November and July (up to  
27           13.6 percent); and increased flows in May and June (up to 13.5 percent).
- 28        • Feather River downstream of the Thermalito Complex
  - 29           – Over long-term conditions, similar flows would occur in November and  
30           April; reduced flows in July through September (up to 43.2 percent); and  
31           increased flows in October, December through March, May, and June (up  
32           to 37.4 percent).
  - 33           – In wet years, similar flows would occur in October, November, and March  
34           through May; reduced flows in July through September (up to  
35           64.9 percent); and increased flows in December through February and  
36           June (up to 35.1 percent).
  - 37           – In dry years, similar flows would occur in December through April;  
38           reduced flows in July (34.4 percent); and increased flows in August  
39           through October, May, and June (up to 38.1 percent).

- 1 • American River downstream of Nimbus Dam
  - 2 – Over long-term conditions, similar flows would occur in November
  - 3 through May and July; reduced flows in September and October (up to
  - 4 30.9 percent); and increased flows in June (5.4 percent).
  - 5 – In wet years, similar flows would occur in October, November, and
  - 6 January through July; reduced flows in September (47.7 percent); and
  - 7 increased flows in August (12.0 percent).
  - 8 – In dry years, similar flows would occur in November through January,
  - 9 March through June, August, and September; reduced flows in October
  - 10 (14.1 percent); and increased flows in February and July (up to
  - 11 7.9 percent).
- 12 • Stanislaus River downstream of Goodwin Dam
  - 13 – Over long-term conditions, similar flows would occur in July through
  - 14 September; reduced flows in October, March, and April (up to
  - 15 59.8 percent); and increased flows in November through February and
  - 16 June (up to 51.1 percent).
  - 17 – In wet years, similar flows would occur in February and April; reduced
  - 18 flows in October, March, May, July, and August (up to 53.9 percent); and
  - 19 increased flows in September, November through January, and June (up to
  - 20 103.2 percent).
  - 21 – In dry years, similar flows would occur in July through September;
  - 22 reduced flows in October and April (up to 60.7 percent); and increased
  - 23 flows in November through March, May, and June (up to 55.5 percent).

24 During the spring and summer months, the changes in flow conditions between  
 25 Alternative 1 as compared to the No Action Alternative vary on a monthly basis  
 26 in the Sacramento, Feather, American, and Stanislaus rivers within a water year  
 27 type. For example, flows in the Sacramento River at Freeport would increase in  
 28 several months under Alternative 1 as compared to the No Action Alternative by  
 29 up to 17 percent, and decrease in several months up to 44 percent. The overall  
 30 range of flows is within the historical operational range; therefore, recreational  
 31 opportunities still exist. However, the value of the recreational opportunities  
 32 would be both improved and reduced depending upon the timing of the changes.

33 Overall, under Alternative 1 as compared to the No Action Alternative,  
 34 recreational opportunities would be improved on the Sacramento River  
 35 downstream of Keswick Dam; and both improved and reduced on the Sacramento  
 36 River near Freeport, Feather River downstream of Thermalito Complex,  
 37 American River downstream of Nimbus Dam, and the Stanislaus River  
 38 downstream of Goodwin Dam depending upon the month.

### 39 *Effects Related to Cross Delta Water Transfers*

40 Potential effects to recreational resources could be similar to those identified in a  
 41 recent environmental analysis conducted by Reclamation for long-term water  
 42 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as

1 described above under the No Action Alternative compared to the Second Basis  
2 of Comparison. For the purposes of this EIS, it is anticipated that similar  
3 conditions would occur during implementation of cross Delta water transfers  
4 under Alternative 1 and the No Action Alternative, and that impacts on  
5 recreational resources would not be substantial in the seller's service area due to  
6 implementation requirements of the transfer programs.

7 Under Alternative 1, water could be transferred throughout the year without an  
8 annual volumetric limit. Under the No Action Alternative, the timing of cross  
9 Delta water transfers would be limited to July through September and include  
10 annual volumetric limits, in accordance with the 2008 USFWS BO and 2009  
11 NMFS BO. Overall, the potential for cross Delta water transfers would be  
12 increased under Alternative 1 as compared to the No Action Alternative.

13 *San Francisco Bay Area, Central Coast, and Southern California Regions*

14 *Potential Changes in Recreational Resources at Reservoirs that Store CVP*  
15 *and SWP Water*

16 Changes in recreational resources at reservoirs that store CVP and SWP water  
17 supplies are assumed to be related to changes in water deliveries over long-term  
18 conditions for this EIS analysis, as described above under the No Action  
19 Alternative as compared to the Second Basis of Comparison. Therefore, under  
20 Alternative 1 as compared to the No Action Alternative, recreational resources  
21 related to surface water elevations in reservoirs that store CVP and SWP water  
22 supplies would be increased by 11 to 21 percent in the San Francisco Bay Area  
23 Region and 21 percent in the Central Coast and Southern California regions.

24 **15.4.3.2.2 Alternative 1 Compared to the Second Basis of Comparison**

25 Alternative 1 is identical to the Second Basis of Comparison.

26 **15.4.3.3 Alternative 2**

27 The CVP and SWP operations under Alternative 2 are identical to the CVP and  
28 SWP operations under the No Action Alternative; therefore, Alternative 2 is only  
29 compared to the Second Basis of Comparison.

30 **15.4.3.3.1 Alternative 2 Compared to the Second Basis of Comparison**

31 The CVP and SWP operations under Alternative 2 are identical to the CVP and  
32 SWP operations under the No Action Alternative. Therefore, changes to  
33 recreational resources conditions under Alternatives 2 as compared to the Second  
34 Basis of Comparison would be the same as the impacts described in Section  
35 15.4.3.1, No Action Alternative.

36 **15.4.3.4 Alternative 3**

37 As described in Chapter 3, Description of Alternatives, CVP and SWP operations  
38 under Alternative 3 are similar to the Second Basis of Comparison with modified  
39 Old and Middle River flow criteria and New Melones Reservoir operations; and  
40 additional predation control actions to reduce the populations of striped bass. As

1 described in Chapter 4, Approach to Environmental Analysis, Alternative 3 is  
2 compared to the No Action Alternative and the Second Basis of Comparison.

### 3 **15.4.3.4.1 Alternative 3 Compared to the No Action Alternative**

#### 4 *Trinity River Region*

##### 5 *Potential Changes in Recreational Resources at Reservoirs that Store CVP* 6 *and SWP Water*

7 Changes in CVP water supplies and operations under Alternative 3 as compared  
8 to the No Action Alternative would result in similar end of September reservoir  
9 elevations and related recreational resources at Trinity Lake in all water year  
10 types, as described in Chapter 5, Surface Water Resources and Water Supplies.

11 There are several boat ramps at Trinity Lake that provide access at different  
12 elevations. Boat ramps at Stuart Fork and Bowerman are not useable when the  
13 water elevation is less than 2,323 feet which occurs approximately 80 percent of  
14 the time under Alternative 3 and the No Action Alternative. Boat ramps at Clark  
15 Springs, Fairview, and Trinity Center are not useable when the water elevation is  
16 lower than 2,300 feet which occurs approximately 62 percent of the time under  
17 Alternative 3 and the No Action Alternative. The Minersville boat ramp is  
18 accessible until the elevation declines below 2,170 feet which occurs  
19 approximately 5 percent of the time under Alternative 3 and the No Action  
20 Alternative.

##### 21 *Potential Changes in Recreational Resources along Rivers Downstream of the* 22 *CVP and SWP Reservoirs*

23 The following changes would occur on the Trinity River under Alternative 3 as  
24 compared to the No Action Alternative, as summarized in Chapter 5, Surface  
25 Water Resources and Water Supplies.

- 26 • Over long-term conditions, flows would be similar in March through  
27 November; and increased in December through February (up to 11.8 percent).
- 28 • In wet years, flows would be similar in April through October; reduced in  
29 November (7.0 percent); and increased in December through March (up to  
30 15.1 percent).
- 31 • In dry years, flows would be similar in all months.

32 Flows in Trinity River would be similar during the recreation season (spring and  
33 summer months); therefore, recreational opportunities would be similar.

#### 34 *Central Valley Region*

##### 35 *Potential Changes in Recreational Resources at Reservoirs that Store CVP* 36 *and SWP Water*

37 Changes in CVP water supplies and operations under Alternative 3 as compared  
38 to the No Action Alternative would result in similar end of September reservoir  
39 elevations and related recreational resources at Shasta Lake, Lake Oroville,  
40 Folsom Lake, and New Melones Reservoir in all water year types; and at San Luis  
41 Reservoir in below normal, dry, and critical dry years, as described in Chapter 5,

1 Surface Water Resources and Water Supplies. Changes in recreational resources  
2 at San Luis Reservoir would be reduced in wet year and critical dry years because  
3 the end of September surface water elevations would be increased by 7.9 percent  
4 in wet years and 5.7 percent in above normal years.

5 There are several boat ramps at each of the reservoirs that provide access at  
6 different elevations. At Shasta Lake, boat ramps at Antlers, Hirz Bay, Packers  
7 Bay, Sugar Loaf, and Centimundi and Jones Valley are not accessible  
8 approximately 55, 30, 15, 10, and 7 percent of the time, respectively, under  
9 Alternative 3; and approximately 55, 35, 20, 10, and 9 percent of the time,  
10 respectively, under the No Action Alternative.

11 At Lake Oroville, boat ramps at Enterprise, Vinton Gulch, and Nelson Bar;  
12 Foreman Creek; Dark Canyon and Loafer Creek; and Bidwell Canyon, Lime  
13 Saddle, and Spillway are not accessible approximately 85, 75, 62, and 25 percent  
14 of the time, respectively, under Alternative 3; and approximately 95, 87, 73, and  
15 35 percent of the time, respectively, under the No Action Alternative.

16 At Folsom Lake, boat ramps at Rattlesnake Bar, Beal's Point; Peninsula, Brown's  
17 Ravine, and Folsom Point; Hobie Cove; and Granite Bay are not accessible  
18 approximately 65, 40, 10, and 7 percent of the time, respectively, under  
19 Alternative 3; and approximately 80, 65, 40, 10, and 7 percent of the time,  
20 respectively, under the No Action Alternative.

21 At New Melones Reservoir, the boat ramp at Angels Creek, Parrott's Ferry, Glory  
22 Hole, and Mark Twain are not accessible approximately 22, 18, 10, and 5 percent  
23 of the time, respectively, under Alternative 3 as compared to approximately  
24 65, 25, 18, and 5 percent of the time, respectively, under the No Action  
25 Alternative.

26 At San Luis Reservoir, the boat ramps at Dinosaur Point and Basalt Area are not  
27 useable approximately 28 and 8 percent of the time, respectively, under  
28 Alternative 3; and approximately 50 and 10 percent of the time, respectively,  
29 under the No Action Alternative.

30 At Lake Oroville, Folsom Lake, New Melones Reservoir, and San Luis Reservoir,  
31 boating opportunities would be increased, and opportunities would be similar at  
32 Shasta Lake under Alternative 3 as compared to the No Action Alternative. At  
33 Shasta Lake, Lake Oroville, and New Melones Reservoir shoreline recreational  
34 opportunities would be increased, and opportunities would be similar at Folsom  
35 Lake and San Luis Reservoir under Alternative 3 as compared to the No Action  
36 Alternative.

37 *Potential Changes in Recreational Resources along Rivers Downstream of the*  
38 *CVP and SWP Reservoirs*

39 The recreational opportunities along the Sacramento, Feather, American, and  
40 Stanislaus rivers would be affected by the following changes in river flows, as  
41 described in Chapter 5.

- 1 • Sacramento River downstream of Keswick Dam
- 2 – Over long-term conditions, similar flows would occur in October,  
3 February through May, July, and August; reduced flows in September and  
4 November (up to 20.1 percent); and increased flows in December,  
5 January, and June (up to 8.9 percent).
- 6 – In wet years, similar flows would occur in February through August;  
7 reduced flows in September through November (up to 42.1 percent); and  
8 increased flows in December and January (up to 16.9 percent).
- 9 – In dry years, similar flows would occur in July through September and  
10 December through May; reduced flows in November (24.6 percent); and  
11 increased flows in January and June (up to 7.3 percent).
- 12 • Sacramento River at Freeport
- 13 – Over long-term conditions, similar flows would occur in October,  
14 December through May, July, and August; reduced flows in September  
15 and November (up to 30.1 percent); and increased flows in June  
16 (12.1 percent).
- 17 – In wet years, similar flows would occur in January through May, July, and  
18 October; reduced flows in August, September, and November (up to  
19 48.1 percent); and increased flows in December and June (up to  
20 6.6 percent).
- 21 – In dry years, similar flows would occur in July through October and  
22 December through April; reduced flows in November (14.2 percent); and  
23 increased flows in May and June (up to 15.7 percent).
- 24 • Feather River downstream of the Thermalito Complex
- 25 – Over long-term conditions, similar flows would occur in October,  
26 November, March, April, and July; reduced flows in August and  
27 September (up to 49.4 percent); and increased flows in December through  
28 February, May, and June (up to 33.9 percent).
- 29 – In wet years, similar flows would occur in October, November, February  
30 through May, and July; reduced flows in August and September (up to  
31 70.0 percent) and increased flows in December, January, and June (up to  
32 28.1 percent).
- 33 – In dry years, similar flows would occur in September and January through  
34 April; reduced flows in October through December and July (up to  
35 14.5 percent); and increased flows in May, June, and August  
36 (36.9 percent).
- 37 • American River downstream of Nimbus Dam
- 38 – Over long-term conditions, similar flows would occur in November,  
39 January through May, July, and August; reduced flows in September and  
40 October (up to 28.7 percent); and increased flows in June (5.8 percent).



- 1       – In wet years, similar flows would occur in October, November, and  
2       January through July; reduced flows in September (45.9 percent); and  
3       increased flows in August and December (up to 8.5 percent).
- 4       – In dry years, similar flows would occur in November through January and  
5       March through September; reduced flows in October (11.2 percent); and  
6       increased flows in February (6.1 percent).
- 7       • Stanislaus River downstream of Goodwin Dam
- 8       – Over long-term conditions, reduced flows would occur in October and  
9       March through June (up to 58.3 percent); and increased flows in  
10       November through February and July through September (up to  
11       36.81 percent).
- 12       – In wet years, similar flows would occur in April; reduced flows in  
13       October, March, and May (up to 52.9 percent); and increased flows in  
14       June through September and November through February (up to  
15       67.8 percent).
- 16       – In dry years, similar flows would occur in March and July through  
17       September; reduced flows in October and April through June (up to  
18       59.6 percent); and increased flows in November through February (up to  
19       37.0 percent).

20       During the spring and summer months, the changes in flow conditions between  
21       Alternative 3 and the No Action Alternative vary on a monthly basis in the  
22       Sacramento, Feather, American, and Stanislaus rivers within a water year type.  
23       For example, flows in the Sacramento River at Freeport would increase in several  
24       months under Alternative 3 as compared to the No Action Alternative by up to  
25       15 percent, and decrease in several months up to 30 percent. The overall range of  
26       flows is within the historical operational range; therefore, recreational  
27       opportunities still exist. However, the value of the recreational opportunities  
28       would be both improved and reduced depending upon the timing of the changes.

29       Overall, under Alternative 3 as compared to the No Action Alternative,  
30       recreational opportunities would be similar or improved on the Sacramento River  
31       downstream of Keswick Dam and American River downstream of Nimbus Dam;  
32       and both improved and reduced on the Sacramento River near Freeport, Feather  
33       River downstream of Thermalito Complex, and the Stanislaus River downstream  
34       of Goodwin Dam depending upon the month.

35       Recreational opportunities related to Striped Bass fishing would initially be  
36       increased when Alternative 3 is implemented. However, by 2030, Striped Bass  
37       fishing opportunities would be reduced under Alternative 3 as compared to the No  
38       Action Alternative due to actions to reduce predation.

39       Recreational opportunities related to sport ocean salmon fishing would be reduced  
40       under Alternative 3 as compared to the No Action Alternative.

1        *Effects Related to Cross Delta Water Transfers*

2 Potential effects to recreational resources could be similar to those identified in a  
3 recent environmental analysis conducted by Reclamation for long-term water  
4 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as  
5 described above under the No Action Alternative compared to the Second Basis  
6 of Comparison. For the purposes of this EIS, it is anticipated that similar  
7 conditions would occur during implementation of cross Delta water transfers  
8 under Alternative 3 and the No Action Alternative, and that impacts on  
9 recreational resources would not be substantial in the seller's service area due to  
10 implementation requirements of the transfer programs.

11 Under Alternative 3, water could be transferred throughout the year without an  
12 annual volumetric limit. Under the No Action Alternative, the timing of cross  
13 Delta water transfers would be limited to July through September and include  
14 annual volumetric limits, in accordance with the 2008 USFWS BO and 2009  
15 NMFS BO. Overall, the potential for cross Delta water transfers would be  
16 increased under Alternative 3 as compared to the No Action Alternative.

17 *San Francisco Bay Area, Central Coast, and Southern California Regions*

18        *Potential Changes in Recreational Resources at Reservoirs that Store CVP*  
19        *and SWP Water*

20 Changes in recreational resources at reservoirs that store CVP and SWP water  
21 supplies are assumed to be related to changes in water deliveries over long-term  
22 conditions for this EIS analysis, as described above under the No Action  
23 Alternative as compared to the Second Basis of Comparison. Therefore, under  
24 Alternative 3 as compared to the No Action Alternative, recreational resources  
25 related to surface water elevations in reservoirs that store CVP and SWP water  
26 supplies would be increased by 9 to 17 percent in the San Francisco Bay Area  
27 Region and 17 percent in the Central Coast and Southern California regions.

28 **15.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison**

29 *Trinity River Region*

30        *Potential Changes in Recreational Resources at Reservoirs that Store CVP*  
31        *and SWP Water*

32 Changes in CVP water supplies and operations under Alternative 3 as compared  
33 to the Second Basis of Comparison would result in similar end of September  
34 reservoir elevations and related recreational resources at Trinity Lake in all water  
35 year types, as described in Chapter 5, Surface Water Resources and Water  
36 Supplies.

37 There are several boat ramps at Trinity Lake that provide access at different  
38 elevations. Boat ramps at Stuart Fork and Bowerman are not useable when the  
39 water elevation is less than 2,323 feet which occurs approximately 80 percent of  
40 the time under Alternative 3 and the Second Basis of Comparison. Boat ramps at  
41 Clark Springs, Fairview, and Trinity Center are not useable when the water  
42 elevation is lower than 2,300 feet which occurs approximately 62 percent of the  
43 time under Alternative 3 and the Second Basis of Comparison. The Minersville

1 boat ramp is accessible until the elevation declines below 2,170 feet which occurs  
2 approximately 5 percent of the time under Alternative 3 and the Second Basis of  
3 Comparison.

4 The potential for reduced recreational resources at Trinity Lake related to  
5 shoreline activities would be greater in critical dry years and similar in dry years  
6 and over the long-term average conditions under the No Action Alternative as  
7 compared to the Second Basis of Comparison.

8 *Potential Changes in Recreational Resources along Rivers Downstream of the*  
9 *CVP and SWP Reservoirs*

10 Flows in the Trinity River and recreational opportunities under Alternative 3  
11 would be similar to the Second Basis of Comparison, as summarized in Chapter 5,  
12 Surface Water Resources and Water Supplies.

13 *Central Valley Region*

14 *Potential Changes in Recreational Resources at Reservoirs that Store CVP*  
15 *and SWP Water*

16 Changes in CVP water supplies and operations under Alternative 3 as compared  
17 to the Second Basis of Comparison would result in similar end of September  
18 reservoir elevations and related recreational resources at Shasta Lake, Lake  
19 Oroville, Folsom Lake, New Melones Reservoir, and San Luis Reservoir in all  
20 water year types, as described in Chapter 5, Surface Water Resources and Water  
21 Supplies.

22 There are several boat ramps at each of the reservoirs that provide access at  
23 different elevations. At Shasta Lake, boat ramps at Antlers, Hirz Bay, Packers  
24 Bay, Sugar Loaf, and Centimundi and Jones Valley are not accessible  
25 approximately 55, 30, 15, 10, and 7 percent of the time, respectively, under  
26 Alternative 3 and the Second Basis of Comparison.

27 At Lake Oroville, boat ramps at Enterprise, Vinton Gulch, and Nelson Bar;  
28 Foreman Creek; Dark Canyon and Loafer Creek; and Bidwell Canyon, Lime  
29 Saddle, and Spillway are not accessible approximately 85, 75, 62, and 35 percent  
30 of the time, respectively, under Alternative 3 and the Second Basis of  
31 Comparison.

32 At Folsom Lake, boat ramps at Rattlesnake Bar; Beal's Point; Peninsula, Brown's  
33 Ravine, and Folsom Point; Hobie Cove; and Granite Bay are not accessible  
34 approximately 70, 65, 40, 10, and 7 percent of the time, respectively, under  
35 Alternative 3 and the Second Basis of Comparison.

36 At New Melones Reservoir, the boat ramp at Angels Creek, Parrott's Ferry, Glory  
37 Hole, and Mark Twain are not accessible approximately 22, 18, 10, and 8 percent  
38 of the time, respectively, under Alternative 3 as compared to approximately  
39 30, 25, 15, and 3 percent of the time, respectively, under the Second Basis of  
40 Comparison.

41 At San Luis Reservoir, the boat ramps at Dinosaur Point and Basalt Area are not  
42 useable approximately 28 and 8 percent of the time, respectively, under

1 Alternative 3; and approximately 20 and 5 percent of the time, respectively, under  
2 the Second Basis of Comparison.

3 Boating opportunities would be increased at New Melones Reservoir, decreased  
4 at San Luis Reservoir, and similar at all other reservoirs under Alternative 3 as  
5 compared to the Second Basis of Comparison. Shoreline recreational  
6 opportunities would be increased at New Melones Reservoir, decreased at Lake  
7 Oroville, and similar at all other reservoirs under Alternative 3 as compared to the  
8 Second Basis of Comparison.

9 *Potential Changes in Recreational Resources along Rivers Downstream of the*  
10 *CVP and SWP Reservoirs*

11 The recreational opportunities along the Sacramento, Feather, American, and  
12 Stanislaus rivers would be affected by the following changes in river flows, as  
13 described in Chapter 5.

- 14 • Similar or increased flows in the Sacramento River downstream of Keswick  
15 Dam and at Freeport.
- 16 • Feather River downstream of the Thermalito Complex
  - 17 – Over long-term conditions, similar flows would occur in November and  
18 January through June; reduced flows in October, December, and  
19 September (up to 12.5 percent); and increased flows in July and August  
20 (up to 17.0 percent).
  - 21 – In wet years, similar flows would occur in November and January through  
22 May; reduced flows in October, December, and September (up to  
23 14.6 percent); and increased flows in June through August (up to  
24 10.9 percent).
  - 25 – In dry years, similar flows would occur in November and January through  
26 June; reduced flows in August through October (up to 21.2 percent); and  
27 increased flows in July (37.1 percent).
- 28 • Similar flows in American River downstream of Nimbus Dam.
- 29 • Stanislaus River downstream of Goodwin Dam
  - 30 – Over long-term conditions, similar flows would occur in October,  
31 December, January, and March; reduced flows would occur in November,  
32 May, and June (up to 52.3 percent); and increased flows in February,  
33 April, and July through September (up to 26.8 percent).
  - 34 – In wet years, similar flows would occur in October, November, January,  
35 and April; reduced flows in May and June (up to 44.8 percent); and  
36 increased flows in December, February, March, and July through  
37 September (up to 68.6 percent).
  - 38 – In dry years, similar flows would occur in July through October; reduced  
39 flows in November through March and May through June (up to  
40 36.0 percent); and increased flows in April (40.2 percent).

1 During the spring and summer months, the changes in flow conditions between  
2 Alternative 3 and the Second Basis of Comparison vary on a monthly basis in the  
3 Sacramento, Feather, American, and Stanislaus rivers within a water year type.  
4 For example, flows in the Stanislaus River downstream of Goodwin Dam would  
5 increase in several months under Alternative 3 as compared to the Second Basis  
6 of Comparison by up to 90 percent, and decrease in several months up to  
7 11 percent. The overall range of flows is within the historical operational range;  
8 therefore, recreational opportunities still exist.

9 Overall, under Alternative 3 as compared to the Second Basis of Comparison,  
10 recreational opportunities would be similar or improved on the Sacramento,  
11 Feather, and American rivers; and both improved and reduced on the Stanislaus  
12 River depending upon the month.

13 Recreational opportunities related to Striped Bass fishing would initially be  
14 increased when Alternative 3 is implemented. However, by 2030, Striped Bass  
15 fishing opportunities would be reduced under Alternative 3 as compared to the  
16 Second Basis of Comparison due to actions to reduce predation.

17 Recreational opportunities related to sport ocean salmon fishing would be reduced  
18 under Alternative 3 as compared to the Second Basis of Comparison.

19 *Effects Related to Cross Delta Water Transfers*

20 Potential effects to recreational resources could be similar to those identified in a  
21 recent environmental analysis conducted by Reclamation for long-term water  
22 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as  
23 described above under the No Action Alternative compared to the Second Basis  
24 of Comparison. For the purposes of this EIS, it is anticipated that similar  
25 conditions would occur during implementation of cross Delta water transfers  
26 under Alternative 3 and the Second Basis of Comparison, and that impacts on  
27 recreational resources would not be substantial in the seller's service area due to  
28 implementation requirements of the transfer programs.

29 Under Alternative 3 and the Second Basis of Comparison, water could be  
30 transferred throughout the year without an annual volumetric limit. Overall, the  
31 potential for cross Delta water transfers would be similar under Alternative 3 and  
32 the Second Basis of Comparison.

33 *San Francisco Bay Area, Central Coast, and Southern California Regions*

34 *Potential Changes in Recreational Resources at Reservoirs that Store CVP*  
35 *and SWP Water*

36 Changes in recreational resources at reservoirs that store CVP and SWP water  
37 supplies are assumed to be related to changes in water deliveries over long-term  
38 conditions for this EIS analysis, as described above under the No Action  
39 Alternative as compared to the Second Basis of Comparison. Therefore, under  
40 Alternative 3 as compared to the Second Basis of Comparison, recreational  
41 resources related to surface water elevations in reservoirs that store CVP and  
42 SWP water supplies would be similar (changes within 5 percent).

1    **15.4.3.5   Alternative 4**

2    The recreational resources under Alternative 4 would be similar to the conditions  
3    under the Second Basis of Comparison with additional predation control actions  
4    to reduce the populations of striped bass.

5    **15.4.3.5.1   Alternative 4 Compared to the No Action Alternative**

6    The CVP and SWP operations under Alternative 4 are identical to the CVP and  
7    SWP operations under the Second Basis of Comparison and Alternative 1.  
8    However, Alternative 4 includes predation controls as compared to the Second  
9    Basis. Therefore, reservoir and flow-related changes in recreational resources  
10   under Alternative 4 as compared to the No Action Alternative would be the same  
11   as the impacts described in Section 15.4.3.2.1, Alternative 1 Compared to the No  
12   Action Alternative.

13   Recreational opportunities related to Striped Bass fishing would initially be  
14   increased when Alternative 4 is implemented. However, by 2030, Striped Bass  
15   fishing opportunities would be reduced under Alternative 4 as compared to the No  
16   Action Alternative due to actions to reduce predation.

17   Recreational opportunities related to sport ocean salmon fishing would be reduced  
18   under Alternative 4 as compared to the No Action Alternative.

19   **15.4.3.5.2   Alternative 4 Compared to the Second Basis of Comparison**

20   The CVP and SWP operations under Alternative 4 are identical to the CVP and  
21   SWP operations under the Second Basis of Comparison and Alternative 1.  
22   However, Alternative 4 includes predation controls as compared to the Second  
23   Basis of Comparison. Therefore, flow-related changes in recreational resources  
24   under Alternative 4 are the same as recreational resources under the Second Basis  
25   of Comparison.

26   Recreational opportunities related to Striped Bass fishing would initially be  
27   increased when Alternative 4 is implemented. However, by 2030, Striped Bass  
28   fishing opportunities would be reduced under Alternative 4 as compared to the  
29   Second Basis of Comparison due to actions to reduce predation.

30   Recreational opportunities related to sport ocean salmon fishing would be reduced  
31   under Alternative 4 as compared to the Second Basis of Comparison.

32   **15.4.3.6   Alternative 5**

33   As described in Chapter 3, Description of Alternatives, CVP and SWP operations  
34   under Alternative 5 are similar to the No Action Alternative with modified Old  
35   and Middle River flow criteria and New Melones Reservoir operations. As  
36   described in Chapter 4, Approach to Environmental Analysis, Alternative 5 is  
37   compared to the No Action Alternative and the Second Basis of Comparison.

1 **15.4.3.6.1 Alternative 5 Compared to the No Action Alternative**

2 *Trinity River Region*

3 *Potential Changes in Recreational Resources at Reservoirs that Store CVP*  
4 *and SWP Water*

5 Changes in CVP water supplies and operations under Alternative 5 as compared  
6 to the No Action Alternative would result in similar end of September reservoir  
7 elevations and related recreational resources at Trinity Lake in all water year  
8 types, as described in Chapter 5, Surface Water Resources and Water Supplies.

9 There are several boat ramps at Trinity Lake that provide access at different  
10 elevations. Boat ramps at Stuart Fork and Bowerman are not useable when the  
11 water elevation is less than 2,323 feet which occurs approximately 80 percent of  
12 the time under Alternative 5 and the No Action Alternative. Boat ramps at Clark  
13 Springs, Fairview, and Trinity Center are not useable when the water elevation is  
14 lower than 2,300 feet which occurs approximately 62 percent of the time under  
15 Alternative 5 and the No Action Alternative. The Minersville boat ramp is  
16 accessible until the elevation declines below 2,170 feet which occurs  
17 approximately 8 percent of the time under Alternative 5 and 5 percent of the time  
18 under the No Action Alternative.

19 The potential for reduced recreational resources at Trinity Lake related to  
20 shoreline activities would be slightly less in critical dry years and similar over the  
21 long-term average conditions and dry years under Alternative 5 as compared to  
22 the No Action Alternative.

23 *Potential Changes in Recreational Resources along Rivers Downstream of the*  
24 *CVP and SWP Reservoirs*

25 Flows in the Trinity River and recreational opportunities under Alternative 5  
26 would be similar to the No Action Alternative, as summarized in Chapter 5,  
27 Surface Water Resources and Water Supplies.

28 *Central Valley Region*

29 *Potential Changes in Recreational Resources at Reservoirs that Store CVP*  
30 *and SWP Water*

31 Changes in CVP water supplies and operations under Alternative 5 as compared  
32 to the No Action Alternative would result in similar end of September reservoir  
33 elevations and related recreational resources at Shasta Lake, Lake Oroville,  
34 Folsom Lake, New Melones Reservoir, and San Luis Reservoir in all water year  
35 types, as described in Chapter 5, Surface Water Resources and Water Supplies.

36 There are several boat ramps at each of the reservoirs that provide access at  
37 different elevations. At Shasta Lake, boat ramps at Antlers, Hirz Bay, Packers  
38 Bay, Sugar Loaf, and Centimundi and Jones Valley are not accessible  
39 approximately 55, 35, 20, 10, and 9 percent of the time, respectively, under  
40 Alternative 5 and the No Action Alternative.

41 At Lake Oroville, boat ramps at Enterprise, Vinton Gulch, and Nelson Bar;  
42 Foreman Creek; Dark Canyon and Loafer Creek; and Bidwell Canyon, Lime  
43 Saddle, and Spillway are not accessible approximately 95, 87, 73, and 35 percent

1 of the time, respectively, under Alternative 5 and the Second Basis of  
2 Comparison.

3 At Folsom Lake, boat ramps at Rattlesnake Bar, Beal's Point; Peninsula, Brown's  
4 Ravine, and Folsom Point; Hobie Cove; and Granite Bay are not accessible  
5 approximately 80, 65, 40, 10, and 7 percent of the time, respectively, under  
6 Alternative 5 and the No Action Alternative.

7 At New Melones Reservoir, the boat ramp at Angels Creek, Parrott's Ferry, Glory  
8 Hole, and Mark Twain are not accessible approximately 35, 30, 22, and 8 percent  
9 of the time, respectively, under Alternative 5 as compared to approximately  
10 65, 25, 18, and 5 percent of the time, respectively, under the No Action  
11 Alternative.

12 At San Luis Reservoir, the boat ramps at Dinosaur Point and Basalt Area are not  
13 useable approximately 50 and 10 percent of the time, respectively, under  
14 Alternative 5 and the No Action Alternative.

15 Increased shoreline recreational opportunities at New Melones Reservoir in long-  
16 term average conditions and dry years, decreased opportunities at New Melones  
17 Reservoir in critical dry years, and similar opportunities at all times analyzed at  
18 all other reservoirs under Alternative 5 as compared to the No Action Alternative.  
19 Increased boating opportunities at New Melones Reservoir and similar  
20 opportunities at all other reservoirs under Alternative 5 as compared to the No  
21 Action Alternative.

22 *Potential Changes in Recreational Resources along Rivers downstream of the*  
23 *CVP and SWP Reservoirs*

24 The recreational opportunities along the Sacramento, Feather, American, and  
25 Stanislaus rivers would be affected by the following changes in river flows, as  
26 described in Chapter 5.

- 27 • Flows in the Sacramento River downstream of Keswick Dam and near  
28 Freeport would be similar.
- 29 • Feather River downstream of the Thermalito Complex
  - 30 – Over long-term conditions, similar flows would occur in June through  
31 April; and reduced flows in May (6.6 percent).
  - 32 – In wet years, similar flows would occur in all months.
  - 33 – In dry years, similar flows would occur in September through April and  
34 June; reduced flows in May (27.1 percent); and increased flows in July  
35 and August (up to 8.9 percent).
- 36 • Flows in the American River downstream of Nimbus Dam would be similar.
- 37 • Stanislaus River downstream of Goodwin Dam
  - 38 – Over long-term conditions, flows would be similar in September through  
39 February and June; reduced flows would occur in March, July, and August



- 1 (up to 8.0 percent); and increased flows in April and May (up to  
2 22.4 percent).
- 3 – In wet years, similar flows would occur in October, November, January,  
4 February, and April through June; reduced flows in December, March, and  
5 July through September (up to 18.0 percent).
  - 6 – In dry years, similar flows would occur in June through March; and  
7 increased flows in April and May (up to 47.3 percent).

8 During the spring and summer months, the changes in flow conditions between  
9 Alternative 5 and the No Action Alternative vary on a monthly basis in the  
10 Sacramento, Feather, American, and Stanislaus rivers within a water year type.  
11 For example, flows in the Feather River downstream of Thermalito Complex  
12 would increase in several months under Alternative 5 and the No Action  
13 Alternative by up to 9 percent, and decrease in several months up to 27 percent.  
14 The overall range of flows is within the historical operational range; therefore,  
15 recreational opportunities still exist. However, the value of the recreational  
16 opportunities would be both improved and reduced depending upon the timing of  
17 the changes.

18 Overall, under Alternative 5 and the No Action Alternative, recreational  
19 opportunities would be similar or improved on the Sacramento and American  
20 rivers; and both improved and reduced on the Feather and Stanislaus rivers.

#### 21 *Effects Related to Cross Delta Water Transfers*

22 Potential effects to recreational resources could be similar to those identified in a  
23 recent environmental analysis conducted by Reclamation for long-term water  
24 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as  
25 described above under the No Action Alternative compared to the Second Basis  
26 of Comparison. For the purposes of this EIS, it is anticipated that similar  
27 conditions would occur during implementation of cross Delta water transfers  
28 under Alternative 5 and the No Action Alternative, and that impacts on  
29 recreational resources would not be substantial in the seller's service area due to  
30 implementation requirements of the transfer programs.

31 Under Alternative 5 and the No Action Alternative, the timing of cross Delta  
32 water transfers would be limited to July through September and include annual  
33 volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO.  
34 Overall, the potential for cross Delta water transfers would be similar under  
35 Alternative 5 and the No Action Alternative.

#### 36 *San Francisco Bay Area, Central Coast, and Southern California Region*

##### 37 *Potential Changes in Recreational Resources at Reservoirs that Store CVP* 38 *and SWP Water*

39 Changes in recreational resources at reservoirs that store CVP and SWP water  
40 supplies are assumed to be related to changes in water deliveries over long-term  
41 conditions for this EIS analysis, as described above under the No Action  
42 Alternative as compared to the Second Basis of Comparison. Therefore, under

1 Alternative 5 as compared to the No Action Alternative, recreational resources  
2 would be similar.

### 3 **15.4.3.6.2 Alternative 5 Compared to the Second Basis of Comparison**

#### 4 *Trinity River Region*

##### 5 *Potential Changes in Recreational Resources at Reservoirs that Store CVP* 6 *and SWP Water*

7 Changes in CVP water supplies and operations under Alternative 5 as compared  
8 to the Second Basis of Comparison would result in similar end of September  
9 reservoir elevations and related recreational resources at Trinity Lake in all water  
10 year types, as described in Chapter 5, Surface Water Resources and Water  
11 Supplies.

12 There are several boat ramps at Trinity Lake that provide access at different  
13 elevations. Boat ramps at Stuart Fork and Bowerman are not useable when the  
14 water elevation is less than 2,323 feet which occurs approximately 80 percent of  
15 the time under Alternative 5 and the Second Basis of Comparison. Boat ramps at  
16 Clark Springs, Fairview, and Trinity Center are not useable when the water  
17 elevation is lower than 2,300 feet which occurs approximately 62 percent of the  
18 time under Alternative 5 and the Second Basis of Comparison. The Minersville  
19 boat ramp is accessible until the elevation declines below 2,170 feet which occurs  
20 approximately 8 percent of the time under Alternative 5 and 5 percent of the time  
21 under the Second Basis of Comparison.

22 The potential for reduced recreational resources at Trinity Lake related to  
23 shoreline activities would be similar under Alternative 5 as compared to the  
24 Second Basis of Comparison.

##### 25 *Potential Changes in Recreational Resources along Rivers Downstream of the* 26 *CVP and SWP Reservoirs*

27 Flows in Trinity River would be similar during the recreation season (spring and  
28 summer months); therefore, recreational opportunities would be similar under  
29 Alternative 5 as compared to the Second Basis of Comparison.

#### 30 *Central Valley Region*

##### 31 *Potential Changes in Recreational Resources at Reservoirs that Store CVP* 32 *and SWP Water*

33 Changes in CVP water supplies and operations under Alternative 5 as compared  
34 to the Second Basis of Comparison would result in similar end of September  
35 reservoir elevations and related recreational resources at Shasta Lake, Lake  
36 Oroville, Folsom Lake, and New Melones Reservoir in all water year types; and  
37 at San Luis Reservoir in wet, above normal, and below normal years, as described  
38 in Chapter 5, Surface Water Resources and Water Supplies. Changes in  
39 recreational resources at San Luis Reservoir would be reduced in dry year and  
40 critical dry years because the end of September surface water elevations would be  
41 decreased by 6.2 percent in dry years and 8.5 percent in critical dry years.

- 1 There are several boat ramps at each of the reservoirs that provide access at  
2 different elevations. At Shasta Lake, boat ramps at Antlers, Hirz Bay, Packers  
3 Bay, Sugar Loaf, and Centimundi and Jones Valley are not accessible  
4 approximately 55, 35, 20, 10, and 9 percent of the time, respectively, under  
5 Alternative 5; and approximately 55, 30, 15, 10, and 7 percent of the time,  
6 respectively, under the Second Basis of Comparison.
- 7 At Lake Oroville, boat ramps at Enterprise, Vinton Gulch, and Nelson Bar;  
8 Foreman Creek; Dark Canyon and Loafer Creek; and Bidwell Canyon, Lime  
9 Saddle, and Spillway are not accessible approximately 95, 87, 73, and 35 percent  
10 of the time, respectively, under Alternative 5; and approximately 85, 75, 62, and  
11 25 percent of the time, respectively, under the Second Basis of Comparison.
- 12 At Folsom Lake, boat ramps at Rattlesnake Bar are not accessible 80 percent of  
13 the time under Alternative 5, and 70 percent of the time, respectively, under the  
14 Second Basis of Comparison. Boat ramps at Beal's Point; Peninsula, Brown's  
15 Ravine, and Folsom Point; Hobie Cove; and Granite Bay are not accessible  
16 approximately 65, 40, 10, and 7 percent of the time, respectively, under  
17 Alternative 5 and the Second Basis of Comparison.
- 18 At New Melones Reservoir, the boat ramp at Angels Creek, Parrott's Ferry, Glory  
19 Hole, and Mark Twain are not accessible approximately 35, 30, 22, and 8 percent  
20 of the time, respectively, under Alternative 5 as compared to approximately  
21 30, 25, 15, and 5 percent of the time, respectively, under the Second Basis of  
22 Comparison.
- 23 At San Luis Reservoir, the boat ramps at Dinosaur Point and Basalt Area are not  
24 useable approximately 50 and 10 percent of the time, respectively, under  
25 Alternative 5; and approximately 20 and 5 percent of the time, respectively, under  
26 the Second Basis of Comparison.
- 27 Decreased shoreline recreational opportunities at Shasta Lake, Lake Oroville, and  
28 New Melones Reservoir, and similar opportunities at all other reservoirs under  
29 Alternative 5 as compared to the Second Basis of Comparison. Decreased  
30 boating opportunities at Lake Oroville, New Melones Reservoir, and San Luis  
31 Reservoir and similar opportunities at all other reservoirs under Alternative 5 as  
32 compared to the Second Basis of Comparison.
- 33 *Potential Changes in Recreational Resources along Rivers Downstream of the*  
34 *CVP and SWP Reservoirs*
- 35 The recreational opportunities along the Sacramento, Feather, American, and  
36 Stanislaus rivers would be affected by the following changes in river flows, as  
37 described in Chapter 5.
- 38 • Sacramento River downstream of Keswick Dam
    - 39 – Over long-term conditions, flows would be similar in July, August,  
40 October, and February through April; reduced in December, January, May  
41 and June (up to 8.2 percent); and increased in September and November  
42 (up to 38.5 percent).

- 1       – In wet years, flows would be similar in January through July; reduced in  
2       December and August (up to 15.0 percent); and increased in September  
3       through November (up to 77.3 percent).
- 4       – In dry years, similar flows would occur in July through October and  
5       December through March; reduced in April through June (up to  
6       10.1 percent); and increased flows in November (32.1 percent).
- 7       • Sacramento River at Freeport
- 8       – Over long-term conditions, flows would be similar in October and  
9       December through April; reduced in May and June (up to 11.5 percent);  
10      and increased in July through September and November (43.4 percent).
- 11      – In wet years, flows would be similar in October and January through June;  
12      reduced in December (6.2 percent); and increased in July through  
13      September and November (up to 89.0 percent).
- 14      – In dry years, similar flows would occur in August through October and  
15      December through April; reduced in May and June (up to 13.6 percent);  
16      and increased flows in July and November (up to 19.3 percent).
- 17      • Feather River downstream of the Thermalito Complex
- 18      – Over long-term conditions, similar flows would occur in November and  
19      April; reduced flows in October, December through March, May, and June  
20      (up to 27.7 percent); and increased flows in July through September (up to  
21      76.2 percent).
- 22      – In wet years, similar flows would occur in October, November, March  
23      through May; reduced flows in December through February and June (up  
24      to 25.6 percent); and increased flows in July through September (up to  
25      181.9 percent).
- 26      – In dry years, similar flows would occur in November through April;  
27      reduced flows in October, May, June, August, and September (up to  
28      45.4 percent); and increased flows in July (60.4 percent).
- 29      • American River downstream of Nimbus Dam
- 30      – Over long-term conditions, similar flows would occur in November  
31      through July; reduced flows in August (5.8 percent); and increased in  
32      September and October (42.4 percent).
- 33      – In wet years, similar flows would occur in October, November, and  
34      January through July; reduced flows in December and August (up to  
35      13.7 percent); and increased flows in September (88.2 percent).
- 36      – In dry years, similar flows would occur in November through September;  
37      and increased flows in October (16.7 percent).
- 38      • Stanislaus River downstream of Goodwin Dam
- 39      – Over long-term conditions, similar flows would occur in August; reduced  
40      flows would occur in November through February, June, July, August, and

1 September (up to 35.8 percent); and increased flows in October and March  
2 through May (up to 144.8 percent).

3 – In wet years, similar flows would occur in February and April; reduced  
4 flows in November through January and June through September (up to  
5 52.8 percent); and increased flows in October and March (up to  
6 113.1 percent).

7 – In dry years, similar flows would occur in July through September;  
8 reduced flows in November through March and June (up to 35.7 percent);  
9 and increased flows in October, April, and May (150.1 percent).

10 During the spring and summer months, the changes in flow conditions between  
11 Alternative 5 and the Second Basis of Comparison vary on a monthly basis in the  
12 Sacramento, Feather, American, and Stanislaus rivers within a water year type.  
13 For example, flows in the Sacramento River at Freeport would increase in several  
14 months under Alternative 5 as compared to the Second Basis of Comparison by  
15 up to 89 percent, and decrease in several months up to 13 percent. The overall  
16 range of flows is within the historical operational range; therefore, recreational  
17 opportunities still exist. However, the value of the recreational opportunities  
18 would be both improved and reduced depending upon the timing of the changes.

19 Overall, under Alternative 5 as compared to the Second Basis of Comparison,  
20 recreational opportunities would be similar or improved on the Sacramento River  
21 downstream of Keswick Dam and American River downstream of Nimbus Dam;  
22 and both improved and reduced on the Sacramento River near Freeport, Feather  
23 River downstream of Thermalito Complex, and the Stanislaus River downstream  
24 of Goodwin Dam depending upon the month.

#### 25 *Effects Related to Cross Delta Water Transfers*

26 Potential effects to recreational resources could be similar to those identified in a  
27 recent environmental analysis conducted by Reclamation for long-term water  
28 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as  
29 described above under the No Action Alternative compared to the Second Basis  
30 of Comparison. For the purposes of this EIS, it is anticipated that similar  
31 conditions would occur during implementation of cross Delta water transfers  
32 under Alternative 5 and the Second Basis of Comparison, and that impacts on  
33 recreational resources would not be substantial in the seller's service area due to  
34 implementation requirements of the transfer programs.

35 Under Alternative 5, the timing of cross Delta water transfers would be limited to  
36 July through September and include annual volumetric limits, in accordance with  
37 the 2008 USFWS BO and 2009 NMFS BO. Under the Second Basis of  
38 Comparison, water could be transferred throughout the year without an annual  
39 volumetric limit. Overall, the potential for cross Delta water transfers would be  
40 reduced under Alternative 5 as compared to the Second Basis of Comparison.

1 *San Francisco Bay Area, Central Coast, and Southern California Regions*  
 2 *Potential Changes in Recreational Resources at Reservoirs that Store CVP*  
 3 *and SWP Water*  
 4 Changes in recreational resources at reservoirs that store CVP and SWP water  
 5 supplies are assumed to be related to changes in water deliveries over long-term  
 6 conditions for this EIS analysis, as described above under the No Action  
 7 Alternative as compared to the Second Basis of Comparison. Therefore, under  
 8 Alternative 5 as compared to the Second Basis of Comparison, recreational  
 9 resources related to surface water elevations in reservoirs that store CVP and  
 10 SWP water supplies would be reduced by 10 to 18 percent in the San Francisco  
 11 Bay Area Region and 18 percent in the Central Coast and Southern California  
 12 regions.

13 **15.4.3.7 Summary of Impact Assessment**

14 The results of the impact assessment of implementation of Alternatives 1  
 15 through 5 as compared to the No Action Alternative and the Second Basis of  
 16 Comparison are presented in Tables 15.28 and 15.29.

17 **Table 15.28 Comparison of Alternatives 1 through 5 to No Action Alternative**

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	<p>Recreational resources would be similar at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir in all water year types; and at San Luis Reservoir in above normal, below normal, and dry years. Recreational resources would be increased by 6 percent in wet and critical dry years at San Luis Reservoir, by 11 to 21 percent in the San Francisco Bay Area Region, and by 21 percent in the Central Coast and Southern California regions.</p> <p>Recreational opportunities would be similar or improved on Trinity River, Sacramento River downstream of Keswick Dam, and American River downstream of Nimbus Dam. On the Sacramento River near Freeport, Feather River downstream of Thermalito Complex, and the Stanislaus River downstream of Goodwin Dam recreational opportunities would be similar or improved in most spring and summer months; and reduced in July in all years and August in wetter years.</p>	No mitigation measures identified at this time to reduce flow reduction impacts on recreation opportunities.
Alternative 2	No effects on recreational resources.	None needed

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Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 3	<p>Recreational resources would be similar at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir in all water year types; and at San Luis Reservoir in above normal, below normal, and dry years. Recreational resources would be increased by 8 percent in wet years and 6 percent in above normal years at San Luis Reservoir, by 9 to 17 percent in the San Francisco Bay Area Region, and by 17 percent in the Central Coast and Southern California regions.</p> <p>Recreational opportunities would be similar or improved on Trinity River, Sacramento River downstream of Keswick Dam, and American River downstream of Nimbus Dam. On the Sacramento River near Freeport and Feather River downstream of Thermalito Complex, recreational opportunities would be similar or improved in most spring and summer months; and reduced in August in all years on both rivers and in July on the Feather River in dry years. On the Stanislaus River downstream of Goodwin Dam recreational opportunities would be similar or improved in summer months; and reduced in May and June in all water year types.</p> <p>Recreational opportunities related to Striped Bass fishing and sport ocean salmon fishing would be reduced.</p>	<p>No mitigation measures identified at this time to reduce flow reduction impacts on recreation opportunities.</p> <p>No mitigation measures identified at this time to reduce impacts to reduction in Striped Bass and sport ocean salmon fishing opportunities.</p>
Alternative 4	<p>Reservoir and flow-related recreational opportunities would be as described for Alternative 1 compared to the No Action Alternative.</p> <p>Recreational opportunities related to Striped Bass fishing and sport ocean salmon fishing would be reduced.</p>	<p>No mitigation measures identified at this time to reduce flow reduction impacts on recreation opportunities.</p> <p>No mitigation measures identified at this time to reduce impacts to reduction in Striped Bass and sport ocean salmon fishing opportunities.</p>
Alternative 5	<p>Recreational resources would be similar at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, San Luis Reservoir, and other reservoirs that store CVP and SWP water in the San Francisco Bay Area, Central Coast, and Southern California regions.</p> <p>Recreational opportunities would be similar or improved on Trinity River, Sacramento River downstream of Keswick Dam and near Freeport, and American River downstream of Nimbus Dam. On the Feather River downstream of Thermalito Complex, recreational opportunities would be similar or improved in most spring and summer months; and reduced in May in all years. On the Stanislaus River downstream of Goodwin Dam recreational opportunities would be similar or improved in spring months; and reduced in July and August in most water year types.</p>	<p>No mitigation measures identified at this time to reduce flow reduction impacts on recreation opportunities.</p>

1 Note: Due to the limitations and uncertainty in the CalSim II monthly model and other  
2 analytical tools, incremental differences of 5 percent or less between alternatives and the  
3 No Action Alternative are considered to be “similar.”

1 **Table 15.29 Comparison of No Action Alternative and Alternatives 1 through 5 to**  
 2 **Second Basis of Comparison**

Alternative	Potential Change	Consideration for Mitigation Measures
No Action Alternative	<p>Recreational resources would be similar at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir in all water year types; and at San Luis Reservoir in above normal, below normal, and dry years. Recreational resources would be reduced by 6 percent in wet and critical dry years at San Luis Reservoir, by 10 to 18 percent in the San Francisco Bay Area Region, and by 18 percent in the Central Coast and Southern California regions.</p> <p>Recreational opportunities would be similar or improved on Trinity River. On the Sacramento River downstream of Keswick Dam and near Freeport, Feather River downstream of Thermalito Complex, American River downstream of Nimbus Dam, and the Stanislaus River downstream of Goodwin Dam recreational opportunities would be similar or improved in most spring and summer months; and reduced in June in most years, August in some years on the Feather and American rivers, and in May in some years on Sacramento River near Freeport and on the Feather River.</p>	Not considered for this comparison.
Alternative 1	No effects on recreational resources.	Not considered for this comparison.
Alternative 2	Same effects as described for No Action Alternative as compared to the Second Basis of Comparison.	Not considered for this comparison.
Alternative 3	<p>Recreational resources would be similar at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, San Luis Reservoir, and other reservoirs that store CVP and SWP water in the San Francisco Bay Area, Central Coast, and Southern California regions.</p> <p>Recreational opportunities would be similar or improved on Trinity River, Sacramento River downstream of Keswick Dam and near Freeport, and American River downstream of Nimbus Dam. On the Feather River downstream of Thermalito Complex, recreational opportunities would be similar or improved in most spring and summer months; and reduced in August in dry years. On the Stanislaus River downstream of Goodwin Dam recreational opportunities would be similar or improved in summer months; and reduced in May and June in all water year types.</p> <p>Recreational opportunities related to Striped Bass fishing and sport ocean salmon fishing would be reduced.</p>	Not considered for this comparison.
Alternative 4	<p>Reservoir and flow-related recreational opportunities would be similar.</p> <p>Recreational opportunities related to Striped Bass fishing and sport ocean salmon fishing would be reduced.</p>	Not considered for this comparison.



Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 5	<p>Recreational resources would be similar at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir in all water year types; and at San Luis Reservoir in above normal, below normal, and dry years. Recreational resources would be reduced by 6 percent in dry years and 9 percent in critical dry years at San Luis Reservoir, by 10 to 18 percent in the San Francisco Bay Area Region, and by 18 percent in the Central Coast and Southern California regions.</p> <p>Recreational opportunities would be similar or improved on Trinity River. On the Sacramento River downstream of Keswick Dam and near Freeport, Feather River downstream of Thermalito Complex, American River downstream of Nimbus Dam, and the Stanislaus River downstream of Goodwin Dam recreational opportunities would be similar or improved in many spring and summer months. Flows would reduce in May and June in most years on the Sacramento and Feather rivers; in August on the American River; and in June through August on the Stanislaus River.</p>	Not considered for this comparison.

1 Note: Due to the limitations and uncertainty in the CalSim II monthly model and other  
 2 analytical tools, incremental differences of 5 percent or less between alternatives and the  
 3 No Action Alternative are considered to be “similar.”

4 **15.4.3.8 Potential Mitigation Measures**

5 Mitigation measures are not included in this EIS to address adverse impacts under  
 6 the alternatives as compared to the Second Basis of Comparison because this  
 7 analysis was included in this EIS for information purposes only.

8 Changes in CVP and SWP operations under Alternatives 1 through 5 as compared  
 9 to the No Action Alternative would not result in adverse changes in recreational  
 10 resources at reservoirs. However, implementation of Alternatives 1, 3, 4, and 5  
 11 would result in adverse changes in recreational opportunities along rivers  
 12 downstream of CVP and SWP reservoirs. Implementation of Alternatives 3 and 4  
 13 would result in adverse changes in recreational Striped Bass and sport ocean  
 14 salmon fishing opportunities. Mitigation measures have not been identified at this  
 15 time.

16 **15.4.3.9 Cumulative Effects Analysis**

17 As described in Chapter 3, the cumulative effects analysis considers projects,  
 18 programs, and policies that are not speculative; and are based upon known or  
 19 reasonably foreseeable long-range plans, regulations, operating agreements, or  
 20 other information that establishes them as reasonably foreseeable.

21 The cumulative effects analysis for Alternatives 1 through 5 for Recreational  
 22 Opportunities are summarized in Table 15.30.

1 **Table 15.30 Summary of Cumulative Effects on Recreational Opportunities with**  
 2 **Implementation of Alternatives 1 through 5 as Compared to the No Action**  
 3 **Alternative**

Scenarios	Actions	Cumulative Effects of Actions
<p>Past &amp; Present, and Future Actions Included and in the No Action Alternative and in All Alternatives in Year 2030</p>	<p>Consistent with Affected Environment conditions plus:</p> <p>Actions in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives), including climate change and sea level rise</p> <p>Actions not included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives):</p> <ul style="list-style-type: none"> <li>- Implementation of Federal and state policies and programs, including Clean Water Act (e.g., Total Maximum Daily Loads); Safe Drinking Water Act; Clean Air Act; and flood management programs</li> <li>- General plans for 2030.</li> <li>- Trinity River Restoration Program.</li> <li>- Central Valley Project Improvement Act programs</li> <li>- Folsom Dam Water Control Manual Update</li> <li>- FERC Relicensing for the Middle Fork of the American River Project</li> <li>- San Joaquin River Restoration Program</li> <li>- Contra Loma Recreation Resource Management Plan</li> <li>- San Luis Reservoir State Recreation Area Resource Management Plan/General Plan</li> </ul>	<p><u>These effects would be the same under all alternatives.</u></p> <p>Climate change and sea level rise and development under the general plans are anticipated to reduce carryover storage in reservoirs and changes in stream flow patterns in a manner that would change recreational opportunities, and could reduce the opportunities for sport ocean salmon fishing.</p> <p>Other actions, including restoration projects, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to improve recreational opportunities.</p>
<p>Future Actions Considered as Cumulative Effects Actions in All Alternatives in Year 2030</p>	<p>Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives):</p> <ul style="list-style-type: none"> <li>- Bay-Delta Water Quality Control Plan Update</li> <li>- FERC Relicensing Projects</li> <li>- Bay Delta Conservation Plan (including the California WaterFix alternative)</li> <li>- Shasta Lake Water Resources, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations</li> <li>- El Dorado Water and Power Authority Supplemental Water Rights Project</li> <li>- Semitropic Water Storage District Delta Wetlands</li> <li>- North Bay Aqueduct Alternative Intake</li> <li>- Irrigated Lands Regulatory Program</li> </ul>	<p><u>These effects would be the same under all alternatives.</u></p> <p>Some of the future reasonably foreseeable actions to improve water quality and FERC Relicensing projects would improve recreational opportunities.</p> <p>Other future reasonably foreseeable actions, such as expanded or new reservoirs would improve recreational opportunities.</p>
<p>No Action Alternative with Associated Cumulative Effects Actions in Year 2030</p>	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO</p>	<p>Implementation of No Action Alternative with future reasonably foreseeable actions would result in changes stream flows would result in changes to related recreational opportunities as compared to historical conditions prior to the BOs.</p>

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Scenarios	Actions	Cumulative Effects of Actions
Alternative 1 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternative 1 with future reasonably foreseeable actions would result in reduced stream flows and related recreational opportunities along the Sacramento River near Freeport, Feather River downstream of Thermalito Complex, American River downstream of Nimbus Dam, and the Stanislaus River downstream of Goodwin Dam in July in all years and August in wetter years compared to the No Action Alternative with the added actions.
Alternative 2 with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions No implementation of structural improvements or other actions that require further study to develop a more detailed action description.	Implementation of Alternative 2 with future reasonably foreseeable actions for recreational opportunities would be the same as for the No Action Alternative with the added actions.
Alternative 3 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant) Slight increase in positive Old and Middle River flows in the winter and spring months Increased bag limits for Striped Bass and Pikeminnow Increased sport ocean salmon fishing harvest limitations	Implementation of Alternative 3 with future reasonably foreseeable actions would result in reduced stream flows and related recreational opportunities along the Sacramento River near Freeport, Feather River downstream of Thermalito Complex would be reduced in August in all years on both rivers and in July on the Feather River in dry years. On the Stanislaus River downstream of Goodwin Dam recreational opportunities would be reduced in May and June in all water year types compared to the No Action Alternative with the added actions. Recreational opportunities related to Striped Bass fishing would initially be increased; however by 2030 recreational fishing related to Striped Bass would be reduced. Recreational opportunities related to sport ocean salmon fishing would be reduced.
Alternative 4 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant) Increased bag limits for Striped Bass and Pikeminnow Increased sport ocean salmon fishing harvest limitations	Implementation of Alternative 4 with future reasonably foreseeable actions would result in reduced stream flows and related recreational opportunities along the Sacramento River near Freeport, Feather River downstream of Thermalito Complex, American River downstream of Nimbus Dam, and the Stanislaus River downstream of Goodwin Dam in July in all years and August in wetter years compared to the No Action Alternative with the added actions. Recreational opportunities related to Striped Bass fishing would initially be increased; however by 2030 recreational fishing related to Striped Bass would be reduced. Recreational opportunities related to sport ocean salmon fishing would be reduced.

Scenarios	Actions	Cumulative Effects of Actions
Alternative 5 with Associated Cumulative Effects Actions in Year 20530	Full implementation of the 2008 USFWS BO and 2009 NMFS BO Positive Old and Middle River flows and increased Delta outflow in spring months	Implementation of Alternative 5 with future reasonably foreseeable actions would result in reduced stream flows and related recreational opportunities along the Feather River downstream of Thermalito Complex would be reduced in May in all years compared to the No Action Alternative with the added actions. On the Stanislaus River downstream of Goodwin Dam recreational opportunities would be reduced in July and August in most water year types compared to the No Action Alternative with the added actions.

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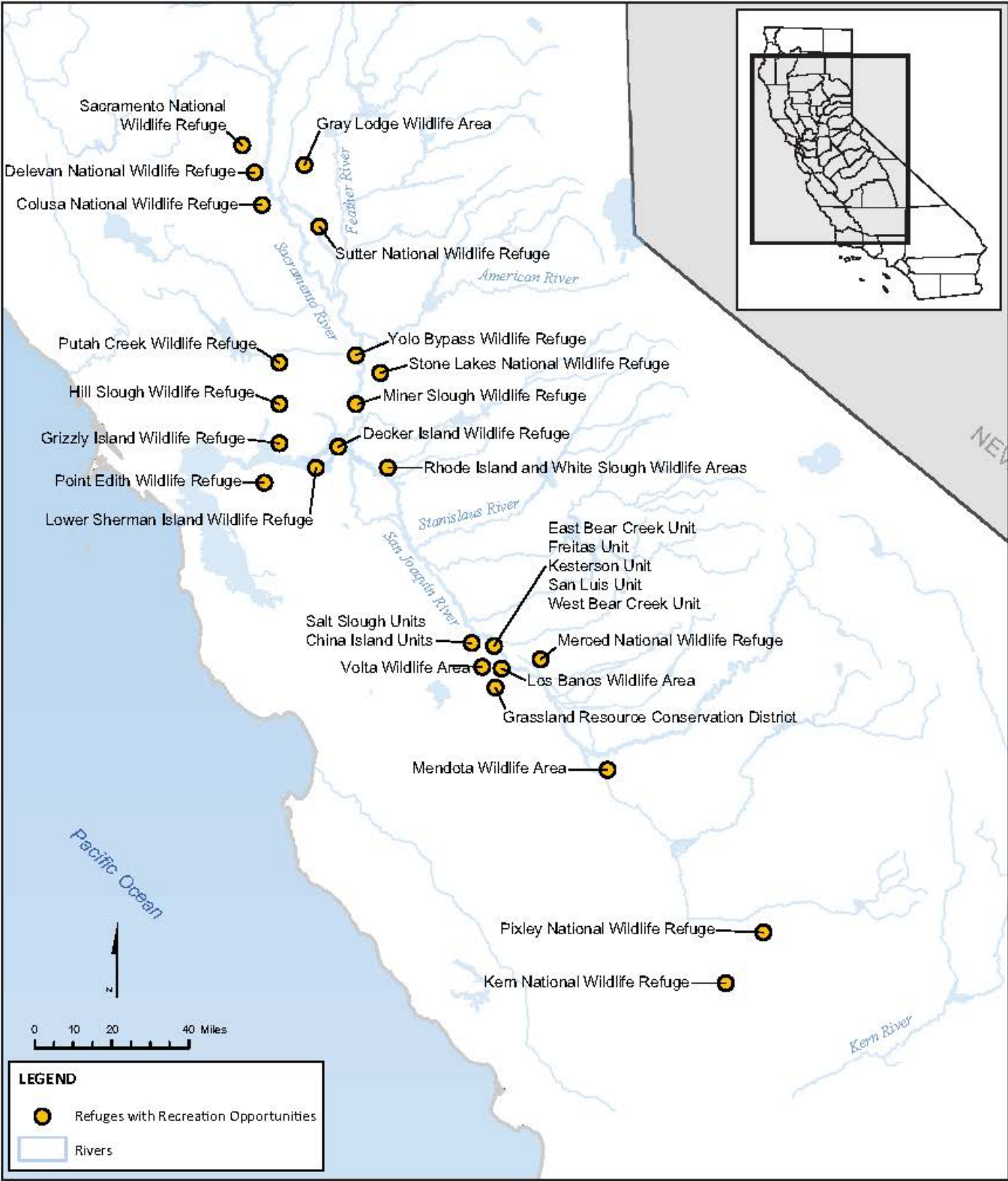
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**Figure 15.1 Wildlife Refuges Identified to Receive Central Valley Project Water Supplies**

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## Chapter 16

# 1 Air Quality and Greenhouse Gas 2 Emissions

## 3 16.1 Introduction

4 This chapter describes existing and future air quality conditions and the potential  
5 for greenhouse gas emissions that could occur as a result of implementing the  
6 alternatives that could change the long-term operation of the Central Valley  
7 Project (CVP) and State Water Project (SWP) as evaluated in this Environmental  
8 Impact Statement (EIS). Implementation of the alternatives could affect CVP and  
9 SWP water deliveries which could indirectly affect air quality.

## 10 16.2 Terminology

11 Important air quality and greenhouse gas emission terminology used in this  
12 chapter are defined by the U.S. Environmental Protection Agency (USEPA) and  
13 the California Air Resources Board (ARB), as summarized below.

- 14 • **Attainment Area:** A geographic area considered to have air quality as good  
15 as or better than the national and/or state ambient air quality standards. An  
16 area may be an attainment area for one pollutant and a non-attainment area for  
17 others (USEPA 2006).
- 18 • **California Ambient Air Quality Standard (CAAQS):** A legal limit that  
19 specifies the maximum level and time of exposure in the outdoor air for a  
20 given air pollutant and which is protective of human health and public welfare  
21 (California Health and Safety Code section 39606b). CAAQS are  
22 recommended by the California Office of Environmental Health Hazard  
23 Assessment and adopted into regulation by the ARB. CAAQS are the  
24 standards which must be met per the requirements of the California Clean Air  
25 Act (ARB 2010).
- 26 • **Criteria Pollutant:** An air pollutant for which acceptable levels of exposure  
27 can be determined and for which an ambient air quality standard has been set  
28 (ARB 2010). The criteria pollutants are ozone (O<sub>3</sub>), carbon monoxide (CO),  
29 nitrogen oxides (NO<sub>x</sub>), sulfur dioxide (SO<sub>2</sub>), particulate matter less than  
30 10 microns in aerodynamic diameter (PM<sub>10</sub>), particulate matter less than  
31 2.5 microns in aerodynamic diameter (PM<sub>2.5</sub>), and lead (Pb).
- 32 • **Greenhouse Gases (GHGs):** Atmospheric gases (such as carbon dioxide  
33 (CO<sub>2</sub>), methane (CH<sub>4</sub>), hydrofluorocarbons (HFC), nitrous oxide (N<sub>2</sub>O), O<sub>3</sub>,  
34 perfluorocarbons (PFC), sulfur hexafluoride (SF<sub>6</sub>), and water vapor) that slow  
35 the passage of re-radiated heat through the Earth's atmosphere (ARB 2010).



- 1 Six of the GHGs are the subject of reductions under the Kyoto Protocol and  
2 California Assembly Bill 32 are CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, HFC, PFC, and SF<sub>6</sub>.
- 3 • **National Ambient Air Quality Standard (NAAQS):** Standards established  
4 by USEPA that apply for outdoor air throughout the United States (USEPA  
5 2006).
  - 6 • **Nonattainment Area:** A geographic area identified by the USEPA and/or  
7 ARB as not meeting either NAAQS or CAAQS for a given pollutant  
8 (ARB 2010).
  - 9 • **Precursor:** In photochemistry, a compound antecedent to a pollutant. For  
10 example, volatile organic compounds (VOC) and NO<sub>x</sub> react in sunlight to  
11 form the criteria pollutant ozone. As such, VOCs and NO<sub>x</sub> are precursors to  
12 O<sub>3</sub> (USEPA 2006).
  - 13 • **Reactive Organic Gas (ROG):** A photochemically reactive chemical gas  
14 composed of non-methane hydrocarbons (HCs) that may contribute to the  
15 formation of smog (ARB 2010). ROG may also be referred to as non-  
16 methane organic gases, VOCs, or HCs.
  - 17 • **State Implementation Plan (SIP):** A plan prepared by states and submitted  
18 to USEPA describing how each area will attain and maintain NAAQS. SIPs  
19 include the technical foundation for understanding the air quality (e.g.,  
20 emission inventories and air quality monitoring), control measures and  
21 strategies, and enforcement mechanisms (ARB 2010).
  - 22 • **Toxic Air Contaminant (TAC):** An air pollutant, identified in regulation by  
23 the ARB, which may cause or contribute to an increase in deaths or in serious  
24 illness, or which may pose a present or potential hazard to human health.  
25 Health effects of TACs may occur at extremely low levels and it is typically  
26 difficult to identify levels of exposure that do not produce adverse health  
27 effects (ARB 2010).

28 In California, local air districts have been established to oversee the attainment of  
29 air quality standards within air basins as defined by the State. Local air districts  
30 administer air quality laws and regulations within the air basins. The local air  
31 districts have permitting authority over all stationary sources of air pollutants  
32 within their district boundaries and provide the primary review of environmental  
33 documents prepared for projects with air quality issues.

### 34 **16.3 Regulatory Environment and Compliance** 35 **Requirements**

36 Potential actions that could be implemented under the alternatives evaluated in  
37 this EIS could affect future air quality conditions and the potential for GHG  
38 emissions. Implementation of the alternatives could affect CVP and SWP water  
39 deliveries which could affect air quality related to agricultural operations and  
40 fugitive dust generation. Changes in air quality and GHG emissions are analyzed

1 in this EIS relative to appropriate Federal and state agency policies and  
2 regulations, as described in Chapter 4, Approach to Environmental Analyses.

3 Several of the Federal and state laws and regulations that provide quantitative  
4 criteria to determine compliance also are summarized in this subsection of this  
5 chapter to provide context for information provided in the remaining sections of  
6 this chapter, including:

- 7 • Federal Clean Air Act
  - 8 – National Ambient Air Quality Standards and Federal Air Quality
  - 9 Designations
  - 10 – Federal General Conformity Requirements
- 11 • California Clean Air Act
- 12 • California Assembly Bill 32, California Global Warming Solutions Act
- 13 of 2006

#### 14 **16.3.1 Federal Clean Air Act**

15 National air quality policies are regulated through the Federal Clean Air Act  
16 (FCAA) of 1970 and its 1977 and 1990 amendments. Basic elements of the  
17 FCCA include NAAQS for criteria air pollutants, hazardous air pollutants  
18 standards, state attainment plans, motor vehicle emissions standards, stationary  
19 source emissions standards and permits, acid rain control measures, stratospheric  
20 ozone protection, and enforcement provisions.

##### 21 **16.3.1.1 National Ambient Air Quality Standards and Federal Air Quality** 22 **Designations**

23 Pursuant to the FCAA, the USEPA established NAAQS for O<sub>3</sub>, CO, NO<sub>2</sub>, sulfur  
24 dioxide (SO<sub>x</sub> as SO<sub>2</sub>), PM<sub>10</sub>, PM<sub>2.5</sub>, and lead. These pollutants are referred to as  
25 criteria pollutants because numerical health-based criteria have been established  
26 that define acceptable levels of exposure for each pollutant. The NAAQS and the  
27 CAAQS are summarized in Table 16.1 (ARB 2013).

1

**Table 16.1 Federal and State Ambient Air Quality Standards**

Pollutant	Averaging Time	National Standards <sup>a</sup> Primary <sup>b, i</sup>	National Standards <sup>a</sup> Secondary <sup>c, i</sup>	California Standards <sup>d</sup>
Ozone	8 Hour 1 Hour	0.075 ppm –	0.075 ppm –	0.07 ppm 0.09 ppm
Carbon monoxide	8 Hour 1 Hour	9 ppm 35 ppm	– –	9.0 ppm 20 ppm
Nitrogen dioxide <sup>j</sup>	Annual Arithmetic Mean 1 Hour	0.053 ppm 100 ppb	0.053 ppm –	0.30 ppm 0.18 ppm
Sulfur dioxide <sup>e</sup>	Annual Arithmetic Mean 24 Hour 3 Hour 1 Hour	0.030 ppm 0.14 ppm – 75 ppb	– – 0.5 ppm –	– 0.04 ppm – 0.25 ppm
PM <sub>10</sub> <sup>f</sup>	Annual Arithmetic Mean 24 Hour	– 150 µg/m <sup>3</sup>	– 150 µg/m <sup>3</sup>	20 µg/m <sup>3</sup> 50 µg/m <sup>3</sup>
PM <sub>2.5</sub> <sup>f</sup>	Annual Arithmetic Mean 24 Hour	12 µg/m <sup>3</sup> 35 µg/m <sup>3</sup>	15 µg/m <sup>3</sup> 35 µg/m <sup>3</sup>	12 µg/m <sup>3</sup> –
Sulfates	24 Hour	–	–	25 µg/m <sup>3</sup>
Lead <sup>g, k</sup>	30 Day Average Calendar Quarter Rolling 3-Month Average	– 1.5 µg/m <sup>3</sup> 0.15 µg/m <sup>3</sup>	– 1.5 µg/m <sup>3</sup> 0.15 µg/m <sup>3</sup>	1.5 µg/m <sup>3</sup> – –
Hydrogen sulfide	1 Hour	–	–	0.03 ppm
Vinyl chloride	24 Hour	–	–	0.01 ppm
Visibility-reducing particles	8 Hour	–	–	See Note <sup>h</sup>

2 Source: ARB 2012, ARB 2013b.

3 Notes:

4 a. National standards, other than ozone, particulate matter, and those based on annual  
5 averages or annual arithmetic means, are not to be exceeded more than once a year.  
6 The ozone standard is attained when the fourth highest eight hour concentration in a  
7 year, averaged over three years, is equal to or less than the standard. For PM<sub>10</sub>, the  
8 24-hour standard is attained when the expected number of days per calendar year with a  
9 24-hour average concentration above 150 µg/m<sup>3</sup> is equal to or less than one. For PM<sub>2.5</sub>,  
10 the 24-hour standard is attained when 98 percent of the daily concentrations, averaged  
11 over 3 years, are equal to or less than the standard.

12 b. National Primary Standards: The levels of air quality necessary, with an adequate  
13 margin of safety, to protect the public health.

- 1 c. National Secondary Standards: The levels of air quality necessary to protect the public  
2 welfare from any known or anticipated adverse effects of a pollutant.
- 3 d. California standards for ozone, carbon monoxide, sulfur dioxide (1-hour and 24-hour),  
4 nitrogen dioxide, suspended particulate matter (PM<sub>10</sub>, PM<sub>2.5</sub>, and visibility reducing  
5 particles), are values that are not to be exceeded. All others are not to be equaled or  
6 exceeded. All others are not to be equaled or exceeded. California ambient air quality  
7 standards are listed in the Table of Standards in Section 70200 of Title 17 of the  
8 California Code of Regulations.
- 9 e. On June 2, 2010, a new 1-hour SO<sub>2</sub> standard was established and the existing 24-hour  
10 and annual primary standards were revoked. To attain the 1-hour national standard, the  
11 3-year average of the annual 99th percentile of the 1-hour daily maximum concentrations  
12 at each site must not exceed 75 ppb. The 1971 SO<sub>2</sub> national standards (24-hour and  
13 annual) remain in effect until one year after an area is designated for the 2010 standard,  
14 except for areas designated nonattainment for the 1971 standards, where the 1971  
15 standards remain in effect until implementation plans to attain or maintain the 2010  
16 standards are approved.
- 17 f. On December 14, 2012, the national annual PM<sub>2.5</sub> primary standard was lowered from  
18 15 µg/m<sup>3</sup> to 12.0 µg/m<sup>3</sup>. The existing national 24-hour PM<sub>2.5</sub> standards (primary and  
19 secondary) were retained at 35 µg/m<sup>3</sup>, as was the annual secondary standard of  
20 15 µg/m<sup>3</sup>. The existing 24-hour PM<sub>10</sub> standards (primary and secondary) of 150 µg/m<sup>3</sup>  
21 also were retained. The form of the annual primary and secondary standards is the  
22 annual mean, averaged over 3 years.
- 23 g. The national standard for lead was revised on October 15, 2008, to a rolling 3-month  
24 average. The 1978 lead standard (1.5 µg/m<sup>3</sup> as a quarterly average) remains in effect  
25 until one year after an area is designated for the 2008 standard, except for areas  
26 designated nonattainment for the 1978 standard, where the 1978 standard remains in  
27 effect until implementation plans to attain or maintain the 2008 standard are approved.
- 28 h. In 1989, the ARB converted both the general statewide 10-mile visibility standard and  
29 the Lake Tahoe 30-mile visibility standard to instrumental equivalents, which are  
30 "extinction of 0.23 per kilometer" and "extinction of 0.07 per kilometer" for the statewide  
31 and Lake Tahoe Air Basin standards, respectively.
- 32 i. Concentration expressed first in units in which it was promulgated. Equivalent units  
33 given in parentheses are based upon a reference temperature of 25°C and a reference  
34 pressure of 760 torr. Most measurements of air quality are to be corrected to a reference  
35 temperature of 25°C and a reference pressure of 760 torr; ppm in this table refers to ppm  
36 by volume, or micromoles of pollutant per mole of gas.
- 37 j. To attain the 1-hour national standard, the 3-year average of the annual 98<sup>th</sup> percentile  
38 of the 1-hour daily maximum concentrations at each site must not exceed 100 ppb. Note  
39 that the national 1-hour standard is in units of parts per billion (ppb). California standards  
40 are in units of parts per million (ppm). To directly compare the national 1-hour standard  
41 to the California standards the units can be converted from ppb to ppm. In this case, the  
42 national standard of 100 ppb is identical to 0.100 ppm.
- 43 k. The ARB has identified lead and vinyl chloride as 'toxic air contaminants' with no  
44 threshold level of exposure for adverse health effects determined. These actions allow  
45 for the implementation of control measures at levels below the ambient concentrations  
46 specified for these pollutants.
- 47 µg/m<sup>3</sup> = micrograms per cubic meter.  
48 ppb = parts per billion (by volume).  
49 ppm = parts per million (by volume).

1 The USEPA designates areas as attainment, nonattainment, or unclassified for  
2 individual criteria pollutants depending on whether the areas achieve (i.e., attain)  
3 the applicable NAAQS for each pollutant. For some pollutants, there are  
4 numerous classifications of the nonattainment designation, depending on the  
5 severity of an area's nonattainment status. Areas that lack monitoring data are  
6 designated as unclassified areas, and considered as attainment areas for regulatory  
7 purposes.

8 Under the 1977 FCAA amendments, states (or areas within states) with ambient  
9 air quality concentrations that do not meet the NAAQS are required to develop  
10 and maintain SIPs. These implementation plans constitute a federally enforceable  
11 definition of the state's approach and schedule for the attainment of the NAAQS.  
12 If a nonattainment area achieves compliance, the area is classified as an  
13 attainment maintenance area for 20 years.

#### 14 **16.3.1.2 Federal General Conformity Requirements**

15 The 1977 FCAA amendments state that the Federal government is prohibited  
16 from engaging in, supporting, providing financial assistance for, licensing,  
17 permitting, or approving any activity that does not conform to an applicable SIP.  
18 In the 1990 FCAA amendments, the USEPA included provisions requiring  
19 Federal agencies to ensure that actions undertaken in nonattainment or attainment  
20 maintenance areas are consistent with applicable SIPs. The process of  
21 determining whether a Federal action is consistent with applicable SIPs is called  
22 "conformity" determination. A conformity determination is required only for the  
23 project alternative that is ultimately selected and approved. The USEPA general  
24 conformity regulation applies only to Federal actions that result in emissions of  
25 "nonattainment or maintenance pollutants" or their precursors in federally  
26 designated nonattainment or maintenance areas. The emission thresholds that  
27 trigger requirements of the general conformity regulation for Federal actions  
28 emitting nonattainment or maintenance pollutants, or their precursors, are called  
29 *de Minimis* levels, as summarized in Table 16.2.

1 **Table 16.2 General Conformity *de Minimis* Levels**

Pollutant	Area Type	Tons/Year
Ozone (VOC or NOx)	Serious nonattainment	50
	Severe nonattainment	25
	Extreme nonattainment	10
	Other areas outside an ozone transport region	100
Ozone (NOx)	Marginal and moderate nonattainment inside an ozone transport region	100
	Maintenance	100
Ozone (VOC)	Marginal and moderate nonattainment inside an ozone transport region	50
	Maintenance within an ozone transport region	50
	Maintenance outside an ozone transport region	100
Carbon monoxide, SO <sub>2</sub> and NO <sub>2</sub>	All nonattainment and maintenance	100
PM <sub>10</sub>	Serious nonattainment	70
	Moderate nonattainment and maintenance	100
PM <sub>2.5</sub> Direct emissions, SO <sub>2</sub> , NOx (unless determined not to be a significant precursor), VOC or ammonia (if determined to be significant precursors)	All nonattainment and maintenance	100
Lead (Pb)	All nonattainment and maintenance	25

2 Source: USEPA 2015b

3 **16.3.1.3 California Clean Air Act**

4 The California Clean Air Act (CCAA) provides the State with a comprehensive  
 5 framework for air quality planning regulation. Prior to passage of the CCAA,  
 6 Federal law contained the only comprehensive planning framework. The CCAA  
 7 requires attainment of state ambient air quality standards by the earliest  
 8 practicable date.

9 The FCAA requires adoption of SIPs for nonattainment areas to describe actions  
 10 that will be undertaken to achieve the NAAQS. In addition, the CCAA requires  
 11 local air districts in nonattainment areas to prepare and maintain Air Quality  
 12 Management Plans (AQMPs) to achieve compliance with CAAQS. These  
 13 AQMPs also serve as a basis for preparing the SIP for the State of California,

1 which must ultimately be approved by the USEPA and codified in the Code of  
2 Federal Register (CFR).

### 3 **16.4 Affected Environment**

4 This section describes the area of analysis, ambient air quality and conditions, and  
5 GHG emissions in the study area.

6 The air basins and air districts in California, including those in the study area, do  
7 not specifically align with the study area regions, as noted below and in the  
8 description of each air basin (ARB 2011a; ARB 2011b).

9 The discussion in this chapter area is organized by the study area regions and air  
10 basins. The study area regions include the following air basins and counties.

- 11 • Trinity River Region is located within portions of the North Coast Air Basin.
  - 12 – The Trinity River Region includes the area in Trinity County along the
  - 13 Trinity River from Trinity Lake to the confluence with the Klamath River;
  - 14 and the area in Humboldt and Del Norte counties along the Klamath River
  - 15 from the confluence with the Trinity River to the Pacific Ocean.
- 16 • Central Valley Region is located within portions of the Sacramento Valley,  
17 Mountain Counties, San Joaquin Valley, San Francisco Bay Area, Mojave  
18 Desert air basins.
  - 19 – The Central Valley Region includes all or portions the counties of Shasta,
  - 20 Plumas, Tehama, Glenn, Colusa, Butte, Sutter, Yuba, Nevada, Placer,
  - 21 El Dorado, Sacramento, Yolo, Solano, Napa, San Joaquin, Stanislaus,
  - 22 Merced, Madera, Fresno, Kings, Tulare, and Kern that are within the CVP
  - 23 and SWP service areas.
- 24 • San Francisco Bay Area Region is located within portions of the San  
25 Francisco Bay Area and North Central Coast air basins.
  - 26 – The San Francisco Bay Area Region includes portions of Contra Costa,
  - 27 Alameda, Santa Clara, and San Benito counties that are within the CVP
  - 28 and SWP service areas.
- 29 • Central Coast Region is located within portions of the South Central Coast  
30 Air Basin.
  - 31 – The Central Coast Region includes portions of San Luis Obispo and Santa
  - 32 Barbara counties served by the SWP.
- 33 • Southern California Region is located within portions of the South Central  
34 Coast, South Coast, San Diego, Mojave Desert, and Salton Sea air basins.
  - 35 – The Southern California Region includes portions of Ventura, Los
  - 36 Angeles, Orange, San Diego, Riverside, and San Bernardino counties
  - 37 served by the SWP.

### 16.4.1 Ambient Air Quality

Air quality conditions and potential impacts in the project area are evaluated and discussed qualitatively, rather than quantitatively. The following subsections briefly describe the existing air quality environmental setting by air basin for the project area. The counties within each air basin in the project area are presented in Table 16.3, along with non-attainment designations to characterize existing ambient air quality. Non-attainment designations indicate that concentrations of pollutants measured in ambient air exceed the applicable ambient air quality standards. As shown in Table 16.3, many of the counties included in the project area are designated as nonattainment for the Federal and/or State ozone and particulate matter standards. These air quality issues may be exacerbated under dry conditions because when irrigation water supplies are decreased, there is increased potential for the formation and transport of fugitive dust.

**Table 16.3 Pollutants Designated as Nonattainment Pursuant to Federal and State Ambient Air Quality Standards**

County	Air Basin	Air District	Federal Nonattainment Designations <sup>a</sup>	State Nonattainment Designations <sup>b</sup>
<b>Trinity River Region</b>				
Trinity	North Coast	North Coast Unified	–	–
Humboldt	North Coast	North Coast Unified	–	–
Del Norte	North Coast	North Coast Unified	–	–
<b>Central Valley Region</b>				
Shasta	Sacramento Valley	Shasta	–	Ozone, PM <sub>10</sub>
Tehama	Sacramento Valley	Tehama	Ozone (Tuscan Buttes area)	Ozone, PM <sub>10</sub>
Butte	Sacramento Valley	Butte	Ozone and PM <sub>2.5</sub> in Chico	Ozone, PM <sub>10</sub> , PM <sub>2.5</sub>
Glenn	Sacramento Valley	Glenn	–	PM <sub>10</sub>
Colusa	Sacramento Valley	Colusa	–	PM <sub>10</sub>
Yuba	Sacramento Valley	Feather River	–	Ozone, PM <sub>10</sub>
Sutter	Sacramento Valley	Feather River	Ozone	Ozone, PM <sub>10</sub>
Yolo	Sacramento Valley	Yolo-Solano	Ozone, PM <sub>2.5</sub>	Ozone, PM <sub>10</sub>
Sacramento	Sacramento Valley	Sacramento Metro	Ozone, PM <sub>2.5</sub>	Ozone, PM <sub>10</sub>



Chapter 16: Air Quality and Greenhouse Gas Emissions

<b>County</b>	<b>Air Basin</b>	<b>Air District</b>	<b>Federal Nonattainment Designations<sup>a</sup></b>	<b>State Nonattainment Designations<sup>b</sup></b>
Plumas	Mountain Counties	Northern Sierra	–	PM <sub>10</sub> PM <sub>2.5</sub> (Portola Valley)
Placer	Sacramento Valley, Mountain Counties, Lake Tahoe	Placer	Ozone, PM <sub>2.5</sub>	Ozone, PM <sub>10</sub>
El Dorado	Sacramento Valley, Mountain Counties, Lake Tahoe	El Dorado	Ozone, PM <sub>2.5</sub>	Ozone, PM <sub>10</sub>
San Joaquin	San Joaquin Valley	San Joaquin Valley	Ozone, PM <sub>2.5</sub>	Ozone, PM <sub>10</sub> , PM <sub>2.5</sub>
Stanislaus	San Joaquin Valley	San Joaquin Valley	Ozone, PM <sub>2.5</sub>	Ozone, PM <sub>10</sub> , PM <sub>2.5</sub>
Merced	San Joaquin Valley	San Joaquin Valley	Ozone, PM <sub>2.5</sub>	Ozone, PM <sub>10</sub> , PM <sub>2.5</sub>
Fresno	San Joaquin Valley	San Joaquin Valley	Ozone, PM <sub>2.5</sub>	Ozone, PM <sub>10</sub> , PM <sub>2.5</sub>
Madera	San Joaquin Valley	San Joaquin Valley	Ozone, PM <sub>2.5</sub>	Ozone, PM <sub>10</sub> , PM <sub>2.5</sub>
Kings	San Joaquin Valley	San Joaquin Valley	Ozone, PM <sub>2.5</sub>	Ozone, PM <sub>10</sub> , PM <sub>2.5</sub>
Tulare	San Joaquin Valley	San Joaquin Valley	Ozone, PM <sub>2.5</sub>	Ozone, PM <sub>10</sub> , PM <sub>2.5</sub>
Kern	San Joaquin Valley, Mojave Desert	San Joaquin Valley, Kern	Ozone, PM <sub>2.5</sub> , PM <sub>10</sub> (East Kern)	Ozone, PM <sub>10</sub> , PM <sub>2.5</sub> (San Joaquin Valley Air Basin)
<b>San Francisco Bay Area Region</b>				
Napa	San Francisco Bay Area	Bay Area	Ozone, PM <sub>2.5</sub>	Ozone, PM <sub>10</sub> , PM <sub>2.5</sub>
Solano	Sacramento Valley, San Francisco Bay Area	Yolo-Solano and Bay Area	Ozone, PM <sub>2.5</sub>	Ozone, PM <sub>10</sub> , PM <sub>2.5</sub>
Contra Costa	San Francisco Bay Area	Bay Area	Ozone, PM <sub>2.5</sub>	Ozone, PM <sub>10</sub> , PM <sub>2.5</sub>
Alameda	San Francisco Bay Area	Bay Area	Ozone, PM <sub>2.5</sub>	Ozone, PM <sub>10</sub> , PM <sub>2.5</sub>
Santa Clara	San Francisco Bay Area	Bay Area	Ozone, PM <sub>2.5</sub>	Ozone, PM <sub>10</sub> , PM <sub>2.5</sub>

County	Air Basin	Air District	Federal Nonattainment Designations <sup>a</sup>	State Nonattainment Designations <sup>b</sup>
San Benito	North Central Coast	Monterey Bay Unified	–	Ozone, PM <sub>10</sub>
<b>Central Coast Region</b>				
San Luis Obispo	South Central Coast	San Luis Obispo	Ozone (Eastern San Luis Obispo)	Ozone, PM <sub>10</sub>
Santa Barbara	South Central Coast	Santa Barbara	–	Ozone, PM <sub>10</sub>
<b>Southern California Region</b>				
Ventura	South Central Coast	Ventura	Ozone	Ozone, PM <sub>10</sub>
Los Angeles	South Coast, Mojave Desert	South Coast, Antelope Valley	Ozone, PM <sub>2.5</sub> , Lead	Ozone; PM <sub>10</sub> ; PM <sub>2.5</sub>
San Bernardino	South Coast, Mojave Desert	South Coast, Mojave Desert	Ozone, PM <sub>10</sub> , PM <sub>2.5</sub>	Ozone, PM <sub>10</sub> , PM <sub>2.5</sub>
Riverside	South Coast, Mojave Desert, Salton Sea	South Coast, Mojave Desert	Ozone, PM <sub>10</sub> , PM <sub>2.5</sub>	Ozone; PM <sub>10</sub> ; PM <sub>2.5</sub>
Orange	South Coast	South Coast	Ozone, PM <sub>2.5</sub>	Ozone, PM <sub>10</sub> , PM <sub>2.5</sub>
San Diego	San Diego County	San Diego	Ozone	Ozone, PM <sub>10</sub> , PM <sub>2.5</sub>

1 Sources: USEPA 2014; ARB 2015

2 Notes:

3 a. Areas designated as nonattainment by U.S. Environmental Protection Agency related  
4 to National Ambient Air Quality Standards as of January 30, 2015.

5 b. Areas designated as nonattainment by California Air Resources Board related to  
6 California Ambient Air Quality Standards as of April 10, 2014. No changes to the state  
7 area designations were proposed for 2014.

#### 8 **16.4.1.1 North Coast Air Basin**

9 The North Coast Air Basin includes Humboldt, Del Norte, Trinity, Mendocino,  
10 and north Sonoma counties (ARB 2013a). This air basin is located within the  
11 Trinity River Region of the study area. The basin is sparsely populated, and  
12 stretches along the northern coastline through forested mountains. Prevailing  
13 winds blow clean air inland from the Pacific Ocean, and air quality is typically  
14 good. Humboldt, Del Norte, and Trinity counties are designated attainment for  
15 the federal and state air quality standards (USEPA 2015b, ARB 2014).

1     **16.4.1.2 Sacramento Valley Air Basin**

2     The Sacramento Valley Air Basin encompasses 9 air districts and 11 counties,  
3     including: all of Shasta, Tehama, Glenn, Colusa, Butte, Sutter, Yuba, Sacramento,  
4     and Yolo counties; the westernmost portion of Placer County; and the  
5     northeastern half of Solano County. The air basin is bounded by tall mountains,  
6     including the Coast Range to the west, the Cascade Range to the north, and the  
7     Sierra Nevada Range to the east. This air basin is located within the northern  
8     portion of the Central Valley Region of the study area.

9     Winters are wet and cool, and summers are hot and dry. When air stagnates, or is  
10    trapped by an inversion layer in the valley, ambient pollutant concentrations can  
11    reach or exceed threshold levels. On-road vehicles are the largest source of smog-  
12    forming pollutants, and particulate matter emissions are primarily from area  
13    sources, such as fugitive dust from paved and unpaved roads and vehicle travel  
14    (ARB 2013a).

15    To characterize the existing ambient air quality in the Sacramento Valley Air  
16    Basin, data from area monitoring stations were reviewed (ARB 2011d). For the  
17    three years from 2007 to 2009, monitoring data indicated the following:

- 18    • Concentrations of O<sub>3</sub> and 24-hour PM<sub>2.5</sub> have exceeded the NAAQS and  
19    CAAQS.
- 20    • Concentrations of PM<sub>10</sub> have exceeded the CAAQS but are below the  
21    NAAQS.
- 22    • Measured concentrations of CO and NO<sub>2</sub> have complied with the NAAQS and  
23    CAAQS.
- 24    • Monitored SO<sub>2</sub> concentrations are extremely low, and lead concentrations are  
25    monitored as part of the air toxics program.

26    In the time since ARB compiled the 2007 to 2009 air quality monitoring data  
27    reported above, Glenn and Colusa counties have been redesignated as attainment  
28    for the California ozone standards (ARB 2014). In addition, Sacramento County  
29    has been redesignated as attainment for the California PM<sub>2.5</sub> standards (ARB  
30    2014). No other changes in air quality nonattainment designations have been  
31    recorded (USEPA 2014; ARB 2014).

32    **16.4.1.3 Mountain Counties Air Basin**

33    The Mountain Counties Air Basin includes the mountainous areas of the central  
34    and northern Sierra Nevada Mountains, from Plumas County south to Mariposa  
35    County, including Plumas, Sierra, Nevada, Central Placer, West El Dorado,  
36    Amador, Calaveras, Tuolumne, and Mariposa counties (ARB 2013a). This air  
37    basin includes portions of the central-eastern Central Valley Region of the study  
38    area; as well as areas located to the east of the study area.

39    Sparsely populated, motor vehicles are the primary source of emissions in the air  
40    basin. Air quality issues often result when eastward surface winds transport  
41    pollution from more populated air basins to the west and south. Wood smoke  
42    from stoves and fireplaces contribute to elevated ambient PM<sub>10</sub> concentrations

1 during winter. Nevada, Placer, El Dorado, Amador, Calaveras, Tuolumne, and  
 2 Mariposa counties are designated as nonattainment for the Federal and State  
 3 ozone standards (ARB 2014). Plumas, Sierra, Nevada, Placer, El Dorado, and  
 4 Calaveras counties are designated as nonattainment for the State PM<sub>10</sub> standards  
 5 (ARB 2014).

#### 6 **16.4.1.4 San Joaquin Valley Air Basin**

7 The San Joaquin Valley Air Basin encompasses eight counties, including: all of  
 8 San Joaquin, Stanislaus, Madera, Merced, Fresno, Kings, Tulare counties; and  
 9 western Kern County. It is bounded on the west by the Coast Range, on the east  
 10 by the Sierra Nevada, and in the south by the Tehachapi Mountains. This air  
 11 basin is located within the central and southern portions of the Central Valley  
 12 Region of the study area.

13 Winters are cool and wet and summers are dry and very hot. The area is heavily  
 14 agricultural, and hosts other localized industries such as forest products, oil and  
 15 gas production, and oil refining. On-road vehicles are the largest source of smog-  
 16 forming pollutants, and PM<sub>10</sub> emissions are primarily from sources such as  
 17 agricultural operations and fugitive dust from paved and unpaved roads and  
 18 vehicle travel (ARB 2013a). Air quality issues may be exacerbated under dry  
 19 conditions. When water supplies and irrigation levels are decreased in urban,  
 20 rural, and agricultural areas, there is increased potential for the formation and  
 21 transport of fugitive dust.

22 To characterize the existing ambient air quality for the San Joaquin Valley Air  
 23 Basin, data from area monitoring stations were reviewed (ARB 2011d). For the  
 24 three years from 2007 to 2009, monitoring data indicated the following:

- 25 • Concentrations of O<sub>3</sub> and 24-hour PM<sub>2.5</sub> have exceeded the NAAQS and  
 26 CAAQS.
- 27 • Concentrations of PM<sub>10</sub> have exceeded the CAAQS but are below the  
 28 NAAQS.
- 29 • Measured concentrations of CO and NO<sub>2</sub> have complied with the NAAQS and  
 30 CAAQS.
- 31 • Monitored SO<sub>2</sub> concentrations are extremely low, and lead concentrations are  
 32 monitored as part of the air toxics program.

33 In the time since ARB compiled the 2007 to 2009 air quality monitoring data  
 34 reported above, no changes in air quality nonattainment designations have been  
 35 recorded in the San Joaquin Valley Region counties in this study (USEPA 2015;  
 36 ARB 2014).

#### 37 **16.4.1.4.1 Dust and Particulate Matter in San Joaquin Valley**

38 The San Joaquin Valley Air Pollution Control District (SJVAPCD) is the local  
 39 regulatory agency with jurisdiction over air quality issues in the San Joaquin  
 40 Valley area. In response to the area's historical air quality problems with dust and  
 41 particulate matter, the SJVAPCD was the first agency in the state to regulate

1 emissions from on-field agricultural operations. In 2004, the agency adopted  
2 Rule 4550, the Conservation Management Practices rule, and Rule 3190, the  
3 Conservation Management Practices Fee rule. To comply with these rules,  
4 farmers with 100 acres or more of contiguous land must prepare and implement  
5 biennial Conservation Management Plans to reduce dust and particulate matter  
6 emissions from on-farm sources, such as unpaved roads and equipment yards,  
7 land preparation, harvest activities, and other farming activities. A handbook  
8 titled “Agricultural Air Quality Conservation Management Practices for San  
9 Joaquin Valley Farms” was published by the agriculture industry in 2004 to  
10 provide guidance to farmers on Conservation Management Practices (SJVAPCD  
11 2004a, 2004b). Examples of Conservation Management Practices include  
12 activities that reduce or eliminate the need for soil disturbance, activities that  
13 protect soil from wind, dust suppressants, alternatives to burning agricultural  
14 wastes, and reduced travel speeds on unpaved roads and equipment yards. Lands  
15 not currently under cultivation or used for pasture are exempt from Rule 4550,  
16 other than recordkeeping to document the exemption. Fees vary depending on the  
17 size of the farm, and include an initial application fee, and a biennial renewal fee.

18 In addition to requirements for on-field agricultural practices, the SJVAPCD rules  
19 and regulations address avoidance of nuisance conditions (Rule 4102),  
20 prohibitions on opening burning (Rule 4103), and fugitive-dust control  
21 (Regulation VIII). Specifically, the SJVAPCD dust-control rules include  
22 Rule 8021 for control of PM<sub>10</sub> from construction, demolition, excavation,  
23 extraction, and other earth moving activities; Rule 8031 for control of PM<sub>10</sub> from  
24 handling and storage of bulk materials; Rule 8051 for control of PM<sub>10</sub> from  
25 disturbed open areas; Rule 8061 for control of PM<sub>10</sub> from travel on paved and  
26 unpaved roads; Rule 8071 for control of PM<sub>10</sub> from unpaved vehicle and  
27 equipment traffic areas; and Rule 8081 for off-field agricultural sources, such as  
28 bulk materials handling and transport and travel on unpaved roads. Each of these  
29 rules requires fugitive dust control, often through application of water, gravel, or  
30 chemical dust stabilizers.

#### 31 **16.4.1.5 San Francisco Bay Area Air Basin**

32 The San Francisco Bay Area Air Basin consists of a single air district and nine  
33 counties, including: all of Napa, Marin, San Francisco, Contra Costa, Alameda,  
34 San Mateo, and Santa Clara counties; the southern portion of Sonoma County;  
35 and the southwestern portion of Solano County (ARB 2013a). The hills of the  
36 Coast Range bound the San Francisco and San Pablo bays and the inland valleys  
37 of the air basin. This air basin includes the San Francisco Bay Area Region of the  
38 study area.

39 The San Francisco Bay Area Air Basin includes the second largest urban area in  
40 California, hosting industry, airports, international ports, freeways, and surface  
41 streets. On-road vehicles are the largest source of smog-forming pollutants, and  
42 PM<sub>10</sub> emissions are primarily from area sources, such as fugitive dust from paved  
43 and unpaved roads and vehicle travel (ARB 2013a). Air quality in the San  
44 Francisco Bay Area is often good as sea breezes blow clean air from the Pacific  
45 Ocean into the air basin, but transport of pollutants from the San Francisco Bay

1 Area can exacerbate air quality problems in the downwind portions of the  
 2 San Francisco Bay Area Air Basin; as well as in the Sacramento Valley and San  
 3 Joaquin Valley air basins.

4 To characterize the existing ambient air quality for the San Francisco Bay Area  
 5 Air Basin, data from area monitoring stations were reviewed (ARB 2011d). For  
 6 the three years from 2007 to 2009, monitoring data indicated the following:

- 7 • Concentrations of O<sub>3</sub> and 24-hour PM<sub>2.5</sub> have exceeded the NAAQS and  
 8 CAAQS.
- 9 • Concentrations of PM<sub>10</sub> exceeded the CAAQS in 2008 but were below the  
 10 CAAQS in 2007 and 2009. Concentrations of PM<sub>10</sub> were below the NAAQS.
- 11 • Measured concentrations of CO and NO<sub>2</sub> have complied with the NAAQS and  
 12 CAAQS.
- 13 • Monitored SO<sub>2</sub> concentrations are extremely low, and lead concentrations are  
 14 monitored as part of the air toxics program.

15 In the time since ARB compiled the 2007 to 2009 air quality monitoring data  
 16 reported above, no changes in air quality nonattainment designations have been  
 17 recorded in the San Francisco Bay Region counties in this study (USEPA 2015;  
 18 ARB 2014).

#### 19 **16.4.1.6 North Central Coast Air Basin**

20 The North Central Coast Air Basin includes Santa Cruz, San Benito and Monterey  
 21 counties (ARB 2013a). This air basin includes San Benito County which is  
 22 located within the San Francisco Bay Area Region of the study area.

23 The North Central Coast Air Basin is in attainment for all NAAQS, and is  
 24 designated as nonattainment for the State ozone and PM<sub>10</sub> standards (ARB 2014).  
 25 Though separated by the Santa Cruz Mountains and Coast Ranges to the north,  
 26 wind can transport air pollution from the San Francisco Bay Area Air Basin and  
 27 contribute to elevated ozone concentrations in the area (ARB 2013a).

#### 28 **16.4.1.7 South Central Coast Air Basin**

29 The South Central Coast Air Basin includes San Luis Obispo, Santa Barbara and  
 30 Ventura counties. It is bordered by the Pacific Ocean on the south and west and  
 31 lies just north of the highly populated South Coast Air Basin. This air basin  
 32 includes the Central Coast Region and the northern Southern California Region of  
 33 the study area.

34 Sources of pollutants in the air basin include power plants, oil production and  
 35 refining, vehicle travel, and agricultural operations. San Luis Obispo, Santa  
 36 Barbara, and Ventura counties are designated as nonattainment for the State ozone  
 37 and PM<sub>10</sub> standards. Eastern San Luis Obispo and Ventura counties are  
 38 designated as nonattainment for the Federal ozone standard (USEPA 2015).  
 39 Wind patterns link Ventura and Santa Barbara counties, resulting in pollutant  
 40 transport between the South Central Coast and South Coast air basins. San Luis  
 41 Obispo County is separated from these counties by mountains, and the air quality

1 in San Luis Obispo County is linked more with conditions in the San Francisco  
2 Bay Area Air Basin and San Joaquin Valley Air Basin. Additionally, air  
3 emissions from the South Coast Air Basin can be blown offshore, and then carried  
4 to the coastal cities of the South Central Coast Air Basin. Under some conditions,  
5 the reverse air flow can carry pollutants from the South Central Coast Air Basin to  
6 the South Coast Air Basin and contribute to ozone violations there (ARB 2013a).

7 **16.4.1.8 South Coast Air Basin**

8 The South Coast Air Basin is California's largest metropolitan region. The area  
9 includes the southern two-thirds of Los Angeles County, all of Orange County,  
10 and the western urbanized portions of Riverside and San Bernardino counties.  
11 The South Coast Air Basin is bounded by the Pacific Ocean on the west and by  
12 mountains on the other three sides. This air basin includes the western-central  
13 portion of the Southern California Region of the study area.

14 The area includes industry, airports, international ports, freeways, and surface  
15 streets. On-road vehicles are the largest source of smog-forming pollutants, and  
16 PM<sub>10</sub> emissions are primarily from area sources, such as fugitive dust from paved  
17 and unpaved roads and vehicle travel (ARB 2013a). One-third of the state's total  
18 criteria pollutant emissions are generated within the basin (ARB 2013a). The  
19 pollutant emissions and fugitive dust generated in the South Coast Air Basin  
20 affects other air basins. For example, fugitive dust generated in the South Coast  
21 Air Basin contributes to poor air quality in the Salton Sea Air Basin and the  
22 Coachella Valley portion of Riverside County (USGS 2014).

23 The persistent high pressure system and frequent low inversion heights caused by  
24 the surrounding mountains on three sides of the air basin trap pollutants in the air  
25 basin (ARB 2013a). Sunny weather contributes to smog formation. Portions of  
26 the South Coast Air Basin are designated as nonattainment for the Federal and  
27 State ozone, PM<sub>10</sub>, and PM<sub>2.5</sub> standards (ARB 2014; USEPA 2015). Wind often  
28 transports air pollutants from the South Coast Air Basin to nearby air basins.

29 **16.4.1.9 Mojave Desert Air Basin**

30 The sparsely populated Mojave Desert Air Basin covers most of California's high  
31 desert and is made up of eastern Kern and Riverside counties and northern Los  
32 Angeles and San Bernardino counties. The San Gabriel and San Bernardino  
33 mountains lie to the south, separating the Mojave Desert Air Basin from the South  
34 Coast Air Basin. To the northwest, the Tehachapi Mountains separate the Mojave  
35 Desert Air Basin from the San Joaquin Valley Air Basin. This air basin includes  
36 the southeastern portion of the Central Valley Region and the northeastern portion  
37 of the Southern California Region of the study area.

38 The primary sources of air pollution in the air basin are military bases, highways,  
39 railroads, cement manufacturing, and mineral processing (ARB 2013a). The  
40 Mojave Desert Air Basin also is affected by air quality conditions in the San  
41 Joaquin Valley and South Coast air basins. Air from the South Coast Air Basin is  
42 transported over the San Gabriel Mountains, heavily impacting the areas of the  
43 Mojave Desert Air Basin located to the north of the South Coast Air Basin.

1 The Mojave Desert Air Basin also is located downwind of the San Joaquin Valley  
2 Air Basin; and the winds pass through the Tehachapi Mountains carrying air  
3 emissions from the San Joaquin Valley Air Basin. Due to the impacts from the  
4 South Coast Air Basin, the worst air quality in the Mojave Desert Air Basin is  
5 along the southern edge that borders the South Coast Air Basin. This is also  
6 where most of the population within the Mojave Desert Air Basin is located  
7 (ARB 2013a).

8 Portions of the Mojave Desert Air Basin are designated as nonattainment for the  
9 Federal and State ozone and PM<sub>10</sub> standards (ARB 2014; USEPA 2015).

#### 10 **16.4.1.10 San Diego Air Basin**

11 The San Diego Air Basin is in the southwest corner of California and comprises  
12 all of San Diego County. This air basin includes the southwestern portion of the  
13 Southern California Region of the study area.

14 The population and emissions are concentrated in the western portion of the air  
15 basin, which is bordered on the west by the Pacific Ocean. The climate is  
16 relatively mild near the ocean, with higher temperatures and seasonal variations  
17 further inland (ARB 2013a).

18 The air basin includes industrial facilities, airports, an international port,  
19 freeways, and surface streets. The San Diego Air Basin is designated as  
20 nonattainment for the Federal ozone standard and the State ozone, PM<sub>10</sub>, and  
21 PM<sub>2.5</sub> standards (ARB 2014). Air quality in the San Diego Air Basin is impacted  
22 not only by local emission sources, but also from transport of air emissions from  
23 the South Coast Air Basin and Mexico.

#### 24 **16.4.1.11 Salton Sea Air Basin**

25 The Salton Sea Air Basin is in the southeast corner of California and includes all  
26 of Imperial County and central Riverside County. The air basin is characterized  
27 by flat terrain and the Salton Sea surrounded by high mountains to the west, north,  
28 and east. The southern portion of the air basin extends towards the Gulf of  
29 California. The flat terrain and strong temperature differentials created by intense  
30 heating and cooling patterns produce moderate winds and deep thermal  
31 circulation systems which disperse local air emissions (DWR 2006). This air  
32 basin includes the northeastern portion of the Southern California Region of the  
33 study area.

34 The primary sources of air pollution are from vehicles and equipment exhaust and  
35 particulate matter from disturbed soils and wind erosion. The Salton Sea Air  
36 Basin is designated as nonattainment for the Federal and State ozone and PM<sub>10</sub>  
37 standards (ARB 2014; USEPA 2015). Portions of the Salton Sea Air Basin  
38 located outside of the study area near Calexico also are in nonattainment for PM<sub>2.5</sub>  
39 standards.



1 **16.4.2 Existing Greenhouse Gases and Emissions Sources**

2 This subsection presents an overview of the greenhouse effect and climate  
3 change, and potential sources of GHG emissions and information related to  
4 climate change and GHG emissions in California. GHG emissions and their  
5 climate-related impacts are not limited to specific geographic locations, but occur  
6 on global or regional scales. GHG emissions contribute cumulatively to the  
7 overall heat-trapping capability of the atmosphere, and the effects of the warming,  
8 such as climate change, are manifested in different ways across the planet.

9 **16.4.2.1 Greenhouse Gas Emissions Regulations and Analyses**

10 Global warming is the name given to the increase in the average temperature of  
11 the Earth's near-surface air and oceans since the mid-20th century and its  
12 projected continuation. Warming of the climate system is now considered to be  
13 unequivocal (DWR 2010) with global surface temperature increasing  
14 approximately 1.33°F over the last one hundred years. Continued warming is  
15 projected to increase global average temperature between 2 and 11 degrees  
16 Fahrenheit (°F) over the next one hundred years.

17 The causes of this warming have been identified as both natural processes and as  
18 the result of human actions. The Intergovernmental Panel on Climate Change  
19 (IPCC) concludes that variations in natural phenomena such as solar radiation and  
20 volcanoes produced most of the warming from pre-industrial times to 1950 and  
21 had a small cooling effect afterward. However, after 1950, increasing GHGs  
22 concentrations resulting from human activity such as fossil fuel burning and  
23 deforestation have been responsible for most of the observed temperature  
24 increase. These basic conclusions have been endorsed by more than 45 scientific  
25 societies and academies of science, including all of the national academies of  
26 science of the major industrialized countries.

27 Increases in GHG concentrations in the Earth's atmosphere are thought to be the  
28 main cause of human-induced climate change. GHGs naturally trap heat by  
29 impeding the exit of solar radiation that has hit the Earth and is reflected back into  
30 space. Some GHGs occur naturally and are necessary for keeping the Earth's  
31 surface inhabitable. However, increases in the concentrations of these gases in  
32 the atmosphere during the last hundred years have decreased the amount of solar  
33 radiation that is reflected back into space, intensifying the natural greenhouse  
34 effect and resulting in the increase of global average temperature (DWR 2010).

35 The principal GHGs considered in this EIS are CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, SF<sub>6</sub>, PFC, and  
36 HFC, in accordance with the California Health and Safety Code section 38505(g)  
37 (DWR 2010). Each of the principal GHGs has a long atmospheric lifetime (one  
38 year to several thousand years). In addition, the potential heat-trapping ability of  
39 each of these gases varies significantly from one another, and also vary over time.  
40 For example, CH<sub>4</sub> is 25 times as potent as CO<sub>2</sub>; while SF<sub>6</sub> is 32,800 times more  
41 potent than CO<sub>2</sub> with a 100-year time horizon (IPCC 2007).

42 The primary man-made processes that release these gases include: burning of  
43 fossil fuels for transportation, heating and electricity generation; agricultural  
44 practices that release CH<sub>4</sub>, such as livestock grazing and crop residue

1 decomposition; and industrial processes that release smaller amounts of high  
 2 global warming potential gases such as SF<sub>6</sub>, PFCs, and HFCs (DWR 2010).  
 3 Deforestation and land cover conversion have also been identified as contributing  
 4 to global warming by reducing the Earth's capacity to remove CO<sub>2</sub> from the air  
 5 and altering the Earth's albedo or surface reflectance, allowing more solar  
 6 radiation to be absorbed.

#### 7 **16.4.2.2 An Overview of the Greenhouse Effect**

8 The greenhouse effect is a natural phenomenon that is essential to keeping the  
 9 Earth's surface warm (DWR 2010). Like a greenhouse window, GHGs allow  
 10 sunlight to enter and then prevent heat from leaving the atmosphere. Solar  
 11 radiation enters the Earth's atmosphere from space. A portion of this radiation is  
 12 reflected by particles in the atmosphere back into space, and a portion is absorbed  
 13 by the Earth's surface and emitted back into space. The portion absorbed by the  
 14 Earth's surface and emitted back into space is emitted as lower-frequency infrared  
 15 radiation. This infrared radiation is absorbed by various GHGs present in the  
 16 atmosphere. While these GHGs are transparent to the incoming solar radiation,  
 17 they are effective at absorbing infrared radiation emitted by the Earth's surface.  
 18 Therefore, some of the lower-frequency infrared radiation emitted by the Earth's  
 19 surface is retained in the atmosphere, creating a warming of the atmosphere.

#### 20 **16.4.2.2.1 Global Climate Trends and Associated Impacts**

21 The rate of increase in global average surface temperature over the last hundred  
 22 years has not been consistent (DWR 2010). The last three decades have warmed  
 23 at a much faster rate than the previous seven decades – on average 0.32°F per  
 24 decade. Eleven of the twelve years from 1995 to 2006, rank among the twelve  
 25 warmest years in the instrumental record of global average surface temperature  
 26 since 1850.

27 Increased global warming has occurred concurrent with many other changes have  
 28 occurred in other natural systems (DWR 2010). Global sea levels have risen on  
 29 average 1.8 millimeters per year; precipitation patterns throughout the world have  
 30 shifted, with some areas becoming wetter and other drier; tropical storm activity  
 31 in the North Atlantic has increased; peak runoff timing of many glacial and snow  
 32 fed rivers has shifted earlier; as well as numerous other observed conditions.  
 33 Though it is difficult to prove a definitive cause and effect relationship between  
 34 global warming and other observed changes to natural systems, there is high  
 35 confidence in the scientific community that these changes are a direct result of  
 36 increased global temperatures.

#### 37 **16.4.2.2.2 Overview of Greenhouse Gas Emission Sources**

38 Naturally occurring GHGs include water vapor, CO<sub>2</sub>, methane, and nitrous oxide.  
 39 Water vapor is introduced to the atmosphere from oceans and the natural  
 40 biosphere. Water vapor introduced directly to the atmosphere from agricultural or  
 41 other activities is not long lived, and thus does not contribute substantially to a  
 42 warming effect (NAS 2005). Carbon and nitrogen contained in CO<sub>2</sub>, methane,  
 43 and nitrous oxide naturally cycle from gaseous forms to organic biomass through

1 processes such as plant and animal respiration and seasonal cycles of plant growth  
2 and decay (USEPA 2012). Although naturally occurring, the emissions and  
3 sequestration of these gases are also influenced by human activities, and in some  
4 cases, are caused by human activities (anthropogenic). In addition to these  
5 GHGs, several classes of halogenated substances that contain fluorine, chlorine,  
6 or bromine also contribute to the greenhouse effect. However, these compounds  
7 are the product of industrial activities for the most part.

8 Each of the GHGs has a different capacity to trap heat in the atmosphere, with  
9 some of these gases being more effective at trapping heat than others. For  
10 calculating emissions, ARB (ARB 2007) uses a metric developed by the IPCC to  
11 account for these differences and to provide a standard basis for calculations. The  
12 metric, called the global warming potential (GWP), is used to compare the future  
13 climate impacts of emissions of various long-lived GHGs. The GWP of each  
14 GHG is indexed to the heat-trapping capability of CO<sub>2</sub>, and allows comparison of  
15 the global warming influence of each GHG relative to CO<sub>2</sub>. The GWP is used to  
16 translate emissions of each GHG to emissions of carbon dioxide equivalents, or  
17 CO<sub>2</sub>e. In this way, emissions of various GHGs can be summed, and total GHG  
18 emissions can be inventoried in common units of metric tons per year of CO<sub>2</sub>e.  
19 Most international inventories, including the United States inventory, use GWP  
20 values from the IPCC Fourth Assessment Report, per international consensus  
21 (IPCC 2007; USEPA 2012).

22 CO<sub>2</sub> is a byproduct of burning fossil fuels and biomass, as well as land-use  
23 changes and other industrial processes (USEPA 2012). It is the principal  
24 anthropogenic GHG that contributes to the Earth's radiative balance, and it  
25 represents the dominant portion of GHG emissions from activities that result from  
26 the combustion of fossil fuels (e.g., construction activities, electrical generation,  
27 and transportation).

#### 28 **16.4.2.3 California Climate Trends and Greenhouse Gas Emissions**

29 Maximum (daytime) and minimum (nighttime) temperatures are increasing  
30 almost everywhere in California but at different rates. The annual minimum  
31 temperature averaged over all of California has increased 0.33°F per decade  
32 during the period 1920 to 2003, while the average annual maximum temperature  
33 has increased 0.1°F per decade (DWR 2010).

34 With respect to California's water resources, the most significant impacts of  
35 global warming have been changes to the water cycle and sea level rise. Over the  
36 past century, the precipitation mix between snow and rain has shifted in favor of  
37 more rainfall and less snow, and snow pack in the Sierra Nevada is melting earlier  
38 in the spring (DWR 2010). The average early spring snowpack in the Sierra  
39 Nevada has decreased by about 10 percent during the last century, a loss of  
40 1.5 million acre-feet of snowpack storage. These changes have significant  
41 implications for water supply, flooding, aquatic ecosystems, energy generation,  
42 and recreation throughout the state.

1 During the same period, sea levels along California's coast have risen. The Fort  
 2 Point tide gauge in San Francisco was established in 1854 and is the longest  
 3 continually monitored gauge in the United States. Sea levels measured at this  
 4 gauge and two other west coast gauges indicate that the sea levels have risen at an  
 5 average rate of about 7.9 inches/century (0.08 inch/year) over the past 150 years  
 6 (BCDC 2011). Continued sea level rise associated with global warming may  
 7 threaten coastal lands and infrastructure, increase flooding at the mouths of rivers,  
 8 place additional stress on levees in the Sacramento-San Joaquin Delta, and  
 9 intensify the difficulty of managing the Sacramento-San Joaquin Delta as the  
 10 heart of the state's water supply system (DWR 2010).

#### 11 **16.4.2.3.1 Potential Effects of Global Climate Change in California**

12 Warming of the atmosphere has broad implications for the environment. In  
 13 California, one of the effects of climate change could be increases in temperature  
 14 that could affect the timing and quantity of precipitation. California receives most  
 15 of its precipitation in the winter months, and a warming environment would raise  
 16 the elevation of snow pack and result in reduced spring snowmelt and more  
 17 winter runoff. These effects on precipitation and water storage in the snow pack  
 18 could have broad implications on the environment in California.

19 The following are some of the potential effects of a warming climate in California  
 20 (California Climate Change Portal 2007):

- 21 • Loss of snowpack storage will cause increased winter runoff that generally  
 22 would not be captured and stored because of the need to reserve flood  
 23 capacity in reservoirs during the winter.
- 24 • Less spring runoff would mean lower early summer storage at major  
 25 reservoirs, which would result in less hydroelectric power production.
- 26 • Higher temperatures and reduced snowmelt would compound the problem of  
 27 providing suitable cold water habitat for salmonid species. Lower reservoir  
 28 levels would also contribute to this problem, reducing the flexibility of cold  
 29 water releases.
- 30 • Sea level rise would affect the Delta, worsening existing levee problems,  
 31 causing more saltwater intrusion, and adversely affecting many coastal  
 32 marshes and wildlife reserves. Release of water to streams to meet water  
 33 quality requirements could further reduce storage levels.
- 34 • Increased temperatures would increase the agricultural demand for water and  
 35 increase the level of stress on native vegetation, potentially allowing for an  
 36 increase in pest and insect epidemics and a higher frequency of large,  
 37 damaging wildfires.

38 Future climate scenarios have also been evaluated in the U.S. Global Change  
 39 Research Program National Climate Assessments. The most recent assessment,  
 40 *Climate Change Impacts in the United States*, was released in May 2014  
 41 (USGCRP 2014). For the Southwest Region of the United States, the report  
 42 projects that water supply availability would be reduced as compared to recent

1 conditions due to reduced snowpack and declining stream flows. Rising  
 2 temperatures in the future would increase disruptions to electricity generation  
 3 which could further reduce water availability. The National Climate Assessment  
 4 also indicates that mitigation policies and other factors have lowered the United  
 5 States' nationwide GHG emissions in recent years; however, substantial global  
 6 emissions reductions are needed to avoid many of the predicted consequences. A  
 7 considerable amount of planning for resilience and adaptation is underway, but  
 8 implementation of adaptive measures have been limited in scope.

9 **16.4.2.3.2 Current California Emission Sources**

10 The recent California's GHG emission inventory was released on April 6, 2012,  
 11 with data updated through October 2011. The GHG emissions in California have  
 12 been estimated for each year from 2000 to 2009, and are reported for several large  
 13 sectors of emission sources. The estimates for 2009 are summarized in  
 14 Table 16.4, reported by sector as millions of tons per year of CO<sub>2</sub> (ARB 2011e).

15 **Table 16.4 California Greenhouse Gas Emissions by Sector in 2009**

Sector	Total Emissions (million tons/year of CO <sub>2</sub> e)	Percent of Statewide Total Gross Emissions <sup>a</sup>
Agriculture	32.1	7
Commercial and Residential	43	9.4
Electric Power	103.6	22.7
Forestry (excluding CO <sub>2</sub> sinks)	0.2	< 1.0
Industrial	81.4	17.8
Recycling and Waste	7.3	1.6
Transportation	172.9	37.9
High Global Warming Potential substance and ozone-depleting substance use <sup>b</sup>	16.3	3.6
<b>Total</b>	<b>456.8</b>	<b>100</b>
Forestry Net Emissions	-3.8	-

16 Source: ARB 2011e.

17 Notes:

18 a. Based on the 456.8 million tons/year of CO<sub>2</sub>e Total Gross Emissions estimate.

19 b. High Global Warming Potential substance and ozone-depleting substance use are not  
 20 attributed to an individual sector.

21 Total gross statewide GHG emissions in 2009 were estimated to be 456.8 million  
 22 tons per year of CO<sub>2</sub>e. The two largest sectors contributing to emissions in  
 23 California are transportation and electric power (the latter sector includes both  
 24 in-state generation and imported electricity). The agricultural sector represents  
 25 only 7 percent of the total gross statewide emissions.

1 The agricultural sector includes manure management, enteric fermentation,  
 2 agricultural residue burning, and soils management. The forestry sector  
 3 contributes to overall emissions, but is a net sink of emissions.

4 The California Global Warming Solutions Act of 2006 (California Assembly  
 5 Bill 32) requires California to reduce statewide emissions to 1990 levels by 2020.

6 In December 2007, ARB adopted an emission limit for 2020 of 427 million tons  
 7 per year of CO<sub>2</sub>e. Increases in the stateside renewable energy portfolio and  
 8 reductions in importation of coal-based electrical power will contribute to meeting  
 9 California's near-term GHG emission reduction goals. The ARB estimates that a  
 10 reduction of 169 million metric tons net CO<sub>2</sub>e emissions below business-as-usual  
 11 would be required by 2020 to meet the 1990 levels (ARB 2007). This amounts to  
 12 approximately a 30 percent reduction from projected "business-as-usual" levels  
 13 in 2020.

## 14 **16.5 Impact Analysis**

15 This section describes the potential mechanisms and analytical methods for  
 16 change in air quality and GHG emissions; results of the impact analysis; potential  
 17 mitigation measures; and cumulative effects.

### 18 **16.5.1 Potential Mechanisms for Change and Analytical Methods**

19 As described in Chapter 4, Approach to Environmental Analysis, the impact  
 20 analysis considers changes in air quality and GHG emissions related to changes in  
 21 CVP and SWP operations under the alternatives as compared to the No Action  
 22 Alternative and Second Basis of Comparison.

23 Changes in CVP and SWP operations under the alternatives as compared to the  
 24 No Action Alternative and Second Basis of Comparison could directly or  
 25 indirectly change air quality and GHG emissions due to use of engines or  
 26 electricity that operate groundwater wells, changes in cropping patterns, or odor  
 27 emissions.

#### 28 **16.5.1.1 Changes in Emissions of Criteria Air Pollutants and Precursors, 29 and/or Exposure of Sensitive Receptors to Substantial 30 Concentrations of Air Contaminants**

31 Changes in CVP and SWP operations under the alternatives could change the use  
 32 of individual engines to operate groundwater wells. The CVHM model is used to  
 33 evaluate changes in groundwater conditions in the Central Valley, as described in  
 34 Chapter 7, Groundwater Resources and Groundwater Quality. To evaluate the  
 35 potential for changes in emissions of criteria air pollutants and precursors, and/or  
 36 exposure of sensitive receptors to substantial concentrations of air contaminants,  
 37 results from the CVHM model that indicate changes in groundwater withdrawals  
 38 due to changes in CVP and SWP operations. However, it is not known how many  
 39 of the groundwater pumps use electricity and how many use diesel engines. The  
 40 diesel engines have the potential to emit criteria air pollutants and precursors, and  
 41 toxic air contaminants.

1 Most of the groundwater wells in the Central Valley use electrical pumps. As  
2 reported in a recent environmental assessment, approximately 14 to 15 percent of  
3 the pumps used diesel fuel in 2003 (Reclamation 2013a). It is assumed for this  
4 EIS, that the portion of groundwater pumps that use electricity would remain  
5 approximately at 85 percent. Therefore, it is assumed that increases or decreases  
6 in groundwater pumping would be indicative of an increase or decrease in the use  
7 of diesel engines in the Central Valley as well as in the San Francisco Bay Area,  
8 Central Coast, and Southern California regions. Changes in CVP and SWP  
9 operations would not result in changes in groundwater pumping in the Trinity  
10 River Region; therefore, this analysis does not address Trinity River Region.

11 **16.5.1.2 Changes in Exposure of Sensitive Receptors to**  
12 **Particulate Matter**

13 Changes in CVP and SWP operations under the alternatives could change the  
14 potential for dust generation on irrigated lands that would be idled due to reduced  
15 CVP and SWP water supplies. However, as described in Chapter 12, Agricultural  
16 Resources, irrigated acreage under Alternatives 1 through 5 would be similar to  
17 irrigated acreage under both the No Action Alternative and the Second Basis of  
18 Comparison. Therefore, there would be no change in potential for dust  
19 generation. Therefore, these changes are not analyzed in this EIS.

20 **16.5.1.3 Changes in Exposure of Sensitive Receptors to Odor Emissions**  
21 **from Wetlands**

22 Restoration of seasonal floodplains and tidally-influenced wetlands could result in  
23 additional odors at surrounding sensitive receptors near the restoration locations.  
24 However, these actions would occur in a similar manner under the No Action  
25 Alternative, Alternatives 1 through 5, and Second Basis of Comparison, as  
26 described in Chapter 3, Description of Alternatives. Therefore, odor emissions  
27 would be the same under all of the alternatives and the Second Basis of  
28 Comparison. Therefore, this change is not analyzed in this EIS.

29 **16.5.1.4 Changes in GHG Emissions due to Changes in Energy**  
30 **Generation or Use**

31 Changes in CVP and SWP operations under the alternatives could change CVP  
32 and SWP energy generation and use, and the associated GHG emissions. In  
33 addition, operational changes could also affect the use of energy by CVP and  
34 SWP water users through the implementation of regional and local alternative  
35 water supplies, such as recycling or desalination. When CVP and SWP water  
36 deliveries decline, CVP and SWP net energy generation changes; and water users  
37 are anticipated to increase use of groundwater, recycled water, and/or desalinated  
38 water from existing facilities or facilities that are reasonably foreseeable to be  
39 constructed by 2030. When CVP and SWP water deliveries increase, CVP and  
40 SWP net energy generation would change; and water users are anticipated to  
41 reduce use of alternate water supplies either due to economic considerations or to  
42 allow the amount of stored water to increase under a conjunctive use pattern. It is  
43 not known whether the changes in CVP and SWP net energy generation would be

1 similar to the changes in energy use for alternate regional and local water  
 2 supplies.

3 Changes in the timing and magnitude of net CVP and SWP hydropower  
 4 generation would result in changes in GHG emissions. Increased net CVP and  
 5 SWP hydropower generation would reduce the need for electricity generated  
 6 through fossil fuel combustion, and would avoid the GHG emissions that would  
 7 result from fossil fuel use. In comparison, reduced hydroelectric generation  
 8 would increase the need for other types of electricity production, including  
 9 electricity generated from fossil fuels, with the result that GHG emissions would  
 10 increase.

11 Potential changes in GHG emissions due to changes in CVP and SWP energy  
 12 generation or use, and the evaluation of potential for changes in use of energy by  
 13 CVP and SWP water users to implement alternative water supplies, are analyzed  
 14 broadly and qualitatively across the overall study area. Some of the changes in  
 15 energy use and generation will occur across the CVP and SWP system, others  
 16 may require additional energy resources. Specific locations of the energy sources  
 17 and users have not been defined.

#### 18 **16.5.1.5 Effects due to Cross Delta Water Transfers**

19 Historically water transfer programs have been developed on an annual basis.  
 20 The demand for water transfers is dependent upon the availability of water  
 21 supplies to meet water demands. Water transfer transactions have increased over  
 22 time as CVP and SWP water supply availability has decreased, especially during  
 23 drier water years.

24 Parties seeking water transfers generally acquire water from sellers who have  
 25 available surface water who can make the water available through releasing  
 26 previously stored water, pump groundwater instead of using surface water  
 27 (groundwater substitution); idle crops; or substitute crops that uses less water in  
 28 order to reduce normal consumptive use of surface water.

29 Water transfers using CVP and SWP Delta pumping plants and south of Delta  
 30 canals generally occur when there is unused capacity in these facilities. These  
 31 conditions generally occur during drier water year types when the flows from  
 32 upstream reservoirs plus unregulated flows are adequate to meet the Sacramento  
 33 Valley water demands and the CVP and SWP export allocations. In non-wet  
 34 years, the CVP and SWP water allocations would be less than full contract  
 35 amounts; therefore, capacity may be available in the CVP and SWP conveyance  
 36 facilities to move water from other sources.

37 Projecting future air quality conditions related to water transfer activities is  
 38 difficult because specific water transfer actions required to make the water  
 39 available, convey the water, and/or use the water would change each year due to  
 40 changing hydrological conditions, CVP and SWP water availability, specific local  
 41 agency operations, and local cropping patterns. Reclamation recently prepared a  
 42 long-term regional water transfer environmental document which evaluated  
 43 potential changes in conditions related to water transfer actions (Reclamation



1 2014c). Results from this analysis were used to inform the impact assessment of  
2 potential effects of water transfers under the alternatives as compared to the No  
3 Action Alternative and the Second Basis of Comparison.

#### 4 **16.5.2 Conditions in Year 2030 without Implementation of** 5 **Alternatives 1 through 5**

6 This EIS includes two bases of comparison, as described in Chapter 3,  
7 Description of Alternatives: the No Action Alternative and the Second Basis of  
8 Comparison. Both of these bases are evaluated at 2030 conditions. Changes that  
9 would occur over the next 15 years without implementation of the alternatives are  
10 not analyzed in this EIS. However, the changes to air quality that are assumed to  
11 occur by 2030 under the No Action Alternative and the Second Basis of  
12 Comparison are summarized in this section. Many of the changed conditions  
13 would occur in the same manner under both the No Action Alternative and the  
14 Second Basis of Comparison.

##### 15 **16.5.2.1 Common Changes in Conditions under the No Action Alternative** 16 **and Second Basis of Comparison**

17 Conditions in 2030 would be different than existing conditions due to:

- 18 • Climate change and sea level rise
- 19 • General plan development throughout California, including increased water  
20 demands in portions of Sacramento Valley
- 21 • Implementation of reasonable and foreseeable water resources management  
22 projects to provide water supplies

23 It is anticipated that climate change would result in warmer temperatures, more  
24 short-duration high-rainfall events, and less snowpack in the winter and early  
25 spring months. The reservoirs would be full more frequently by the end of April  
26 or May by 2030 than in recent historical conditions. However, as the water is  
27 released in the spring, there would be less snowpack to refill the reservoirs. This  
28 condition would reduce reservoir storage and available water supplies to  
29 downstream uses in the summer. The reduced end of September storage also  
30 would reduce the ability to release stored water to downstream regional  
31 reservoirs. These conditions would occur for all reservoirs in the California  
32 foothills and mountains, including non-CVP and SWP reservoirs.

33 These changes would result in a decline of the long-term average CVP and SWP  
34 water supply deliveries by 2030 as compared to recent historical long-term  
35 average deliveries under the No Action Alternative and the Second Basis of  
36 Comparison. However, the CVP and SWP water deliveries would be less under  
37 the No Action Alternative as compared to the Second Basis of Comparison, as  
38 described in Chapter 5, Surface Water Resources and Water Supplies, which  
39 could result in more crop idling which could result in increased dust generation.

1 Under the No Action Alternative and the Second Basis of Comparison, land uses  
2 in 2030 would occur in accordance with adopted general plans. Development  
3 under the general plans would be required to be implemented in accordance with  
4 adopted air quality management plans.

5 The No Action Alternative and the Second Basis of Comparison assumes  
6 completion of water resources management and environmental restoration  
7 projects that would have occurred without implementation of Alternatives 1  
8 through 5, including regional and local recycling projects, surface water and  
9 groundwater storage projects, conveyance improvement projects, and desalination  
10 projects. These projects would increase energy demand and could be associated  
11 with increases in indirect greenhouse gas emissions.

12 By 2030, more efficient energy use, increases in renewable energy production,  
13 and energy conservation are also anticipated to reduce future GHG emissions  
14 rates.

15 Under the No Action Alternative and the Second Basis of Comparison, there are  
16 several major variables with varying degrees of uncertainty. These variables  
17 include future population growth in the air basins, the extent and emissivity of  
18 various emissions sources from existing and future activities, and the success of  
19 the local jurisdictions and others in implementing effective air emissions control  
20 measures. It is assumed that air quality in 2030 will be similar to the conditions  
21 described in the Affected Environment even with population growth because the  
22 current air quality management plans were developed with consideration of future  
23 growth by at least 2030. It is anticipated that the non-attainment areas will reduce  
24 the contaminants to a level of attainment in accordance with adopted air quality  
25 management plans. In addition, it is assumed that the California Renewables  
26 Portfolio Standard (RPS) will be implemented by 2020. The RPS was established  
27 in accordance with California Senate Bill 1078 in 2002, Senate Bill 107 in 2006,  
28 and Senate Bill 2 in 2011 to require investor-owned utilities, electric service  
29 providers, and community-choice aggregators (e.g., local agencies that purchase  
30 or generate electricity for their community) to provide at least 33 percent of their  
31 total energy procurement from renewable energy sources by 2020.

32 Increased groundwater use and related groundwater elevation reductions could  
33 occur due to reduction in CVP and SWP water supplies. The increased pumping  
34 would increase demand for electricity, and could result indirectly in increases in  
35 greenhouse gas emissions. As described above, approximately 15 percent of  
36 groundwater pumps rely upon diesel fuels. Increased groundwater pumping could  
37 result in increased emissions of criteria air pollutants and precursors, and/or  
38 exposure of sensitive receptors to substantial concentrations of air contaminants  
39 from increased use of diesel engines.

40 The No Action Alternative and the Second Basis of Comparison would include  
41 restoration of more than 10,000 acres of intertidal and associated subtidal  
42 wetlands in Suisun Marsh and Cache Slough; and 17,000 to 20,000 acres of  
43 seasonal floodplain restoration in Yolo Bypass. Operation of wetlands restoration  
44 projects could result in periodic odors due to anaerobic decomposition of organic

1 matter in portions of the wetlands. As a result, odorous compounds, such as  
2 ammonia and hydrogen sulfide, are generated and may be released into the  
3 environment. Marshes and wetlands can also be a source of odors during some  
4 time periods when ponds or shallow water areas undergo algal or vegetative  
5 growth. Marshes, wetlands, shallow water areas, or canals may require periodic  
6 maintenance to inhibit algal or vegetative growth, and avoid conditions conducive  
7 to anaerobic digestion. The occurrence and severity of odor impacts depend on  
8 numerous factors, including the nature, frequency, and intensity of the source;  
9 wind speed and direction; and the presence of sensitive receptors. Although odors  
10 rarely cause any physical harm, they can still be unpleasant to some individuals.

### 11 **16.5.3 Evaluation of Alternatives**

12 Alternatives 1 through 5 have been compared to the No Action Alternative; and  
13 the No Action Alternative and Alternatives 1 through 5 have been compared to  
14 the Second Basis of Comparison.

15 During review of the numerical modeling analyses used in this EIS, an error was  
16 determined in the CalSim II model assumptions related to the Stanislaus River  
17 operations for the Second Basis of Comparison, Alternative 1, and Alternative 4  
18 model runs. Appendix 5C includes a comparison of the CalSim II model run  
19 results presented in this chapter and CalSim II model run results with the error  
20 corrected. Appendix 5C also includes a discussion of changes in the comparison  
21 of groundwater conditions for the following alternative analyses.

- 22 • No Action Alternative compared to the Second Basis of Comparison
- 23 • Alternative 1 compared to the No Action Alternative
- 24 • Alternative 3 compared to the Second Basis of Comparison
- 25 • Alternative 5 compared to the Second Basis of Comparison

#### 26 **16.5.3.1 No Action Alternative**

27 The No Action Alternative is compared to the Second Basis of Comparison.

##### 28 **16.5.3.1.1 Central Valley Region**

29 *Changes in Emissions of Criteria Air Pollutants and Precursors, and/or Exposure*  
30 *of Sensitive Receptors to Substantial Concentrations of Air Contaminants Related*  
31 *to Changes in Groundwater Pumping*

32 As described in Chapter 7, Groundwater Resources and Groundwater Quality,  
33 groundwater pumping in the San Joaquin Valley portion of the Central Valley  
34 Region would increase by 8 percent under the No Action Alternative as compared  
35 to the Second Basis of Comparison. It is not known if the additional groundwater  
36 pumping would rely upon electricity or diesel to drive the pump engines. Under  
37 the worst case analysis, it is assumed that the increased use of diesel engines  
38 would be proportional to the increased use of groundwater. Therefore, under the  
39 No Action Alternative, there would be a potential increase in emissions of criteria  
40 air pollutants and precursors, and/or exposure of sensitive receptors to substantial  
41 concentrations of air contaminants as compared to the Second Basis of  
42 Comparison.

1 *Effects Related to Cross Delta Water Transfers*

2 Potential effects to air quality could be similar to those identified in a recent  
 3 environmental analysis conducted by Reclamation for long-term water transfers  
 4 from the Sacramento to San Joaquin valleys (Reclamation 2014c). Potential  
 5 effects to air quality were identified as increased emissions of air pollutants due to  
 6 the use of diesel engines for groundwater pumps that were used to provide  
 7 transfer water through groundwater substitution programs. The analysis indicated  
 8 that the effects could be reduced to avoid substantial impacts through the use of  
 9 electric engines or reducing the amount of groundwater substitution. Other  
 10 identified effects were considered to be not substantial or beneficial as related to  
 11 crop idling to provide transfer water in the seller's service area; and reduction of  
 12 groundwater pumping that could use diesel engines or dust generation from crop  
 13 idled lands in the purchaser's service area.

14 Under the No Action Alternative, the timing of cross Delta water transfers would  
 15 be limited to July through September and include annual volumetric limits, in  
 16 accordance with the 2008 USFWS BO and 2009 NMFS BO. Under the Second  
 17 Basis of Comparison, water could be transferred throughout the year without an  
 18 annual volumetric limit. Overall, the potential for cross Delta water transfers  
 19 would be less under the No Action Alternative than under the Second Basis of  
 20 Comparison.

21 **16.5.3.1.2 San Francisco Bay Area, Central Coast, and Southern**  
 22 **California Regions**

23 *Changes in Emissions of Criteria Air Pollutants and Precursors, and/or Exposure*  
 24 *of Sensitive Receptors to Substantial Concentrations of Air Contaminants Related*  
 25 *to Changes in Groundwater Pumping*

26 It is anticipated that CVP and SWP water supplies would be decreased by  
 27 10 percent and 18 percent, respectively, in the San Francisco Bay Area, Central  
 28 Coast, and Southern California regions under No Action Alternative as compared  
 29 to the Second Basis of Comparison. The decrease in surface water supplies could  
 30 result in additional use of groundwater pumps and emissions of air pollutants and  
 31 contaminants if the use of diesel engines is also increased.

32 **16.5.3.1.3 Overall Study Area**

33 *Changes in GHG Emissions due to Changes in Energy Generation or Use*

34 As described in Chapter 8, Energy, changes in CVP and SWP operations under  
 35 the No Action Alternative as compared to the Second Basis of Comparison would  
 36 result in a reduction of CVP and SWP water deliveries to areas located south of  
 37 the Delta; and therefore, annual energy use for conveyance would decline. CVP  
 38 annual net generation would be similar; and SWP net energy generation would  
 39 increase which could result indirectly in less GHG emissions if the hydropower  
 40 generation replaces fossil fuel generation.

41 In addition to changes in CVP and SWP energy generation and use and the  
 42 associated GHG emissions, CVP and SWP operations under the No Action  
 43 Alternative as compared to the Second Basis of Comparison could potentially

1 increase use of energy by CVP and SWP water users to implement regional and  
2 local alternate water supplies, such as increased groundwater pumping and use of  
3 recycled water treatment plants and desalination water treatment plants. These  
4 facilities would require energy which could result in increased GHG emissions.

5 **16.5.3.2 Alternative 1**

6 Alternative 1 is identical to the Second Basis of Comparison. Alternative 1 is  
7 compared to the No Action Alternative and the Second Basis of Comparison.  
8 However, because CVP and SWP operations conditions under Alternative 1 are  
9 identical to conditions under the Second Basis of Comparison; Alternative 1 is  
10 only compared to the No Action Alternative.

11 **16.5.3.2.1 Alternative 1 Compared to the No Action Alternative**

12 *Central Valley Region*

13 *Changes in Emissions of Criteria Air Pollutants and Precursors, and/or*  
14 *Exposure of Sensitive Receptors to Substantial Concentrations of Air*  
15 *Contaminants Related to Changes in Groundwater Pumping*

16 Groundwater pumping in the San Joaquin Valley portion of the Central Valley  
17 Region would decrease by 8 percent under Alternative 1 as compared to the No  
18 Action Alternative. It is not known if the reduction in groundwater pumping  
19 would result in a reduction of the use of electricity or diesel to drive the pump  
20 engines. For this analysis, it is assumed that the decreased use of diesel engines  
21 would be proportional to the decreased use of groundwater. Therefore, under  
22 Alternative 1, there would be a potential decrease in emissions of criteria air  
23 pollutants and precursors, and/or exposure of sensitive receptors to substantial  
24 concentrations of air contaminants as compared to the No Action Alternative.

25 *Effects Related to Cross Delta Water Transfers*

26 Potential effects to air quality could be similar to those identified in a recent  
27 environmental analysis conducted by Reclamation for long-term water transfers  
28 from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described  
29 above under the No Action Alternative compared to the Second Basis of  
30 Comparison. For the purposes of this EIS, it is anticipated that similar conditions  
31 would occur during implementation of cross Delta water transfers under  
32 Alternative 1 and the No Action Alternative, and that impacts on air quality would  
33 not be substantial due to implementation requirements of the transfer programs.

34 Under Alternative 1, water could be transferred throughout the year without an  
35 annual volumetric limit. Under the No Action Alternative, the timing of cross  
36 Delta water transfers would be limited to July through September and include  
37 annual volumetric limits, in accordance with the 2008 USFWS BO and 2009  
38 NMFS BO. Overall, the potential for cross Delta water transfers would be  
39 increased under Alternative 1 as compared to the No Action Alternative.

1 *San Francisco Bay Area, Central Coast, and Southern California Regions*  
 2 *Changes in Emissions of Criteria Air Pollutants and Precursors, and/or*  
 3 *Exposure of Sensitive Receptors to Substantial Concentrations of Air*  
 4 *Contaminants Related to Changes in Groundwater Pumping*

5 It is anticipated that CVP and SWP water supplies would be increased by  
 6 11 percent and 21 percent, respectively, in the San Francisco Bay Area, Central  
 7 Coast, and Southern California regions under Alternative 1 as compared to the  
 8 No Action Alternative. The increase in surface water supplies could result in the  
 9 reduction in use of groundwater pumps and emissions of air pollutants and  
 10 contaminants if the use of diesel engines is also decreased.

11 *Overall Study Area*

12 *Changes in GHG Emissions due to Changes in Energy Generation or Use*

13 As described in Chapter 8, Energy, changes CVP and SWP operations under  
 14 Alternative 1 as compared to the No Action Alternative would result in an  
 15 increase of CVP and SWP water deliveries to areas located south of the Delta; and  
 16 therefore, annual energy use for conveyance would increase. CVP annual net  
 17 generation would be similar, and SWP annual net generation would be decrease  
 18 over the long-term average conditions. This could result in increased GHG  
 19 emissions if fossil fuel generation replaces hydropower generation.

20 In addition to changes in CVP and SWP energy generation and use, and the  
 21 associated GHG emissions, CVP and SWP operations under Alternative 1 as  
 22 compared to the No Action Alternative could potentially decrease the use of  
 23 energy by CVP and SWP water users due to less need to implement regional and  
 24 local alternative water supplies, such as increased groundwater pumping and use  
 25 of recycled water treatment plants and desalination water treatment plants. As the  
 26 need for alternative water supplies is decreased, the associated energy demand  
 27 and indirect GHG emissions would also be decreased under Alternative 1 as  
 28 compared to the No Action Alternative.

29 **16.5.3.2.2 Alternative 1 Compared to the Second Basis of Comparison**

30 Alternative 1 is identical to the Second Basis of Comparison.

31 **16.5.3.3 Alternative 2**

32 The CVP and SWP operations under Alternative 2 are identical to the CVP and  
 33 SWP operations under the No Action Alternative, as described in Chapter 3,  
 34 Description of Alternatives; therefore, Alternative 2 is only compared to the  
 35 Second Basis of Comparison.

36 **16.5.3.3.1 Alternative 2 Compared to the Second Basis of Comparison**

37 The CVP and SWP operations under Alternative 2 are identical to the CVP and  
 38 SWP operations under the No Action Alternative. Therefore, changes to air  
 39 quality and GHG emission conditions under Alternatives 2 as compared to the  
 40 Second Basis of Comparison would be the same as the impacts described in  
 41 Section 16.5.3.1, No Action Alternative.

1 **16.5.3.4 Alternative 3**

2 As described in Chapter 3, Description of Alternatives, CVP and SWP operations  
3 under Alternative 3 are similar to the Second Basis of Comparison with modified  
4 Old and Middle River flow criteria and New Melones Reservoir operations. As  
5 described in Chapter 4, Approach to Environmental Analysis, Alternative 3 is  
6 compared to the No Action Alternative and the Second Basis of Comparison.

7 **16.5.3.4.1 Alternative 3 Compared to the No Action Alternative**

8 *Central Valley Region*

9 *Changes in Emissions of Criteria Air Pollutants and Precursors, and/or*  
10 *Exposure of Sensitive Receptors to Substantial Concentrations of Air*  
11 *Contaminants Related to Changes in Groundwater Pumping*

12 Groundwater pumping in the San Joaquin Valley portion of the Central Valley  
13 Region would decrease by 6 percent under Alternative 3 as compared to the No  
14 Action Alternative. It is not known if the reduction in groundwater pumping  
15 would result in a reduction of the use of electricity or diesel to drive the pump  
16 engines. For this analysis, it is assumed that the decreased use of diesel engines  
17 would be proportional to the decreased use of groundwater. Therefore, under  
18 Alternative 3, there would be a potential decrease in emissions of criteria air  
19 pollutants and precursors, and/or exposure of sensitive receptors to substantial  
20 concentrations of air contaminants as compared to the No Action Alternative.

21 *Effects Related to Cross Delta Water Transfers*

22 Potential effects to air quality could be similar to those identified in a recent  
23 environmental analysis conducted by Reclamation for long-term water transfers  
24 from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described  
25 above under the No Action Alternative compared to the Second Basis of  
26 Comparison. For the purposes of this EIS, it is anticipated that similar conditions  
27 would occur during implementation of cross Delta water transfers under  
28 Alternative 3 and the No Action Alternative, and that impacts on air quality would  
29 not be substantial due to implementation requirements of the transfer programs.

30 Under Alternative 3, water could be transferred throughout the year without an  
31 annual volumetric limit. Under the No Action Alternative, the timing of cross  
32 Delta water transfers would be limited to July through September and include  
33 annual volumetric limits, in accordance with the 2008 USFWS BO and 2009  
34 NMFS BO. Overall, the potential for cross Delta water transfers would be  
35 increased under Alternative 3 as compared to the No Action Alternative.

36 *San Francisco Bay Area, Central Coast, and Southern California Regions*

37 *Changes in Emissions of Criteria Air Pollutants and Precursors, and/or*  
38 *Exposure of Sensitive Receptors to Substantial Concentrations of Air*  
39 *Contaminants Related to Changes in Groundwater Pumping*

40 It is anticipated that CVP and SWP water supplies would be increased by  
41 9 percent and 17 percent, respectively, in the San Francisco Bay Area, Central  
42 Coast, and Southern California regions under Alternative 3 as compared to the  
43 No Action Alternative. The increase in surface water supplies could result in the

1 reduction in use of groundwater pumps and emissions of air pollutants and  
2 contaminants if the use of diesel engines is also decreased.

### 3 *Overall Study Area*

#### 4 *Changes in GHG Emissions due to Changes in Energy Generation or Use*

5 As described in Chapter 8, Energy, changes in CVP and SWP operations under  
6 Alternative 3 as compared to the No Action Alternative would result in an  
7 increase of CVP and SWP water deliveries to areas located south of the Delta; and  
8 therefore, annual energy use for conveyance would increase. CVP annual net  
9 energy generation would be similar; and SWP annual net energy generation  
10 would be less which could result in increased GHG emissions if fossil fuel  
11 generation replaces hydropower generation.

12 In addition to changes in CVP and SWP energy generation and use, and the  
13 associated GHG emissions, CVP and SWP operations under Alternative 3 as  
14 compared to the No Action Alternative could potentially decrease the use of  
15 energy by CVP and SWP water users due to less need to implement regional and  
16 local alternative water supplies, such as increased groundwater pumping and use  
17 of recycled water treatment plants and desalination water treatment plants. As the  
18 need for alternative water supplies is decreased, the associated energy demand  
19 and GHG emissions would also be decreased under Alternative 3 as compared to  
20 the No Action Alternative.

### 21 **16.5.3.4.2 Alternative 3 Compared to the Second Basis of Comparison**

#### 22 *Central Valley Region*

#### 23 *Changes in Emissions of Criteria Air Pollutants and Precursors, and/or* 24 *Exposure of Sensitive Receptors to Substantial Concentrations of Air* 25 *Contaminants Related to Changes in Groundwater Pumping*

26 Groundwater pumping in the San Joaquin Valley portion of the Central Valley  
27 Region would be similar (within a 5 percent change) under Alternative 3 as  
28 compared to the Second Basis of Comparison. Therefore, the emissions of  
29 criteria air pollutants and precursors, and/or exposure of sensitive receptors to  
30 substantial concentrations of air contaminants would be similar under  
31 Alternative 3 as compared to the Second Basis of Comparison.

#### 32 *Effects Related to Cross Delta Water Transfers*

33 Potential effects to air quality could be similar to those identified in a recent  
34 environmental analysis conducted by Reclamation for long-term water transfers  
35 from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described  
36 above under the No Action Alternative compared to the Second Basis of  
37 Comparison. For the purposes of this EIS, it is anticipated that similar conditions  
38 would occur during implementation of cross Delta water transfers under  
39 Alternative 3 and the Second Basis of Comparison, and that impacts on air quality  
40 would not be substantial in the seller's service area due to implementation  
41 requirements of the transfer programs.



1 Under Alternative 3 and the Second Basis of Comparison, water could be  
2 transferred throughout the year without an annual volumetric limit. Overall, the  
3 potential for cross Delta water transfers would be similar under Alternative 3 and  
4 the Second Basis of Comparison.

5 *San Francisco Bay Area, Central Coast, and Southern California Regions*  
6 *Changes in Emissions of Criteria Air Pollutants and Precursors, and/or*  
7 *Exposure of Sensitive Receptors to Substantial Concentrations of Air*  
8 *Contaminants Related to Changes in Groundwater Pumping*

9 It is anticipated that CVP and SWP water supplies and emissions from diesel  
10 engines used for groundwater pumping would be similar in the San Francisco Bay  
11 Area, Central Coast, and Southern California regions under Alternative 3 as  
12 compared to the Second Basis of Comparison.

13 *Overall Study Area*

14 *Changes in GHG Emissions due to Changes in Energy Generation or Use*

15 As described in Chapter 8, Energy, changes in CVP and SWP operations under  
16 Alternative 3 as compared to the Second Basis of Comparison would result in a  
17 decrease of CVP and SWP water deliveries to areas located south of the Delta;  
18 and therefore, annual energy use for conveyance would decrease. CVP annual net  
19 energy generation would be similar; and SWP annual net energy generation  
20 would be greater which could result in decreased GHG emissions if hydropower  
21 generation replaces fossil fuel generation.

22 In addition to changes in CVP and SWP energy generation and use, and the  
23 associated GHG emissions, CVP and SWP operations under Alternative 3 as  
24 compared to the Second Basis of Comparison could potentially increase the use of  
25 energy by CVP and SWP water users to implement regional and local alternative  
26 water supplies, such as increased groundwater pumping and use of recycled water  
27 treatment plants and desalination water treatment plants. These facilities would  
28 require energy which could indirectly result in increased GHG emissions.

29 **16.5.3.5 Alternative 4**

30 The air quality and GHG emissions under Alternative 4 would be identical to the  
31 air quality and GHG emissions under the Second Basis of Comparison; therefore,  
32 Alternative 4 is only compared to the No Action Alternative.

33 **16.5.3.5.1 Alternative 4 Compared to the No Action Alternative**

34 The CVP and SWP operations under Alternative 4 is identical to the CVP and  
35 SWP operations under the Second Basis of Comparison and Alternative 1.  
36 Therefore, changes in air quality and GHG emissions under Alternative 4 as  
37 compared to the No Action Alternative would be the same as the impacts  
38 described in Section 16.5.3.2.1, Alternative 1 Compared to the No Action  
39 Alternative.

1 **16.5.3.6 Alternative 5**

2 As described in Chapter 3, Description of Alternatives, CVP and SWP operations  
3 under Alternative 5 are similar to the No Action Alternative with modified Old  
4 and Middle River flow criteria and New Melones Reservoir operations. As  
5 described in Chapter 4, Approach to Environmental Analysis, Alternative 5 is  
6 compared to the No Action Alternative and the Second Basis of Comparison.

7 **16.5.3.6.1 Alternative 5 Compared to the No Action Alternative**

8 *Central Valley Region*

9 *Changes in Emissions of Criteria Air Pollutants and Precursors, and/or*  
10 *Exposure of Sensitive Receptors to Substantial Concentrations of Air*  
11 *Contaminants Related to Changes in Groundwater Pumping*

12 Groundwater pumping in the San Joaquin Valley portion of the Central Valley  
13 Region would be similar under Alternative 5 as compared to the No Action  
14 Alternative. Therefore, the emissions of criteria air pollutants and precursors,  
15 and/or exposure of sensitive receptors to substantial concentrations of air  
16 contaminants would be similar under Alternative 5 as compared to the No  
17 Action Alternative.

18 *Effects Related to Cross Delta Water Transfers*

19 Potential effects to air quality could be similar to those identified in a recent  
20 environmental analysis conducted by Reclamation for long-term water transfers  
21 from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described  
22 above under the No Action Alternative compared to the Second Basis of  
23 Comparison. For the purposes of this EIS, it is anticipated that similar conditions  
24 would occur during implementation of cross Delta water transfers under  
25 Alternative 5 and the No Action Alternative, and that impacts on air quality would  
26 not be substantial in the seller's service area due to implementation requirements  
27 of the transfer programs.

28 Under Alternative 5 and the No Action Alternative, the timing of cross Delta  
29 water transfers would be limited to July through September and include annual  
30 volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO.  
31 Overall, the potential for cross Delta water transfers would be similar under  
32 Alternative 5 and the No Action Alternative.

33 *San Francisco Bay Area, Central Coast, and Southern California Regions*

34 *Changes in Emissions of Criteria Air Pollutants and Precursors, and/or*  
35 *Exposure of Sensitive Receptors to Substantial Concentrations of Air*  
36 *Contaminants Related to Changes in Groundwater Pumping*

37 It is anticipated that CVP and SWP water supplies and emissions from diesel  
38 engines used for groundwater pumping would be similar in the San Francisco Bay  
39 Area, Central Coast, and Southern California regions under Alternative 5 as  
40 compared to the No Action Alternative.

1 *Overall Study Area*

2 *Changes in GHG Emissions due to Changes in Energy Generation or Use*

3 As described in Chapter 8, Energy, changes in CVP and SWP operations under  
4 Alternative 5 as compared to the No Action Alternative would result in similar  
5 CVP and SWP water deliveries to areas located south of the Delta except in April  
6 and May when exports would decline. Overall, annual CVP and SWP net energy  
7 generation would be similar under Alternative 5 and the No Action Alternative.

8 In addition to changes in CVP and SWP energy generation and use, and the  
9 associated GHG emissions, CVP and SWP operations under Alternative 5 as  
10 compared to the No Action Alternative could potentially increase the use of  
11 energy by CVP and SWP water users to implement regional and local alternative  
12 water supplies, such as increased groundwater pumping and use of recycled water  
13 treatment plants and desalination water treatment plants. These facilities would  
14 require energy which could indirectly result in increased GHG emissions.

15 **16.5.3.6.2 Alternative 5 Compared to the Second Basis of Comparison**

16 *Central Valley Region*

17 *Changes in Emissions of Criteria Air Pollutants and Precursors, and/or*  
18 *Exposure of Sensitive Receptors to Substantial Concentrations of Air*  
19 *Contaminants Related to Changes in Groundwater Pumping*

20 Groundwater pumping in the San Joaquin Valley portion of the Central Valley  
21 Region would increase by 8 percent under Alternative 5 as compared to the  
22 Second Basis of Comparison. It is not known if the additional groundwater  
23 pumping would rely upon electricity or diesel to drive the pump engines. Under  
24 the worst case analysis, it is assumed that the increased use of diesel engines  
25 would be proportional to the increased use of groundwater. Therefore, under  
26 Alternative 5, there would be a potential increase in emissions of criteria air  
27 pollutants and precursors, and/or exposure of sensitive receptors to substantial  
28 concentrations of air contaminants as compared to the Second Basis of  
29 Comparison.

30 *Effects Related to Cross Delta Water Transfers*

31 Potential effects to air quality could be similar to those identified in a recent  
32 environmental analysis conducted by Reclamation for long-term water transfers  
33 from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described  
34 above under the No Action Alternative compared to the Second Basis of  
35 Comparison. For the purposes of this EIS, it is anticipated that similar conditions  
36 would occur during implementation of cross Delta water transfers under  
37 Alternative 5 and the Second Basis of Comparison, and that impacts on air quality  
38 would not be substantial in the seller's service area due to implementation  
39 requirements of the transfer programs.

40 Under Alternative 5, the timing of cross Delta water transfers would be limited to  
41 July through September and include annual volumetric limits, in accordance with  
42 the 2008 USFWS BO and 2009 NMFS BO. Under the Second Basis of  
43 Comparison, water could be transferred throughout the year without an annual

1 volumetric limit. Overall, the potential for cross Delta water transfers would be  
 2 reduced under Alternative 5 as compared to the Second Basis of Comparison.

3 *San Francisco Bay Area, Central Coast, and Southern California Regions*  
 4 *Changes in Emissions of Criteria Air Pollutants and Precursors, and/or*  
 5 *Exposure of Sensitive Receptors to Substantial Concentrations of Air*  
 6 *Contaminants Related to Changes in Groundwater Pumping*

7 It is anticipated that CVP and SWP water supplies would be decreased by  
 8 10 percent and 18 percent, respectively, in the San Francisco Bay Area, Central  
 9 Coast, and Southern California regions under Alternative 5 as compared to the  
 10 Second Basis of Comparison. The decrease in surface water supplies could result  
 11 in increased use of groundwater pumps and emissions of air pollutants and  
 12 contaminants if the use of diesel engines is also increased.

13 *Overall Study Area*

14 *Changes in GHG Emissions due to Changes in Energy Generation or Use*

15 As described in Chapter 8, Energy, changes in CVP and SWP operations under  
 16 Alternative 5 as compared to the Second Basis of Comparison would result in a  
 17 decrease of CVP and SWP water deliveries to areas located south of the Delta;  
 18 and therefore, annual energy use for conveyance would decrease. CVP annual net  
 19 generation would be similar; and SWP net energy generation would increase  
 20 which could result indirectly in less GHG emissions if the hydropower generation  
 21 replaces fossil fuel generation.

22 In addition to changes in CVP and SWP energy generation and use, and the  
 23 associated GHG emissions, CVP and SWP operations under Alternative 5 as  
 24 compared to the Second Basis of Comparison could potentially increase the use of  
 25 energy by CVP and SWP water users to implement regional and local alternative  
 26 water supplies, such as increased groundwater pumping and use of recycled water  
 27 treatment plants and desalination water treatment plants. These facilities would  
 28 require energy which could indirectly result in increased GHG emissions.

29 **16.5.3.7 Summary of Environmental Consequences**

30 The results of the environmental consequences of implementation of  
 31 Alternatives 1 through 5 as compared to the No Action Alternative and the  
 32 Second Basis of Comparison are presented in Tables 16.5 and 16.6.

1 **Table 16.5 Comparison of Alternatives 1 through 5 to No Action Alternative**

<b>Alternative</b>	<b>Potential Change</b>	<b>Consideration for Mitigation Measures</b>
Alternative 1	<p>Decrease potential for emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants by 8 percent in the Central Valley, 11 to 21 percent in the San Francisco Bay Area Region, and by 21 percent in the Central Coast and Southern California regions.</p> <p>Potentially, could indirectly result in an increase of GHG emissions due to a decrease in SWP net energy generation; however, GHG emissions could decrease due to a reduced need for additional energy for alternative water supplies. The overall changes in GHG emissions are not known at this time because the need for energy use by alternative water supplies is not known at this time.</p>	None needed
Alternative 2	No effects on air quality.	None needed
Alternative 3	<p>Decrease potential for emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants by 6 percent in the Central Valley, 9 to 17 percent in the San Francisco Bay Area Region, and by 17 percent in the Central Coast and Southern California regions.</p> <p>Potentially, could indirectly result in an increase of GHG emissions due to a decrease in SWP net energy generation; however, GHG emissions could decrease due to a reduced need for additional energy for alternative water supplies. The overall changes in GHG emissions are not known at this time because the need for energy use by alternative water supplies is not known at this time.</p>	None needed
Alternative 4	Same effects as described for Alternative 1 compared to the No Action Alternative.	None needed

<b>Alternative</b>	<b>Potential Change</b>	<b>Consideration for Mitigation Measures</b>
Alternative 5	<p>Similar potential for emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants in the Central Valley, San Francisco Bay Area, Central Coast, and Southern California regions.</p> <p>Potentially, could indirectly result in an increase of GHG emissions due to the need for additional energy for alternative water supplies. The overall changes in GHG emissions are not known at this time because the need for energy use by alternative water supplies is not known at this time.</p>	None needed

Note: Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools, incremental differences of 5 percent or less between alternatives and the No Action Alternative are considered to be “similar.”

1 **Table 16.6 Comparison of Alternatives 1 through 5 to Second Basis of Comparison**

<b>Alternative</b>	<b>Potential Change</b>	<b>Consideration for Mitigation Measures</b>
No Action Alternative	<p>Increase potential for emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants by 8 percent in the Central Valley, 10 to 18 percent in the San Francisco Bay Area Region, and by 18 percent in the Central Coast and Southern California regions.</p> <p>Potentially, could indirectly result in a decrease of GHG emissions due to an increase in SWP net energy generation; however, GHG emissions could increase due to the need for additional energy for alternative water supplies. The overall changes in GHG emissions are not known at this time because the need for energy use by alternative water supplies is not known at this time.</p>	Not considered for this comparison.
Alternative 1	No effects on air quality.	Not considered for this comparison.
Alternative 2	Same effects as described for No Action Alternative as compared to the Second Basis of Comparison.	Not considered for this comparison.

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 3	<p>Similar potential for emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants in the Central Valley, San Francisco Bay Area, Central Coast, and Southern California regions.</p> <p>Potentially, could indirectly result in a decrease of GHG emissions due to an increase in SWP net energy generation; however, GHG emissions could increase due to the need for additional energy for alternative water supplies. The overall changes in GHG emissions are not known at this time because the need for energy use by alternative water supplies is not known at this time.</p>	Not considered for this comparison.
Alternative 4	No effects on air quality.	Not considered for this comparison.
Alternative 5	<p>Increase potential for emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants by 8 percent in the Central Valley, 10 to 18 percent in the San Francisco Bay Area Region, and by 18 percent in the Central Coast and Southern California regions.</p> <p>Potentially, could indirectly result in a decrease of GHG emissions due to an increase in SWP net energy generation; however, GHG emissions could increase due to the need for additional energy for alternative water supplies. The overall changes in GHG emissions are not known at this time because the need for energy use by alternative water supplies is not known at this time.</p>	Not considered for this comparison.

1 Note: Due to the limitations and uncertainty in the CalSim II monthly model and other  
 2 analytical tools, incremental differences of 5 percent or less between alternatives and the  
 3 No Action Alternative are considered to be “similar.”

4 **16.5.3.8 Potential Mitigation Measures**

5 Mitigation measures are presented in this section to avoid, minimize, rectify,  
 6 reduce, eliminate, or compensate for adverse environmental effects of  
 7 Alternatives 1 through 5 as compared to the No Action Alternative. Mitigation  
 8 measures were not included to address adverse impacts under the alternatives as  
 9 compared to the Second Basis of Comparison because this analysis was included  
 10 in this EIS for information purposes only.

1 Changes in CVP and SWP operations under Alternatives 1 through 5 as compared  
2 to the No Action Alternative would not result in changes in air quality. Therefore,  
3 there would be no adverse impacts to air quality; and no mitigation measures  
4 are required.

5 **16.5.3.9 Cumulative Effects Analysis**

6 As described in Chapter 3, the cumulative effects analysis considers projects,  
7 programs, and policies that are not speculative; and are based upon known or  
8 reasonably foreseeable long-range plans, regulations, operating agreements, or  
9 other information that establishes them as reasonably foreseeable.

10 The cumulative effects analysis considers potential incremental impacts of the  
11 alternatives when added to other past and present actions (as described in the  
12 Affected Environment section) and reasonably foreseeable future actions (as  
13 described in the No Action Alternative section plus cumulative effects) regardless  
14 of what agency (federal or non-federal) or person undertakes such actions  
15 (40 CFR 1508.7, 1508.25, and 43 CFR 46.115). The quantitative effects of these  
16 items are based upon the quantitative comparisons of Alternatives 1 through 5 to  
17 the No Action Alternative presented in previous sections of this chapter; and the  
18 qualitative cumulative effects of the alternatives are based upon the qualitative  
19 comparisons of Alternatives 1 through 5 to the No Action Alternative presented in  
20 previous sections of this chapter and the effects of the cumulative actions that are  
21 less certain than future actions under the No Action Alternative.

22 The cumulative effects analysis for Alternatives 1 through 5 for Air Quality issues  
23 are summarized in Table 16.7.



1  
2

**Table 16.7 Summary of Cumulative Effects on Air Quality with Implementation of Alternatives 1 through 5 as Compared to the No Action Alternative**

Scenarios	Actions	Cumulative Effects of Actions
<p>Past &amp; Present, and Future Actions included in the No Action Alternative and in All Alternatives in Year 2030</p>	<p>Consistent with Affected Environment conditions plus:</p> <p>Actions in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives), including climate change and sea level rise</p> <p>Actions not included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives):</p> <ul style="list-style-type: none"> <li>• Implementation of Federal and state policies and programs, including Clean Water Act (e.g., Total Maximum Daily Loads); Safe Drinking Water Act; Clean Air Act; and flood management programs</li> <li>• General plans for 2030.</li> <li>• Trinity River Restoration Program.</li> <li>• Central Valley Project Improvement Act programs</li> <li>• Folsom Dam Water Control Manual Update</li> <li>• FERC Relicensing for the Middle Fork of the American River Project</li> <li>• San Joaquin River Restoration Program</li> <li>• Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects with completed environmental documents)</li> </ul>	<p><u>These effects would be the same under all alternatives.</u></p> <p>Climate change and sea level rise, development under the general plans, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce carryover storage in reservoirs and changes in stream flow patterns in a manner that could reduce hydroelectric generation in the summer and fall months which could result in increased use of fossil fuels and indirectly increase GHG emissions for fossil fuel generation and increased use of diesel engines for additional groundwater use.</p> <p>Reduced CVP and SWP water deliveries south of the Delta would reduce CVP and SWP electricity use for conveyance; and could reduce the need for electricity generation using fossil fuels and indirectly reduce GHG emissions.</p> <p>Future water supply projects are anticipated to both improve water supply reliability due to reduced surface water supplies and to accommodate planned growth in the general plans. It is anticipated that some of these projects could increase energy use, such as implementation of desalination projects. However, other projects, such as water recycling, would not substantially increase energy use because most of the energy use was previously required for wastewater treatment. It is anticipated that energy required for water treatment of alternative water supplies would be similar as treatment for CVP and SWP water supplies. Increased energy use could increase use of electricity generation by fossil fuels; which could increase air quality issues and indirectly increase GHG emissions.</p> <p>Most of these programs were initiated prior to implementation of the 2008 USFWS BO and 2009 NMFS BO which reduced CVP and SWP water supply reliability.</p>

Scenarios	Actions	Cumulative Effects of Actions
<p>Future Actions considered as Cumulative Effects Actions in All Alternatives in Year 2030</p>	<p>Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives):</p> <ul style="list-style-type: none"> <li>• Bay-Delta Water Quality Control Plan Update</li> <li>• FERC Relicensing Projects</li> <li>• Bay Delta Conservation Plan (including the California WaterFix alternative)</li> <li>• Shasta Lake Water Resources, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations</li> <li>• El Dorado Water and Power Authority Supplemental Water Rights Project</li> <li>• Sacramento River Water Reliability Project</li> <li>• Semitropic Water Storage District Delta Wetlands</li> <li>• North Bay Aqueduct Alternative Intake</li> <li>• Irrigated Lands Regulatory Program</li> <li>• San Luis Reservoir Low Point Improvement Project</li> <li>• <i>Westlands Water District v. United States Settlement</i></li> <li>• Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects that did not have completed environmental documents during preparation of the EIS)</li> </ul>	<p><u>These effects would be the same under all alternatives.</u></p> <p>Most of the future reasonably foreseeable actions are anticipated to improve water supplies in California to reduce impacts due to climate change, sea level rise, increased water allocated to improve habitat conditions, and future growth. If CVP and SWP water supply reliability increases, energy use for conveyance of CVP and SWP water supplies also would increase.</p> <p>Some of the future reasonably foreseeable actions are anticipated to potentially reduce CVP and SWP water supply reliability (e.g., Water Quality Control Plan Update and FERC Relicensing Projects).</p> <p>Future water supply projects are anticipated to both improve water supply reliability due to reduced surface water supplies and to accommodate planned growth in the general plans. It is anticipated that some of these projects could increase energy use, such as implementation of desalination projects. However, other projects, such as water recycling, would not substantially increase energy use because most of the energy use was previously required for wastewater treatment. It is anticipated that energy required for water treatment of alternative water supplies would be similar as treatment for CVP and SWP water supplies. Increased use of groundwater pumps would increase energy use.</p>

Scenarios	Actions	Cumulative Effects of Actions
No Action Alternative with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP	<p>Implementation of No Action Alternative would result in changes stream flows and related changes in hydroelectric generation patterns, and reduced CVP and SWP water supplies as compared to conditions prior to the BOs.</p> <p>If CVP and SWP water supply reliability decreases, energy use for conveyance of CVP and SWP water supplies also would decrease and energy use for alternative water supplies could increase.</p> <p>Increased energy use could increase use of electricity generation by fossil fuels; which could increase air quality issues and indirectly increase GHG emissions.</p>
Alternatives 1 and 4 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	<p>Implementation of Alternatives 1 and 4 with reasonably foreseeable actions would result in changes in stream flows and related hydroelectric generation patterns, and increased CVP and SWP water supplies as compared to the No Action Alternative with the added actions.</p> <p>Increased CVP and SWP water supply reliability would increase energy use for conveyance of CVP and SWP water supplies; and it is anticipated that energy use for alternative water supplies would decrease as compared to the No Action Alternative with the added actions.</p> <p>Increased energy use for CVP and SWP conveyance could increase use of electricity generation by fossil fuels; which could increase air quality issues and indirectly increase GHG emissions. However, decreased energy use for alternative water supplies could decrease use of electricity generation by fossil fuels; which could decrease air quality issues and indirectly decrease GHG emissions as compared to for the No Action Alternative with the added actions.</p>
Alternative 2 with Associated Cumulative Effects Actions in Year 2030	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions</p> <p>No implementation of structural improvements or other actions that require further study to develop a more detailed action description.</p>	Implementation of Alternative 2 with reasonably foreseeable actions for energy resources would be the same as for the No Action Alternative with the added actions.

Scenarios	Actions	Cumulative Effects of Actions
<p>Alternative 3 with Associated Cumulative Effects Actions in Year 2030</p>	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)</p> <p>Slight increase in positive Old and Middle River flows in the winter and spring months</p>	<p>Implementation of Alternative 3 with reasonably foreseeable actions would result in changes in stream flows and related hydroelectric generation patterns, and increased CVP and SWP water supplies as compared to the No Action Alternative with the added actions.</p> <p>Increased CVP and SWP water supply reliability would increase energy use for conveyance of CVP and SWP water supplies; and it is anticipated that energy use for alternative water supplies would decrease as compared to the No Action Alternative with the added actions.</p> <p>Increased energy use for CVP and SWP conveyance could increase use of electricity generation by fossil fuels; which could increase air quality issues and indirectly increase GHG emissions. However, decreased energy use for alternative water supplies could decrease use of electricity generation by fossil fuels; which could decrease air quality issues and indirectly decrease GHG emissions as compared to for the No Action Alternative with the added actions.</p>
<p>Alternative 5 with Associated Cumulative Effects Actions in Year 20530</p>	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO</p> <p>Positive Old and Middle River flows and increased Delta outflow in spring months</p>	<p>Implementation of Alternative 5 with reasonably foreseeable actions would result in similar net CVP and SWP hydroelectric generation, and reduced CVP and SWP water supplies as compared to the No Action Alternative with the added actions.</p> <p>It is anticipated that energy use for alternative water supplies would increase as compared to the No Action Alternative with cumulative effects which could increase air quality issues and indirectly increase GHG emissions as compared to for the No Action Alternative with the added actions.</p>

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## Chapter 17

# 1 Cultural Resources

## 2 17.1 Introduction

3 Cultural resources are defined as prehistoric and historic archaeological sites,  
4 architectural features (e.g., buildings, bridges, flumes, trestles, railroads), and  
5 traditional cultural properties. However, the focus of this chapter is more on  
6 cultural resources than historic properties.

7 This chapter describes the known existing cultural resources conditions in the  
8 study area and the potential changes that could occur as a result of implementing  
9 the alternatives evaluated in this Environmental Impact Statement (EIS).

10 Implementation of the alternatives could affect cultural and historic resources  
11 through potential changes in the operation of the Central Valley Project (CVP)  
12 and State Water Project (SWP). Changes in CVP and SWP operations could  
13 increase the frequency and duration of low-elevation reservoir conditions that  
14 would increase the time of exposure of inundated cultural resources within  
15 reservoirs that store CVP and SWP water. Changes in CVP and SWP operations  
16 also could reduce water supply availability to agricultural lands, and those lands  
17 could be subject to land use changes that could increase disturbances of cultural  
18 resources if present.

## 19 17.2 Regulatory Environment and Compliance 20 Requirements

21 Potential actions that could be implemented under the alternatives evaluated in  
22 this EIS could affect reservoirs, streams, and lands served by CVP and SWP  
23 water supplies located on lands with cultural resources. Actions implemented,  
24 funded, or approved by Federal and state agencies would need to be compliant  
25 with appropriate Federal and state agency policies and regulations, as summarized  
26 in Chapter 4, Approach to Environmental Analyses.

## 27 17.3 Affected Environment

28 This section describes the types of cultural resources that could be potentially  
29 affected by the implementation of the alternatives considered in this EIS.  
30 Changes in areas with cultural resources due to changes in CVP and SWP  
31 operations may occur at reservoirs that store CVP and SWP water and on lands  
32 that use CVP and SWP water supplies in the Trinity River, Central Valley, San  
33 Francisco Bay Area, and Central Coast and Southern California regions.



1    **17.3.1    Prehistoric Context**

2    **17.3.1.1    Introduction to the Prehistoric Context**

3    The study area has a long and complex cultural history with distinct regional  
4    patterns that extend back more than 11,000 years (Reclamation 1997). The first  
5    generally agreed upon evidence for the presence of prehistoric peoples in the  
6    study area is represented by the distinctive fluted spear points called Clovis  
7    points. These artifacts have been found on the margins of extinct lakes in the San  
8    Joaquin Valley. The Clovis points are found on the same surface with the bones  
9    of animals that are now extinct, such as mammoths, sloths, and camels. The  
10   subsequent period from about 10000 to 8000 BP (before present) was  
11   characterized by a small number of sites with stemmed spear points instead of  
12   fluted spear points. Approximately 8,000 years ago, many California cultures  
13   shifted the main focus of their subsistence strategies from hunting to seed  
14   gathering as evidenced by the increase in food-grinding implements found in  
15   archaeological sites dating to this period. In the last 3,000 years, the  
16   archaeological record becomes more complex as specialized adaptations to locally  
17   available resources were developed and populations expanded. Many sites dated  
18   to this time period contain mortars and pestles or are associated with bedrock  
19   mortars, implying that the occupants exploited acorns intensively. The range of  
20   subsistence resources that were used increased, exchange systems expanded, and  
21   social stratification and craft specialization occurred as indicated by well-made  
22   artifacts such as charm stones and beads, which were often found with burials.

23   **17.3.1.2    Prehistory of the Trinity River Region**

24   The Trinity River Region includes portions of Trinity County including Trinity  
25   Lake, Lewiston Reservoir, and Trinity River from Lewiston Reservoir to the  
26   Humboldt County boundary (near the eastern boundary of Hoopa Valley Indian  
27   Reservation); portions of Humboldt County including the Hoopa Valley Indian  
28   Reservation, Trinity River from the Humboldt County border to the Del Norte  
29   County border (near the confluence of the Trinity and Klamath rivers); and Del  
30   Norte County including the Lower Klamath River from the confluence with the  
31   Trinity River to the Pacific Ocean.

32   The area surrounding the present Trinity Lake and the Trinity River to its  
33   confluence with the Klamath River and along the Klamath River to the Pacific  
34   Ocean was inhabited by the Wintu, Chimariko, Yurok, and Hupa Indians at the  
35   time of Euroamerican contact.

36   **17.3.1.3    Prehistory of the Central Valley Region**

37   The Central Valley Region extends from above Shasta Lake to the Tehachapi  
38   Mountains and includes the Sacramento Valley, San Joaquin Valley, and the  
39   Delta and Suisun Marsh areas. The Sacramento Valley and San Joaquin Valley  
40   are divided into Eastern and Western subregions.

### 1 **17.3.1.3.1 Prehistory of the Sacramento Valley**

2 The western Sierra Nevada foothills appear to have been first used by Great Basin  
3 people around 8000 BP (Reclamation 1997). By approximately 4000 BP, people  
4 possibly from the Great Basin were seasonally hunting and gathering in the Sierra  
5 Nevada and the Sacramento Valley.

6 In the northern western portion of Sacramento Valley, between approximately  
7 12,000 and 150 years ago (12000 to 100 BP), the prehistoric societies of northern  
8 California underwent a series of slow but significant changes in subsistence and  
9 economic orientation, population densities and distribution, and social  
10 organization. These changes are thought to reflect migrations of various peoples  
11 into the area and displacement of earlier populations (Jensen and Reed 1980;  
12 Farber 1985; Reclamation 1997). Early archaeological investigations within  
13 Nomlaki and Wintu ethnographic territory, particularly the present Redding area  
14 and adjacent tracts of the southern Klamath Mountains, appear to indicate that  
15 human occupation of this area began approximately 1050 to 950 BP.

16 Little is known of human occupation on the floor of the Sacramento Valley prior  
17 to 4500 BP (Reclamation 1997). Because of alluvial and colluvial deposition  
18 over the past 10,000 years, ancient cultural deposits have been deeply buried in  
19 many areas. Initially, humans appeared to adapt to lakes, marshes, and grasslands  
20 environments until approximately 8000 to 7000 BP (Placer County 2007). The  
21 earliest evidence of widespread villages and permanent occupation of the lower  
22 Sacramento Valley, Delta, and Suisun Marsh areas comes from several sites  
23 assigned to the Windmill Pattern (previously, “Early Horizon”), dated circa  
24 4500 to 2500 BP (Ragir 1972; Reclamation 1997; Reclamation et al. 2010).

25 From circa 2500 to 1500 BP in the Central Valley area, villages were  
26 characterized by deep midden deposits, suggesting intensified occupation and a  
27 broadened subsistence base (Reclamation 1997, 2005a; Reclamation et al. 2010;  
28 Beardsley 1948; Heizer and Fenenga 1939; Moratto 1984).

29 During the late prehistoric period from 1500 to 100 BP, development may have  
30 been initiated due to the southward expansion of Wintuan populations into the  
31 Sacramento Valley (Moratto 1984; Reclamation 1997; Reclamation et al. 2010).  
32 The period is characterized by intensified hunting, fishing, and gathering  
33 subsistence with larger communities, highly developed trade networks, elaborate  
34 ceremonial and mortuary practices, and social stratification.

### 35 **17.3.1.3.2 Prehistory of the San Joaquin Valley**

36 Evidence of prehistoric occupation of the central and southern Sierra Nevada  
37 foothills goes back to 9,500 years ago. The vast majority of investigated sites,  
38 however, are less than 500 years old, probably representing a relatively recent  
39 proliferation of settlements by Yokut Indians (Moratto 1984; Reclamation 1997).  
40 The chronological sequence developed in the south-central Sierra Nevada as a  
41 result of the Buchanan Reservoir project in present Madera County is still used as  
42 a general framework (Reclamation 1997). Similar findings were identified in

1 major settlement sites along the San Joaquin River and in the present New  
2 Melones Reservoir area (Reclamation 2010; Reclamation and DWR 2011).

3 During the early Holocene period (10,000 to 12,000 years ago), peoples probably  
4 inhabited or passed through the San Joaquin Valley; however, few indications of  
5 this period have been discovered, probably due to burial beneath accumulated  
6 river sediment (Reclamation 1997, 2012). Examples of early Holocene cultural  
7 remains are known primarily from the Tulare Basin in the southern San Joaquin  
8 Valley. Evidence along the southern shoreline of the ancient Tulare Lake  
9 indicates that human presence may have occurred from 11000 BP (Reclamation  
10 and State Parks 2013).

11 From approximately 1650 to 950 BP, there is evidence that the people of the  
12 eastern San Joaquin Valley may have interacted with people in the Delta area  
13 (Reclamation 1997, 2012).

14 From approximately 450 to 100 BP, the people of the eastern San Joaquin Valley  
15 may have interacted with people in the Central Coast and Southern California  
16 areas. Material found in Pacheco to Panoche strata indicates a trade relationship  
17 with people of the Delta, Central Coast, and Southern California regions (Moratto  
18 1984; Reclamation 1997, 2012).

19 **17.3.1.4 Prehistory of the San Francisco Bay Area Region**

20 The San Francisco Bay Area Region only includes portions of the Bay Area that  
21 could be affected through implementation of the alternatives considered in this  
22 EIS, which includes Contra Costa, Alameda, Santa Clara, and San Benito  
23 counties. The prehistory context is different throughout the San Francisco Bay  
24 Area Region. Human occupation in the northern valley regions of present San  
25 Benito County occurred as described above for the western San Joaquin Valley  
26 (San Benito County 2010).

27 Human occupation in the coastal regions of present Contra Costa and Alameda  
28 counties occurred as described above for the southern portion of the Sacramento  
29 Valley (Reclamation 1997; DWR 2008; Zone 7 2006). From 5000 to 2500 BP,  
30 dense settlements extended from the coastal marshes to interior grasslands and  
31 woodlands (Zone 7 2006). From about 2500 to 950 BP, coastal communities  
32 relied upon shellfish, and major shellmounds were created near these  
33 communities, including near the present Alameda County shorelines and some  
34 interior valleys.

35 Settlement of the interior valleys of the present Contra Costa, Alameda, and Santa  
36 Clara counties occurred during the past 12,000 years. From 6000 to 1700 BP,  
37 settlements occurred, as there was less emphasis on nomadic hunting for large  
38 animals and increased emphasis on the use of plant materials and hunting, fishing,  
39 and shellfish collection (Santa Clara County 2012; CCWD et al. 2009). The  
40 communities established economies and traded between the communities.

1 **17.3.1.5 Prehistory of the Central Coast Region**

2 The prehistory of the Central Coast Region for this EIS (present day San Luis  
3 Obispo and Santa Barbara counties) is poorly known but may have begun around  
4 11000 BP and probably represents mobile hunter-gatherers (Reclamation 1997;  
5 San Luis Obispo County 2010; Santa Barbara 2010). Fishing, intensive shellfish  
6 collecting, and hunting began around 9000 BP. Use of milling stones and  
7 establishment of communities occurred after about 8500 BP. After about  
8 5000 BP, there was greater reliance on hunting of land and sea mammals,  
9 gathering of shellfish, and use of mortars and pestles. Subsequently, larger  
10 settlements occurred for ethnographically known peoples, including the Chumash.

11 **17.3.1.6 Prehistory of the Southern California Region**

12 The Southern California Region includes the present Ventura, Los Angeles,  
13 Orange, San Diego, Riverside, and San Bernardino counties, which have  
14 substantially different prehistory characteristics.

15 In the coastal areas of the Southern California Region (present Ventura, Los  
16 Angeles, Orange, and San Diego counties), early habitation extends over  
17 12,000 years ago (Ventura County 2005; Los Angeles 2005; San Diego County  
18 2011b). Between 12000 and 7500 BP, the inhabitants were hunter-gatherer  
19 populations that used land and marine resources. The population along the  
20 northern coast of Southern California began expanding between 9000 and  
21 8500 BP. Permanent coastal settlements expanded as plants, shellfish, and marine  
22 mammals became a large part of the subsistence (Glassow et al. 2007; Los  
23 Angeles 2005). From 5000 to 450 BP, the use of plant materials and exploitation  
24 of fish and sea mammals increased sedentism and socioeconomic interaction  
25 (Glassow 1999; Los Angeles 2005; San Diego County 2011b).

26 The interior area within the Southern California Region considered in this EIS  
27 includes portions of Riverside and San Bernardino counties that use SWP water  
28 supplies, including the Mojave Desert and the Peninsular Ranges.

29 Clovis (circa 12000 to 10000 BP) is the only cultural complex dating from the  
30 Pleistocene that can be consistently identified in the Mojave Desert (Sutton et al.  
31 2007). The Clovis culture characteristics appear to be associated with Paleo-  
32 Indian groups as big game hunters. More recently, there have been indications  
33 that the people had greater cultural and economic diversity than previously  
34 recognized (CDFG 2009). Paleo-Indian groups were likely small, highly mobile  
35 populations living in small, temporary camps near permanent water sources  
36 (Sutton et al. 2007).

37 From 10000 and 8000 BP, communities were organized around relatively small  
38 social units (Sutton et al. 2007; Riverside County 2000). From 7000 to 4000 BP,  
39 hunting continued while foraging subsistence transformed during this period to  
40 more collection of plant and animal materials within adjacent ecological zones  
41 (CDFG 2009; Riverside County 2000; Sutton et al. 2007). Between 4000 and  
42 1750 BP, permanent seasonally occupied settlements occurred in the lower valley  
43 with the use of oak woodlands and mesquite groves (Riverside County 2000;  
44 Sutton et al. 2007).

1 From 1750 to 850 BP, communities increased and trade between communities  
2 expanded (CDFG 2009; Gardner 2002, 2006; Riverside County 2000;  
3 Sutton et al. 2007; Sutton 1988, 1996; Warren and Crabtree 1986). During this  
4 period, the lower Coloradan culture became more prevalent along the shoreline of  
5 the Lake Cahuilla area (site of the present Salton Sea and Coachella Valley Water  
6 District) (Riverside County 2000). The lower Coloradans relied upon shellfish,  
7 fish, aquatic birds, marsh and riparian vegetation, and mammals. The culture may  
8 have been influenced by the Anasazi settlements of present Southern Nevada,  
9 including cultivation of corns, beans, and squash. The Anasazi people also  
10 occupied portions of present San Bernardino County where turquoise was mined.  
11 Extensive trading occurred between the people in the inland areas and the people  
12 along the coast.

13 After about 850 BP, populations appeared to decline, and several cultural  
14 complexes emerged (Sutton et al. 2007). Late Prehistoric occupation sites were  
15 based on hunting and gathering, especially of plant foods and small game  
16 (Riverside County 2000). Villages in Antelope Valley began to disappear in the  
17 later prehistoric times, probably due to the disappearance of lakes that were the  
18 headwaters of the Mojave River or changes in trade route locations (DWR 2009).  
19 Lake Cahuilla declined around 450 BP and the large populations dispersed to the  
20 Colorado River, western Peninsular Ranges in present western Riverside County,  
21 and the Pacific Ocean coast (Riverside County 2000).

## 22 **17.3.2 Ethnographic Context**

### 23 **17.3.2.1 Introduction to Ethnographic Context**

24 This section provides brief ethnographic sketches for each native cultural group  
25 whose traditional territories are within the study area. Each ethnographic sketch  
26 presents the territorial limits of each respective cultural group and then focuses  
27 mainly on those aspects of culture that are potentially represented in the  
28 archaeological record.

29 The study area encompasses lands occupied by more than 40 distinct Native  
30 American cultural groups. Although most California tribes shared similar  
31 elements of social organization and material culture, linguistic affiliation and  
32 territorial boundaries primarily distinguish them from each other. Before  
33 European settlement of California, an estimated 310,000 native Californians  
34 spoke dialects of as many as 80 mutually unintelligible languages representing  
35 six major North American language stocks (Cook 1978; Moratto 1984;  
36 Reclamation 1997; Shipley 1978).

### 37 **17.3.2.2 Ethnography of the Trinity River Region**

38 The Trinity River Region includes portions of Shasta, Trinity, Siskiyou,  
39 Humboldt, and Del Norte counties. This area is bounded by the Sacramento  
40 River on the east, the Pacific Ocean on the west, and the middle and upper  
41 Klamath Basin on the north. The ethnography of the Yurok, Hupa, Wintu, and  
42 Chimariko is described below.

1 **17.3.2.2.1 Yurok**

2 The Yurok inhabited California's northwestern coastline from Little River to  
3 Damnation Creek; along the Klamath River from the confluence with the Pacific  
4 Ocean up past the Klamath-Trinity confluence to Slate Creek; and approximately  
5 6 miles along the Trinity River upstream of the confluence with the Klamath  
6 River (Pilling 1978; USFWS et al. 1999). The Yurok life, communities, society,  
7 and ceremonies are deeply connected with the Klamath River (DOI and CDFG  
8 2012). Yurok culture and traditional stories describe that the Klamath River was  
9 created to facilitate the interaction with two neighboring people, the Hupa and the  
10 Karuk, and with the salmon that lived in the Klamath River. Both the Hupa and  
11 Karuk culture and traditional stories also describe this close interaction of the  
12 peoples, salmon, and Klamath River.

13 Yurok are recognized for their highly stylized art forms and their skills in making  
14 redwood canoes, weaving fine baskets, hunting, and especially riverine salmon  
15 fishing. The ancient traditions are continued through contemporary times  
16 (USFWS et al. 1999). The redwood canoes for ocean conditions can be 30 to  
17 40 feet in length, designed to haul large amounts of fish and seal carcasses, and  
18 paddled by 5 to 20 paddlers (DOI and CDFG 2012). The canoes are used to  
19 gather food and materials, transport people and materials, and for ceremonial  
20 aspects of the Yurok culture. The Jump and Deerskin ceremonies are held in late  
21 fall to give thanks for abundant food supplies. The Deerskin Ceremony includes a  
22 Boat Ceremony in which the participants travel down the Klamath River to thank  
23 the river for continuing to flow and provide resources.

24 **17.3.2.2.2 Hupa**

25 The Hupa inhabited the area surrounding the lower reaches of the Trinity River  
26 from approximately Salyer to approximately 6 miles upstream from the  
27 confluence with the Klamath River (Wallace 1978a; USFWS et al. 1999). Hupa  
28 life is defined by extended families affiliated with villages.

29 The Hupa believe that the Klamath and Trinity rivers were created to provide  
30 interaction with other peoples (Yurok and Karuk) and with the salmon (DOI and  
31 CDFG 2012). Many of the Hupa ceremonies highlight their relationship with the  
32 rivers, including world renewal ceremonies and ceremonies for bountiful harvests.  
33 The world renewal ceremonies include the White Deerskin and Jump ceremonies  
34 to honor the earth and the creator for providing food and other resources. The  
35 ceremonies for bountiful harvest of fish and acorns include the First Salmon  
36 ceremony and the Acorn Feast.

37 **17.3.2.2.3 Wintu**

38 When the Europeans and Americans first explored California, most of the western  
39 side of the Sacramento Valley north of about Suisun Bay was inhabited by  
40 Wintun-speaking people (USFWS et al. 1999). Early in the anthropological study  
41 of the region, a linguistic and cultural distinction was recognized between the  
42 Wintun-speaking people in the southwestern Central Valley (the Patwin) and the

1 people occupying the northwestern Central Valley and Trinity River Valley  
2 (LaPena 1978; USFWS et al. 1999).

### 3 **17.3.2.2.4 Chimariko**

4 The Chimariko lived in a 20-mile-long reach of the Trinity River from  
5 approximately Big Bar to the confluence with the South Fork (Silver 1978a;  
6 USFWS et al. 1999). Although the Chimariko language is now extinct, early  
7 ethnographers recorded some words, and the language is thought to be of Hokan  
8 stock.

### 9 **17.3.2.3 Ethnography of the Central Valley Region**

#### 10 **17.3.2.3.1 Ethnography of the Sacramento Valley**

##### 11 *Maidu, Konkow, and Nisenan*

12 Maidu (also known as northeastern Maidu), Konkow (also known as northwestern  
13 Maidu), and Nisenan (also known as southern Maidu) inhabited an area of  
14 California from Lassen Peak to the Cosumnes River, and from the Sacramento  
15 River to Honey Lake (Reclamation 1997; Shipley 1978). Northeastern Maidu  
16 territory extended from Lassen Peak on the west to Honey Lake on the east,  
17 Sierra Buttes on the south, and Eagle Lake on the north. The Konkow inhabited  
18 the region from the Lower Feather River in the north, to the Sutter Buttes in the  
19 south, and to the west beyond the Sacramento River. The Nisenan lived in the  
20 area east of the Sacramento River and along the Middle Fork Feather River, Bear  
21 River, American River, and Cosumnes River from the Sacramento River  
22 almost to Lake Tahoe (Riddell 1978; Wilson and Towne 1978; Reclamation  
23 1997, 2005b).

##### 24 *Yana*

25 The Yana of north-central California inhabited an area from Lassen Peak and the  
26 southern Cascade foothills on the east, Rock Creek on the south, Pit River on the  
27 north, and the eastern bank of the Sacramento River on the west. The western  
28 boundary is the most uncertain (J. Johnson 1978a; Reclamation 1997).

##### 29 *Achumawi, Atsugewi, and Shasta*

30 The Achumawi and Atsugewi of northeastern California are two linguistically and  
31 culturally distinct but related groups (Reclamation 1997). The Achumawi and  
32 Atsugewi languages belong to the Palaihnihan family, or Hokan stock. The  
33 territory of the Achumawi extended generally to Mount Lassen, west to Mount  
34 Shasta, northeast to Goose Lake, and east to the Warner Range (Kroeber 1925;  
35 Olmsted and Stewart 1978; Garth 1978; Reclamation 1997). Overlapping this  
36 area to some extent, the Atsugewi territory ranged from Mount Lassen in the  
37 southwest, the Pit River in the north, and Horse Lake to the east.

38 The Shasta peoples were originally thought to be associated with the Achumawi  
39 and Atsugewi but then were considered as a separate group (Kroeber 1925;  
40 Reclamation 1997; Shipley 1978). The Shasta peoples inhabited the area from  
41 southern Oregon at the Rogue River, south to the present Cecilville, and the area  
42 between the Marble and Salmon mountains to Mount Shasta in the west and the

1 Cascade Range in the east. In California, the core areas of settlement were in  
 2 Shasta Valley, Scotts Valley, and along the Klamath River from about Scotts  
 3 River to the town of Hornbrook (Silver 1978b).

4 *Plains Miwok*

5 The Plains Miwok established villages along river courses in the foothills located  
 6 east of Sacramento and the Delta (Reclamation 2005b).

7 *Nomlaki*

8 Two major divisions existed among the Nomlaki: the River and Hill Nomlaki  
 9 (Goldschmidt 1978; DuBois 1935; Reclamation 1997). The River Nomlaki  
 10 occupied the Sacramento River Valley in present eastern Tehama County. The  
 11 Hill Nomlaki occupied the eastern side of the Coast Ranges in present Tehama  
 12 and Glenn counties. The Nomlaki and Wintu conducted trading between the  
 13 peoples (Goldschmidt 1978; DuBois 1935; Reclamation 1997).

14 *Patwin*

15 The Patwin lived along the western side of the Sacramento Valley from the  
 16 present Princeton to Benicia, including Suisun Marsh (Kroeber 1925;  
 17 Reclamation 1997; Reclamation et al. 2010). Within this large area, the Patwin  
 18 have traditionally been divided into River, Hill, and Southern Patwin groups.  
 19 Settlements generally were located on high ground along the Sacramento River or  
 20 tributary streams, or in the eastern Coast Range valleys. The ethnographically  
 21 recorded villages of Aguasto and Suisun were located near San Pablo and Suisun  
 22 bays (P. Johnson 1978b; Reclamation 1997; Reclamation et al. 2010).

23 **17.3.2.3.2 Ethnography of the San Joaquin Valley**

24 *Eastern Miwok*

25 The Miwok cultures in present California include the Coast Miwok, Lake Miwok,  
 26 and Eastern Miwok divisions. The Eastern Miwok included five separate groups  
 27 (Bay, Plains, Northern Sierra, Central Sierra, and Southern Sierra) that inhabited  
 28 the area from present Walnut Creek in Contra Costa County and the Delta, along  
 29 the lower Mokelumne and Cosumnes rivers and along the Sacramento River from  
 30 present Rio Vista to Freeport, the foothill and mountain areas of the upper  
 31 Mokelumne River and Calaveras River watersheds, the upper Stanislaus River  
 32 and Tuolumne River watersheds, and the upper Merced River and Chowchilla  
 33 River watersheds, respectively (Levy 1978a; Reclamation 1997; Shipley 1978).  
 34 No one Miwok tribal organization encompassed all the peoples speaking  
 35 Miwokan languages, nor was there a single tribal organization that encompassed  
 36 an entire division.

37 *Yokuts*

38 Yokuts are a large and diverse number of people in the San Joaquin Valley and  
 39 Sierra Nevada foothills of central California, including the Southern San Joaquin  
 40 Valley Yokuts, Northern San Joaquin Valley Yokuts, and Foothill Yokuts  
 41 (Reclamation 1997; Reclamation et al. 2011a; SJRRP 2011). The three  
 42 subdivisions of the Yokuts languages belong to the Yokutsan family, or Penutian  
 43 stock (Shipley 1978).



1 The Southern Valley Yokuts inhabited the southern San Joaquin Valley from  
2 present Fresno to the Tehachapi Mountains (Wallace 1978b). The Northern  
3 Valley Yokuts inhabited the northern San Joaquin Valley from Bear Creek to the  
4 San Joaquin River near present Mendota, western San Joaquin Valley near present  
5 San Luis Reservoir, and eastern present Contra Costa and Alameda counties  
6 (ECCCHCPA et al. 2006; Wallace 1978c; Reclamation and State Parks 2012;  
7 Reclamation and DWR 2011). The Foothill Yokuts inhabited the western slopes  
8 of the Sierra Nevada foothills from the Fresno River to the Kern River (Spier  
9 1978b; Reclamation and State Parks 2013). Yokuts were mobile hunters and  
10 gatherers with semipermanent villages and seasonal travel corridors to food  
11 sources.

12 The Yokuts probably traded with the Costanoan people from the coastal areas  
13 based upon the abalone and other mussel shells found in settlement sites  
14 (Reclamation and State Parks 2012).

15 *Dumna and Kechayi*

16 The Dumna and Kechayi lived along the San Joaquin River in the Sierra Nevada  
17 foothills near the present Millerton Lake (Reclamation and State Parks 2013).

18 **17.3.2.4 Ethnography of the San Francisco Bay Area Region**

19 Native inhabitants of the San Francisco Bay Area Region include the Miwok,  
20 Cholvon Northern Valley Yokuts, and the Costanoan Indians (Reclamation 1997;  
21 CCWD et al. 2009; ECCCHCPA et al. 2006; EBMUD 2009; Reclamation 2005b;  
22 Santa Clara County 2012; San Benito County 2013).

23 **17.3.2.4.1 Miwok**

24 In the San Francisco Bay Area Region, the Coast Miwok people lived along lower  
25 San Joaquin River and San Pablo Bay and in the interior of the present Contra  
26 Costa and Alameda counties (Reclamation 1997; ECCCHCPA et al. 2006; Kelly  
27 1978). The Bay Miwok villages were located in the San Ramon Valley with other  
28 settlements on the western slopes of the Diablo Range. The Volvons, speakers of  
29 the Bay Miwok language, settled along Marsh Creek and Kellogg Creek on the  
30 northern side of the Diablo Range and near the present Los Vaqueros Reservoir  
31 (CCWD et al. 2009). The Miwok people may have held lands at the peak of  
32 Mount Diablo.

33 **17.3.2.4.2 Costanoan**

34 The Costanoans (also known as Ohlone) are a linguistically defined group with  
35 several autonomous tribelets that speak related languages (Levy 1978b;  
36 Reclamation 1997; EBMUD 2009; Zone 7 2006; Santa Clara County 2012). The  
37 Costanoans inhabited coastal shorelines along San Francisco, San Pablo, and  
38 Suisun Bay and along the Pacific Ocean Coast from the Golden Gate to Monterey  
39 Bay and interior valleys that extended approximately 60 miles inland, including  
40 areas within Santa Clara and San Benito counties (Reclamation 1997;  
41 ECCCHCPA et al. 2006; San Benito County 2010).

1 **17.3.2.5 Ethnography of the Central Coast Region**

2 The Central Coast Region considered in this EIS includes the coastal areas of  
3 present San Luis Obispo and Ventura counties. This area was home to the  
4 Salinan, Chumash, and Tataviam people.

5 The Salinan territory extends from about the present location of Soledad  
6 (Monterey County) to San Luis Obispo (Hester 1978). The Chumash are  
7 considered to have been one of the most elaborate cultures in California. The  
8 Chumash culture is characterized by large villages with social ranking, intensive  
9 trade, craft specialization, and well-developed art styles (Grant 1978b;  
10 Greenwood 1978; Kroeber 1925; Moratto 1984; Reclamation 1997; San Luis  
11 Obispo County 2010; Santa Barbara 2010; Santa Barbara County 2010). The  
12 Chumash inhabited the central coastal area of California from approximately  
13 present San Luis Obispo to Malibu Canyon and inland to western San Joaquin  
14 Valley.

15 **17.3.2.6 Ethnography of the Southern California Region**

16 The coastal portion of the Southern California Region considered in this EIS  
17 includes the present Ventura, Los Angeles, Orange, and San Diego counties. The  
18 interior portion of the Southern California Region includes the present western  
19 and central Riverside County and western San Bernardino County.

20 **17.3.2.6.1 Prehistory of Southern California Region, Coastal Portion**

21 The Chumash and Tataviam people lived in the present Ventura County and  
22 northern Los Angeles County areas. The ethnography of the Chumash people is  
23 similar to that described above for the Central Coast Region. The Tataviam  
24 people lived inland of the Chumash and Gabrielino on the upper reaches of the  
25 Santa Clara River drainage east of Piru Creek and extending over the Sawmill  
26 Mountains to the edge of the southwestern Antelope Valley (King and  
27 Blackburn 1978).

28 The Gabrielino and Juaneño people lived in the present Los Angeles and Orange  
29 counties areas. The Gabrielino (also known as Gabrielino Tongva or Gabrieleño)  
30 occupied the Southern California coast in the vicinity around Mission San  
31 Gabrielal areas. The Juaneño occupied the area around the mission (Bean and  
32 Smith 1978; Los Angeles 2005; Riverside County 2000). These people traded  
33 with other people in Southern California.

34 The Luiseño and Tipai-Ipai people lived in the present Orange and San Diego  
35 counties areas. The Luiseño occupied most of the San Luis Rey and Santa  
36 Margarita River drainages near San Luis Rey Mission (Bean and Shipek 1978).  
37 The Luiseño shared many cultural traits with the Gabrielino and Chumas people.  
38 The Tipai-Ipai (also known as Kumeyaay) occupied extreme Southern California  
39 and Northern Baja California in autonomous, seminomadic bands of patrilineal  
40 clans (Luomala 1978; San Diego County 2011b; CDFG 2009). The Ipai occupied  
41 the areas north of the San Diego River, and the Tipai occupied the area south of  
42 the San Diego River (San Diego County 2011b).

1     **17.3.2.6.2 Prehistory of Southern California Region, Interior Portion**

2     The Cahuilla, Serrano, Tubatalabal, Kawaiisu, and Quechan people lived in  
3     present Riverside, eastern Los Angeles, southeastern Kern, and western San  
4     Bernardino counties. The Tubatalabal also lived in the southeastern San Joaquin  
5     Valley in present southeastern Kern County.

6     *Cahuilla*

7     The Cahuilla lived inland within present Riverside County. Villages were located  
8     in canyons or on alluvial fans close to food and water sources. The Cahuilla  
9     interacted frequently with other people in Southern California (Bean 1978;  
10    Riverside County 2000).

11    *Serrano*

12    The Serrano lived in the San Bernardino Mountains within present northeastern  
13    Los Angeles County and southwestern San Bernardino County and in the  
14    northwestern valleys and mountains of Riverside County. Villages were located  
15    close to food and water sources along perennial streams and lakes. The Serrano  
16    interacted frequently with other people in Southern California (Riverside County  
17    2000; DWR 2009).

18    *Kawaiisu*

19    The Kawaiisu occupied a mountainous area between the Mojave Desert and the  
20    southern San Joaquin Valley, mostly in Kern County, and the Tehachapi Valley  
21    (Zigmond 1986; California State Parks 2014). The Kawaiisu lived in permanent  
22    winter villages and traveled during the warmer months into the Mojave Desert  
23    and Antelope Valley. They traded and interacted with neighboring groups,  
24    including the Chumash, Yokuts, and Tubatalabal people.

25    *Quechan*

26    The Quechan were Yuman people that occupied areas along the Colorado River  
27    and adjacent valleys, including present Coachella and Imperial valleys (Riverside  
28    County 2000). The Quechan had a strong tribal identity and traveled extensively  
29    for trade.

30    **17.3.3 Historical Context**

31    The historical context presented in this section is focused on historical activities  
32    and resources that affected and/or were affected by implementation of water  
33    resource actions of CVP and SWP water users. Changes in CVP and SWP  
34    operations under implementation of alternatives considered in this EIS could not  
35    only affect CVP and SWP facilities. These changes also could affect regional and  
36    local water supplies, reservoirs, and associated land uses of those that use CVP  
37    and SWP water.

38    **17.3.3.1 Introduction to Historical Context**

39    Initial contact with Europeans and Americans occurred with Spanish missionaries  
40    and soldiers, who entered California from the south in 1769, eventually founding  
41    21 missions along the California coast (Reclamation 1997). This period is  
42    characterized by the establishment of missions and military presidios, the

1 development of large tracts of land owned by the missions, and subjugation of the  
2 local Indian population for labor. This way of life began to change in 1822 when  
3 Mexico became independent of Spain. The mission lands were divided by  
4 government grants into large ranchos often consisting of tens of thousands of  
5 acres. The owners of these large *estancias* built homes, often of adobe, and  
6 maintained large herds of cattle and horses.

7 During the Spanish and Mexican periods, explorers entered the region. Fort Ross  
8 on the Sonoma coast was established by the Russians from 1812 until 1841 to  
9 support hunting, fishing, and whaling businesses (Reclamation 1997). American  
10 explorer Jedediah Smith and Peter Skene Odgen, Chief Trader for the Hudson  
11 Bay Company, with other members of the Hudson Bay Company also came to  
12 California during this period.

13 In 1848, the Treaty of Guadalupe Hidalgo transferred the lands of California from  
14 the Mexican Republic to the United States and initiated what is called the  
15 American Period in California history (Reclamation 1997). During that same  
16 year, gold was discovered in the foothills of the Sierra Nevada, and thousands of  
17 hopeful miners as well as storekeepers, settlers, and farmers entered the region.  
18 Mining in the Trinity River Region was expanded for both gold and copper mines  
19 (Placer County 2007).

20 To support this growth, extensive transportation systems were created to support  
21 wagon routes, steamboats on the major rivers, and numerous railroads  
22 (Reclamation 1997). Many of the supply centers and shipment points along these  
23 transportation corridors developed into cities, towns, and settlements. Logging  
24 and ranching also expanded to meet the needs of the new settlers. American  
25 ranchers found Central California ideally suited for grazing large herds of stock.  
26 During the latter part of the 19th century, American ranchers amassed large tracts  
27 of former rancho land, and several great cattle empires were formed. As  
28 settlements grew, farming increased. A primary constraint to expansion of crop  
29 diversity and areas under cultivation was the lack of water. Irrigation was  
30 virtually unknown in California until the 1880s, when large-scale irrigation  
31 systems were developed to improve agriculture yields. With the development of  
32 irrigation and improved transportation, new crops were added to the grains  
33 obtained from dry farming, including vegetables, fruits, and nuts.

34 Irrigation capabilities further expanded in the 1950s and 1960s with the  
35 implementation of multiple water projects. The availability of water also  
36 expanded the agricultural and urban water supplies in the Central Valley,  
37 San Francisco Bay Area, Central Coast, and Southern California regions.

### 38 **17.3.3.2 History of the Trinity River Region**

39 Explorers from the Philippines and Europe may have visited and interacted with  
40 the Yurok people as early as the late 1700s. Peter Skene Odgen and Jedediah  
41 Smith initially visited the Lower and Middle Klamath River reaches in the 1820s.  
42 In 1828, Jedediah Smith and his party of explorers were the first white men  
43 known to have visited the Trinity River watershed (USFWS et al. 1999).

1 Although the area was first used extensively by trappers, gold was discovered on  
2 the Trinity River in 1848, and by the late 1840s, gold mining was a major activity  
3 along the Trinity River (Hoover et al. 1990; Del Norte County 2003; USFWS  
4 et al. 1999). Weaverville was the center of gold mining activity after 1849 with  
5 numerous mining camps and settlements along the Trinity River. Mining  
6 continued along the Trinity River through the early and mid-1900s with  
7 large-scale dragline and bucket dredging operations beginning in 1939.  
8 Logging has occurred since the 1880s and continues in the Trinity River Region.  
9 These activities resulted in significant changes to rivers and may have caused  
10 the destruction of many prehistoric or historic archaeological sites (Hoover  
11 et al. 1990).

12 Increased activities within the Trinity River Region led to conflicts between the  
13 new residents and the Yurok and Hupa people. On November 16, 1855, the  
14 Klamath Indian Reservation was established by Executive Order for lands from  
15 the mouth of the Klamath River to a location upstream of Tectah Creek that  
16 extended 1 mile wide on either side of the river for the approximately 20-mile  
17 reach (DOI and CDFG 2012). The Hoopa Valley Reservation was established in  
18 1864 and expanded in 1891 to include lands from the mouth of the Klamath River  
19 to the Hoopa Valley that extended 1 mile wide on either side of the river  
20 including portions of the Klamath Indian Reservation. In 1988, the Hoopa-Yurok  
21 Settlement Act (Public Law 100-580) partitioned portions of the previously  
22 established reservations into the Yurok Indian Reservation and Hoopa Valley  
23 Reservation and established the Resighini Rancheria.

### 24 **17.3.3.3 History of the Central Valley Region**

#### 25 **17.3.3.3.1 History of the Sacramento Valley**

26 Europeans, Americans, and Canadians may have initially entered the Sacramento  
27 Valley in the late 1700s and early 1800s as part of missionary or military  
28 expeditions (Reclamation 1997, 2005a; Reclamation et al. 2006; Placer County  
29 2007). By 1776, Jose Canizares explored areas located south of the present  
30 Sacramento community, and in 1813, there was a major battle between the  
31 Spanish and the Miwok people near the confluence of the Cosumnes River along  
32 the Sacramento River. Fur trappers moved through this area from the 1820s  
33 to 1840s.

34 The first settlements in this area occurred in the 1830s and 1840s on Mexican  
35 Land Grants. The New Helvetica Land Grant, which included more than  
36 40,000 acres in the Sacramento Valley, was awarded to John Sutter in 1841  
37 (DSC 2011).

38 Following the discovery of gold on the New Helvetica Land Grant in 1848 near  
39 present-day Coloma, numerous mining-related settlements were established in  
40 areas with the Nisenan, Maidu, Konkow, and Atsugewi people in the eastern  
41 portion of the Sacramento Valley and in areas with the Nomlaki and Wintu people  
42 in the western Sacramento Valley. Many of the Native Americans died after

1 exposure to diseases from the new settlers, including malaria. Numerous other  
 2 Native American died during battles against the new settlers.

3 Mining activities in the northern Sacramento Valley foothills and mountains near  
 4 present Redding primarily were related to gold and copper (Reclamation 2013a).  
 5 Mining activities in the central Sierra Nevada foothills primarily were related to  
 6 gold. In 1848, mining started along the Trinity River and upper Sacramento River  
 7 tributaries, primarily for copper and gold (Reclamation 2013a; Reclamation et al.  
 8 2006). Smelters, mills, and communities grew rapidly near the mining areas,  
 9 including the town of Keswick, and communities were established within and  
 10 adjacent to the present day Folsom Lake. The development of hydraulic mining  
 11 in 1851 required establishment of substantial water diversions, flumes, and  
 12 ditches to convey the water and displacement of vast amounts of sediment into the  
 13 streams and along the banks of the waterways.

14 Logging also was a dominant industry in the western Sacramento Valley since the  
 15 1850s (Reclamation 1997, 2013a). The logging industry grew as the railroads  
 16 were extended. Establishment of logging in the Sierra Nevada foothills and  
 17 mountains also led to development of water infrastructure to move and/or mill the  
 18 logs. One of the first water system infrastructures developed for these purposes  
 19 was the original Folsom Dam constructed in 1893 (Reclamation et al. 2006).

20 Agricultural activities were successful throughout the Sacramento Valley to serve  
 21 the mining communities (Reclamation 1997). The completion of the first  
 22 transcontinental railroad in 1869 increased the number of settlers and allowed  
 23 transport of crops from the Sacramento Valley to Nevada, Utah, and subsequently  
 24 to other areas of the nation (Reclamation 2005b). The expanded agricultural  
 25 markets expanded due to the establishment and development of commercial  
 26 crops, accessibility to markets, and new farming techniques and irrigation.

27 Construction of hydroelectric power and water storage facilities in the Sacramento  
 28 Valley foothills started in the early 1900s to provide hydropower and water  
 29 supplies to local and regional users, as well as export to other portions of the state  
 30 using CVP, SWP, City and County of San Francisco, and East Bay Municipal  
 31 Utility District facilities.

### 32 **17.3.3.3.2 History of the San Joaquin Valley**

33 The San Joaquin Valley area was not widely settled by Europeans or Mexicans  
 34 when California lands were under Spanish rule (1769 to 1821) or Mexican rule  
 35 (1821 to 1848). Numerous expeditions travelled through the San Joaquin Valley  
 36 during this period but did not establish major settlements (Reclamation 2010).  
 37 During the Spanish rule, several settlements occurred along Fresno Slough  
 38 (Reclamation and State Parks 2012; Reclamation and DWR 2011). There were  
 39 several settlements along the San Joaquin River and along the western boundary  
 40 of the San Joaquin Valley during Mexican rule when ranches were established in  
 41 the Coast Range foothills, including in Pacheco Pass and along Los Banos Creek.

42 In the latter half of the 19th century, agricultural settlements and mining camps  
 43 were established in the San Joaquin Valley along the railroad corridors

1 (Reclamation 1997; Reclamation and DWR 2011). The town of Rootville,  
2 subsequently renamed Millerton in honor of Major Miller, was established near  
3 the present Millerton Lake with a military post, Camp Barbour (later named Fort  
4 Miller) to maintain order in the mining camps.

5 Initially, agricultural activities were related to ranching and dry farming.  
6 Livestock ranching expanded in the late 1860s (Reclamation et al. 2011b). With  
7 the increased availability of electric pumps, groundwater and surface water  
8 irrigation was used throughout the valley. Many irrigation districts were formed  
9 after the passage of the Wright Act in 1877 that provided methods to finance  
10 major irrigation projects. One of the first irrigation systems constructed in the  
11 eastern San Joaquin Valley was the “Main Canal” as part of the Miller and Lux’s  
12 San Joaquin and Kings River Canal and Irrigation Company (Reclamation and  
13 State Parks 2013).

14 Historic resources are related to the settlement of the valley and include  
15 homesteads, transportation infrastructure (such as ship landings, ferry ports, and  
16 bridges), food processing and other industrial facilities, residential properties,  
17 commercial establishments, mining features (in the eastern portion), and  
18 government facilities (Reclamation 1997, 2010; Reclamation and DWR 2011).

#### 19 **17.3.3.3 History of the Delta and Suisun Marsh**

20 Communities were not established in the Delta and Suisun Marsh areas until the  
21 mid-1800s. There were numerous Spanish expeditions under Spanish rule. In the  
22 1830s and 1840s, Mexico established land grants, including Rancho Suisun  
23 located west of present City of Fairfield (Reclamation et al. 2010).

24 Following the discovery of gold in the Sacramento Valley, settlements occurred in  
25 the Delta to provide support services and agricultural products for those traveling  
26 to the gold fields and the Sacramento and San Francisco areas. Passage of the  
27 Swamp and Overflow Act in 1850 led to the transfer of lands from the U.S.  
28 Government in the Delta to the State of California, which subsequently sold the  
29 land to individuals. The new settlers in the Delta constructed levees to protect the  
30 lands from periodic flooding and drained other lands to reduce the potential for  
31 mosquito-borne diseases. By the 1920s, numerous communities were established  
32 around food processing and packing houses that supported a wide range of crops  
33 such as asparagus, barley, celery, corn, winter grain, sugar beets, onions, and  
34 alfalfa for local dairy farms were introduced to the area (DSC 2011; Reclamation  
35 et al. 2010). By the 1950s, major food packers and processors moved from the  
36 Delta, and many communities became smaller. Recreational opportunities were  
37 established in the 1850s with duck hunting opportunities in the Suisun Marsh  
38 area.

#### 39 **17.3.3.4 History of the San Francisco Bay Area Region**

40 In 1579, Sir Francis Drake and other Spanish explorers led expeditions into the  
41 San Francisco Bay Area. However, in general, the Spanish did not settle Northern  
42 California until the 1700s when other Europeans established trading settlements  
43 for fur, mining, and other products. Initially, the Spanish confined their

1 settlement to the coastline to establish military bases, or presidios (Hoover et al.  
 2 1990). Father Junipero Serra and other Franciscans worked with the Spanish  
 3 explorers to establish missions along the Alta California coastal areas between  
 4 present Sonoma County (San Francisco Solano established in 1823) to present  
 5 Ventura County (San Buenaventura established in 1782), including three missions  
 6 in areas that use CVP and SWP water (Mission San Jose established in 1797,  
 7 Mission Santa Clara established in 1777, and Mission San Juan Bautista  
 8 established in 1797).

9 San Jose was one the first towns established in Alta California as Pueblo de San  
 10 José de Guadalupe (Santa Clara County 2012). The Spanish government awarded  
 11 land grants in the San Francisco Bay Area Region (DWR 2008; EBMUD 2009;  
 12 Hoover et al. 1990; Reclamation 2005b; San Benito County 2010; Zone 7 2006).  
 13 In 1821, Mexico won independence from Spain, began to establish more secular  
 14 communities around the missions, and divided many of the ranchos into smaller  
 15 pueblos (Santa Clara County 2012). These actions supported growth in the  
 16 present California coastal areas.

17 Following California statehood in 1849, ranching and farming communities were  
 18 established in the interior valleys of the San Francisco Bay Area Region (Santa  
 19 Clara County 2012; CCWD et al. 2009; ECCCHCPA et al. 2006). Starting in the  
 20 late 1800s, expansion of the railroads in the area and use of improved irrigation  
 21 systems led to the expansion of agriculture throughout the area. In mid-1900s,  
 22 industrial expansion occurred in Contra Costa, Alameda, and Santa Clara  
 23 counties.

#### 24 **17.3.3.5 History of the Central Coast Region**

25 In 1542, Portuguese explorer Juan Rodríguez Cabrillo entered Santa Barbara  
 26 Harbor (Puerto de Santa Bárbara). In 1587, Pedro de Unamuno brought his ship  
 27 into Morro Bay, explored inland to the present site of the City of San Luis  
 28 Obispo, and claimed the area for Spain. In 1595, Sebastián Rodríguez Cermeño  
 29 entered San Luis Obispo Bay (Hoover et al. 1990). The explorations laid the  
 30 foundation for the founding of five missions in the Central Coast Region  
 31 considered in this EIS. Ranchos were granted throughout the region in the 1830s  
 32 and 1840s.

33 Following the California statehood, ranching and farming continued to be the  
 34 main economic activity of the Central Coast Region to the present.

#### 35 **17.3.3.6 History of the Southern California Region**

36 In 1540, Hernando de Alarcón explored the inland areas of the Southern  
 37 California Region with an expedition that had explored the Colorado River. In  
 38 1542, Cabrillo apparently became the first European to sight the coast of Southern  
 39 California, including the Los Angeles area and Santa Catalina Island, although he  
 40 did not make landfall (Hoover et al. 1990).

41 In 1769, Gaspar de Portolá explored a trail by land from present San Diego  
 42 through present San Diego, Orange, and Los Angeles counties (Hoover et al.  
 43 1990). He camped near the Los Angeles River and the Indian Village of Yang-Na



1 (within the present City of Los Angeles). In 1772, Pedro Fages made an inland  
2 journey from present San Diego through western Riverside County to San Luis  
3 Obispo (Hoover et al. 1990; Riverside County 2000). In 1776, friar Francisco  
4 Garcés explored from present San Gabriel Valley to the Antelope Valley. More  
5 than 20 missions were established along the Southern California coastline (Los  
6 Angeles 2005). Pueblos were established near the missions, including the Pueblo  
7 of Los Angeles in 1781.

8 The first known discovery of gold in California was made between 1775 and 1780  
9 in the Potholes district of southeastern California in present Imperial County  
10 (Clark 1970). Other placer deposits were found in 1828 at San Ysidro in present  
11 San Diego County, and in 1835 and 1842 at San Francisquito Canyon and  
12 Placerita Canyon, respectively, in present Los Angeles County (Clark 1970;  
13 Vredenburg 1991). Some of the mines continued to produce gold through the  
14 early 1990s.

15 Following the end of Spanish Rule, the Mexican Government deeded the  
16 extensive land holdings to ranchos to develop ranches and orchards (Riverside  
17 County 2000). Oranges and lemons became major agricultural crops between the  
18 1850s and 1880s, and railroads were built to transport the products.

19 Water supply systems were constructed to provide water to missions and pueblo  
20 villages. One of the first systems was the Zanja Madre that was constructed in  
21 1781 to convey water to the pueblo in the present City of Los Angeles (Los  
22 Angeles 2005; DWR 2009). The system was expanded in the 1850s and 1860s to  
23 convey water to vineyards and fruit orchards. During the late 1800s and early  
24 1900s, numerous dams and conveyance facilities were constructed in the area to  
25 support the communities and agriculture.

#### 26 **17.3.4 Known Cultural Resources**

27 The following subsections describe known cultural resources in the counties  
28 within the study area as determined through review of reports prepared for other  
29 projects in the study area. No physical or record surveys were conducted for this  
30 EIS because no site-specific construction actions were considered in this EIS.

31 The EIS evaluates alternatives to continue the coordinated long-term operation of  
32 the CVP and SWP. The resources described in this subsection indicate the types  
33 of resources that occur in areas served by CVP and SWP water and adjacent  
34 areas. Therefore, some of the known resources presented in this chapter are  
35 located in portions of the counties that are not within the CVP and SWP water  
36 service areas.

##### 37 **17.3.4.1 Known Cultural Resources of the Trinity River Region**

38 Within Trinity County, a cultural resources records search of the Trinity River  
39 Region was conducted for the Trinity River Mainstem Fishery Restoration  
40 EIS/Environmental Impact Report (EIR) (USFWS et al. 1999). The area covered  
41 included 660 feet on either side of the Trinity River from Trinity Lake to the  
42 eastern boundary of Hoopa Valley Indian Reservation and the inundation areas of  
43 the Trinity Lake and Lewiston Reservoir. More than 150 recorded cultural

1 resources were identified along the mainstem of Trinity River within Trinity  
 2 County, including 20 types of prehistoric and historic sites. Among these were  
 3 Native American villages, camps, and lithic scatters; historic Indian sites; mines;  
 4 ditches; cabins; structures; a school; USFWS stations and campgrounds;  
 5 cemeteries; a rock wall; trails; a wagon road; and a bridge. Fifty-one sites are  
 6 inundated within Trinity Lake and Lewiston Reservoir. Few of these sites have  
 7 been evaluated for eligibility to be included in the National Register of Historic  
 8 Places (NRHP). With respect to more recent historic sites in Trinity County, none  
 9 of the sites listed in the NRHP, California State Historical Landmarks, California  
 10 Register of Historical Resources (CRHR), and/or Points of Interest is located  
 11 within or along banks of the Trinity River (CSPOHP 2014a).

12 Within Humboldt County, numerous culturally sensitive areas are located along  
 13 the Lower Klamath and Lower Trinity rivers. The culturally sensitive areas  
 14 include the areas along the riverbanks associated with religious and/or resource-  
 15 producing important sites, in addition to specific known cultural resources. Many  
 16 cultural resource locations are in the Hoopa Valley Indian Reservation and Yurok  
 17 Reservation, including villages, cemeteries, ceremonial and gathering areas, and  
 18 along ridgeline corridors that were used for traveling between villages (Humboldt  
 19 County 2012). With respect to more recent historic sites in Humboldt County,  
 20 none of the sites listed in the NRHP, California State Historical Landmarks,  
 21 CRHR, and/or Points of Interest is located within or along banks of the Trinity or  
 22 Klamath rivers (CSPOHP 2014b).

23 Within Del Norte County, numerous culturally sensitive areas are located along  
 24 the Lower Klamath River, including areas within the Yurok Reservation and the  
 25 Resighini Rancheria along the southern shoreline of the mouth of the Klamath  
 26 River at the Pacific Ocean (Del Norte County 2003). The mouth of the Klamath  
 27 River is of great spiritual significance for the Yurok people (Yurok Tribe 2005).  
 28 The Yurok Tribe has suggested that the entire Klamath River, including the  
 29 Lower Klamath River, be designated as a Cultural Riverscape and be submitted  
 30 for consideration as a NRHP (Yurok Tribe 2005). With respect to more recent  
 31 historic sites in Del Norte County, none of the sites listed in the NRHP, California  
 32 State Historical Landmarks, CRHR, and/or Points of Interest is located within or  
 33 along banks of the Klamath River (CSPOHP 2014c).

#### 34 **17.3.4.2 Previously Recorded Cultural Resources in the Central Valley** 35 **Region**

36 The Central Valley Region is rich in both historic- and prehistoric-period  
 37 resources (Reclamation 1997), including large, deep midden sites (which  
 38 generally contains waste materials that indicate human inhabitation) that provide  
 39 information on prehistoric culture extending over thousands of years.

40 As described above, implementation of the alternatives considered in this EIS  
 41 could affect cultural resources at CVP and SWP reservoir facilities and in areas  
 42 that use CVP and SWP water that could experience land uses because of changes  
 43 in CVP and SWP water supply availability.

1 **17.3.4.2.1 Cultural Resources at CVP and SWP Reservoir Facilities in the**  
2 **Sacramento Valley**

3 Previous cultural resource studies were conducted at and/or near Shasta Lake,  
4 Lake Oroville, and Folsom Lake.

5 The studies near Shasta Lake surveyed approximately 8 percent of the study area  
6 and identified 261 cultural resources, including 190 prehistoric properties,  
7 45 historic resources, and 26 properties with prehistoric and historic resources  
8 (Reclamation 2013a). The prehistoric sites include habitation sites, artifact and  
9 lithic scatters, caves used as shelter, and cemeteries. The historic sites included  
10 bridges, railways, a dam, buildings, ranches, orchards, mines, towns, and  
11 cemeteries. Several prehistoric and historic cemeteries located within the  
12 inundation area were moved prior to completion of the Shasta Lake complex. The  
13 Dog Creek Bridge is the only resource in this area that is listed on the NRHP.  
14 The Shasta and Keswick dams were determined to be NRHP-eligible.

15 The studies near Lake Oroville identified 261 cultural resources areas, including  
16 234 prehistoric properties, 462 historic resources, and 91 properties with  
17 prehistoric and historic resources (DWR 2004, 2007). Within the Lake Oroville  
18 inundation area, 93 prehistoric properties and 19 historic sites were identified  
19 prior to the completion of the reservoir. The prehistoric sites include habitation  
20 sites, milling sites, quarries, artifact and lithic scatters, caves used as shelter, rock  
21 art, fishing and hunting grounds, battle sites, trails, and cemeteries. The historic  
22 sites included bridges, railways, a dam, buildings, ranches, orchards, mines,  
23 towns, and cemeteries.

24 Oroville Dam and peripheral dams, Thermalito Diversion Dam, Thermalito  
25 Forebay and Afterbay, Fish Barrier Dam, Hyatt Pumping-Generating Plant and  
26 Intake Structure, Thermalito Power Plant and Power Canal, Lake Oroville Visitor  
27 Center and Visitor Viewing Platform, and Feather River Fish Hatchery were  
28 determined to be NRHP-eligible.

29 The studies near Folsom Lake identified 185 prehistoric properties and 59 historic  
30 sites (Reclamation 2005b; Reclamation et al. 2006). The prehistoric sites include  
31 habitation sites, middens, groundstones, and artifact and lithic scatters. The  
32 historic sites included buildings, mining areas, and refuse dumps. Folsom Dam  
33 was determined to be NRHP-eligible.

34 **17.3.4.2.2 Cultural Resources at CVP and SWP Reservoir and Pumping**  
35 **Plant Facilities in the San Joaquin Valley**

36 Previous cultural resource studies were conducted at and/or near New Melones  
37 Reservoir, San Luis Reservoir, and Millerton Lake and San Joaquin River  
38 downstream of Friant Dam.

39 The studies near New Melones Reservoir surveyed approximately 78 percent of  
40 the study area and identified 725 cultural resources within the New Melones  
41 Reservoir area or within 0.25 mile of this area (Reclamation 2010). The  
42 prehistoric sites include habitation sites, artifact and lithic scatters, mortars, caves,  
43 rock art, and cemeteries. The historic sites included bridges, buildings, ranches,

1 orchards, towns, water and power systems, transportation infrastructure, and  
 2 cemeteries. Many of the sites are located within the inundation area. However,  
 3 substantial surveys were conducted prior to construction of New Melones  
 4 Reservoir in the 1980s.

5 The studies near San Luis Reservoir identified 51 prehistoric and historic cultural  
 6 resources (Reclamation and State Parks 2012). The prehistoric sites include  
 7 habitation sites and artifact and lithic scatters. The historic sites included bridges,  
 8 water infrastructure, buildings, ranches, orchards, towns, and cemeteries. One of  
 9 the major historic sites in this area is the remnant locations of Rancho San Luis  
 10 Gonzaga. Many portions of the ranch are located within the inundation area.  
 11 However, many of the structures were moved to a site near Pacheco Pass. The  
 12 remaining portions of the ranch were deeded to the State of California in 1992 to  
 13 become part of the Pacheco State Park. Rancho San Luis Gonzaga, a historic  
 14 stock ranch landscape, has been designated by the state to be a Historic  
 15 District/Cultural Landscape that is potentially NRHP-eligible and CRHR-eligible.

16 Recent studies along the San Joaquin River identified 19 prehistoric sites within  
 17 the seasonal inundation area of Millerton Lake (Reclamation and DWR 2011;  
 18 Reclamation and State Parks 2013). Additional sites are located within the area of  
 19 the lake that is constantly inundated. Some of the known sites include the  
 20 remains of Kuyu Illik; the Dumna “head” village; the Kechaye/”Dumna” village  
 21 of Sanwo Kianu; remains of Fort Miller, Millerton, and Collins Sulphur Springs;  
 22 and prehistoric sites with housepits, mortars, grinding sticks, and rock alignments  
 23 (Reclamation and State Parks 2013).

24 Along the San Joaquin River downstream of Friant Dam (which forms Millerton  
 25 Lake) to the confluence of the Merced River, 84 prehistoric sites, 18 historic sites,  
 26 and 7 sites with both prehistoric and historic resources were identified as part of  
 27 the San Joaquin River Restoration Program. The prehistoric sites include  
 28 habitation sites, artifact and lithic scatters, and bedrock milling features. The  
 29 historic sites included bridges, buildings, ranches, orchards, towns, water and  
 30 power systems, and transportation infrastructure.

31 The Friant Dam, Friant-Kern Canal, associated features (berms, siphons, control  
 32 structures, inlets, outlets, and check structures), approximately 40 bridges that  
 33 cross the canal, and Little Dry Creek Wasteway Facility are considered historic  
 34 resources (Reclamation and State Parks 2013; Reclamation et al. 2011b). The  
 35 Friant Dam and Friant-Kern Canal was determined to be NRHP-eligible.

#### 36 **17.3.4.2.3 Cultural Resources in the areas that use CVP and SWP Water** 37 **Supplies in the Central Valley**

38 Numerous cultural and historical resources are in the Central Valley, as  
 39 summarized in Table 17.1. Most of the cultural resources are located within areas  
 40 that would not be affected by land use changes that could result from changes in  
 41 CVP and SWP water supplies. The resources listed in Table 17.1 also include the  
 42 sites described above near CVP and SWP facilities.

1 **Table 17.1 Previously Recorded Cultural and Historical Resources of the Central**  
 2 **Valley Region**

County	Historic Site Types	Prehistoric Site Types
Butte	26 NRHP properties, 8 California Historical Landmarks, and 21 California Points of Historical Interest (Reclamation 1997; CSPOHP 2014e).	1,198 Known Prehistoric Site Types (Reclamation 1997).
Colusa	7 NRHP properties, 3 California Historical Landmarks, and 3 California Points of Historical Interest (Reclamation 1997; CSPOHP 2014g).	115 Known Prehistoric Site Types (Reclamation 1997).
El Dorado	18 NRHP properties, 30 California Historical Landmarks, 8 California Points of Historical Interest; numerous historic sites, such as mining features, building foundations, trash scatters, and bridges, were inundated by Folsom Lake (Reclamation 1997; CSPOHP 2014h).	595 Known Prehistoric Site Types (Reclamation 1997).
Fresno	38 NRHP properties, 8 California Historic Landmarks, and 13 of which are California Points of Historical Interest (Reclamation 1997; CSPOHP 2014i).	2,603 Known Prehistoric Site Types (Reclamation 1997).
Glenn	2 NRHP properties, 2 California Historical Landmarks, and 17 California Points of Historical Interest (Reclamation 1997; CSPOHP 2014j).	373 Known Prehistoric Site Types (Reclamation 1997).
Kern	20 NRHP properties, 47 California Historic Landmarks, and 11 California Points of Historical Interest (Reclamation 1997; CSPOHP 2014k).	3,850 Known Prehistoric and Historic Site Types (Reclamation 1997).
Kings	4 NRHP properties, 3 California Historic Landmarks; the San Luis Canal, the only CVP facility in Kings County, has no historic or architectural resources in its vicinity (Reclamation 1997; CSPOHP 2014l).	56 Known Prehistoric Site Types (Reclamation 1997).
Madera	2 NRHP property, 1 California Historic Landmarks, and 9 California Points of Historical Interest (Reclamation 1997; CSPOHP 2014n).	2,043 Known Prehistoric Site Types (Reclamation 1997).
Merced	14 NRHP properties, 5 California Historic Landmarks, 1 CRHR properties, and 8 California Points of Historical Interest (Reclamation 1997; CSPOHP 2014p).	316 Known Prehistoric Site Types (Reclamation 1997).

County	Historic Site Types	Prehistoric Site Types
Napa	76 NRHP properties, 17 California Historical Landmarks, and 13 California Points of Historical Interest (Reclamation 1997; CSPOHP 2014q).	700 Known Prehistoric Site Types (Reclamation 1997).
Placer	18 NRHP properties, 20 California Historical Landmarks, 21 California Points of Historical Interest; numerous historic sites, such as mining features, building foundations, trash scatters, and bridges, were inundated by Folsom Lake, which is a CVP facility (Reclamation 1997; CSPOHP 2014s).	627 Known Prehistoric Site Types (Reclamation 1997).
Plumas	6 NRHP properties, 13 California Historical Landmarks, and 5 California Points of Historical Interest (Reclamation 1997; CSPOHP 2014t).	1,639 prehistoric sites in Plumas County (Plumas County 2012).
Sacramento	<p>90 NRHP properties, 56 California Historical Landmarks, 4 CRHR properties, 20 California Points of Historical Interest; numerous historic sites, such as mining features, building foundations, trash scatters, and bridges, were inundated by Folsom Lake; the Folsom Mining District surrounds Lake Natoma (Reclamation 1997; CSPOHP 2014u).</p> <p>There are over 40 historic sites along the Sacramento River between Sutter County boundary and Freeport (Reclamation 2005b); including Natomas Main Drainage Canal, Town of Freeport, Sacramento Weir, Yolo Bypass, homes and farms, and a church.</p> <p>There are 14 historic sites along the American River between Folsom Dam and the confluence with the Sacramento River (Reclamation 2005b).</p>	<p>407 Known Prehistoric Site Types (Reclamation 1997). There are 24 prehistoric sites along the Sacramento River between Sutter County boundary and Freeport (Reclamation 2005b). There are 22 prehistoric sites along the American River between Folsom Dam and the confluence with the Sacramento River (Reclamation 2005b).</p>
San Joaquin	31 NRHP properties, 25 California Historical Landmarks, 3 CRHR properties, and 7 are California Points of Historical Interest (Reclamation 1997; CSPOHP 2014v).	189 Known Prehistoric Site Types (Reclamation 1997).

<b>County</b>	<b>Historic Site Types</b>	<b>Prehistoric Site Types</b>
Shasta	26 NRHP properties, 19 California Historical Landmarks, 1 CRHR properties, 15 California Points of Historical Interest (Reclamation 1997; CSPOHP 2014w). The Anderson-Cottonwood Irrigation District Diversion Dam has been determined to be eligible for NRHP listing (Reclamation 2013a).	1,419 Known Prehistoric Site Types. Many of these sites occur along the Sacramento River near Redding and between Battle Creek and Table Mountain (Reclamation 2013a).
Solano	23 NRHP properties, 14 California Historical Landmarks, and 9 California Points of Historical Interest (Reclamation 1997; CSPOHP 2014x).	300 Known Prehistoric Site Types (Reclamation 1997).
Stanislaus	21 NRHP properties, 5 California Historic Landmarks, and 7 are California Points of Historical Interest; the former right-of-way for the Patterson and Western Railroad, which was constructed in 1916, bisects the Delta-Mendota Canal (Reclamation 1997; CSPOHP 2014y).	280 Known Prehistoric Site Types (Reclamation 1997).
Sutter	7 NRHP properties, 2 California Historical Landmarks, and 22 California Points of Historical Interest (Reclamation 1997; CSPOHP 2014z).	62 Known Prehistoric Site Types (Reclamation 1997).
Tehama	10 NRHP properties, 3 California Historical Landmarks, and 1 California Point of Historical Interest (Reclamation 1997; CSPOHP 2014aa).	1,415 Known Prehistoric Site Types (Reclamation 1997).
Tulare	34 NRHP properties, 8 California Historic Landmarks, and no California Points of Historical Interest (Reclamation 1997; CSPOHP 2014ab).	1,857 Known Prehistoric Site Types (Reclamation 1997).
Yolo	21 NRHP properties, 2 California Historical Landmarks, 1 CRHR properties, and 8 California Points of Historical Interest (Reclamation 1997; CSPOHP 2014ad).	175 Known Prehistoric Site Types (Reclamation 1997). Includes possible fishing stations along Putah and Cache Creeks, the Sacramento, and ephemeral tributaries to these watercourses.
Yuba	10 NRHP properties, 6 California Historical Landmarks, and 14 California Points of Historical Interest (Reclamation 1997; CSPOHP 2014ae).	1,112 Known Prehistoric Site Types (Reclamation 1997).

1 **17.3.4.3 Previously Recorded Cultural Resources in the San Francisco**  
 2 **Bay Area Region**

3 The San Francisco Bay Area Region includes Alameda, Contra Costa, Santa  
 4 Clara, and San Benito counties. Much of this region is highly urbanized and that  
 5 development has affected archaeological resources. Numerous cultural and  
 6 historical resources are in the San Francisco Bay Area Region, as summarized in  
 7 Table 17.2. Most of the cultural resources are located within areas that would not  
 8 be affected by land use changes that could result from changes in CVP and SWP  
 9 water supplies.

10 **Table 17.2 Previously Recorded Cultural Resources of the San Francisco Bay Area**  
 11 **Region**

County	Historic Site Types	Prehistoric Site Types
Alameda	141 NRHP properties, 34 California Historical Landmarks, 2 CRHR properties, and 4 California Points of Historical Interest (CSPOHP 2014af).	No comprehensive inventory of prehistoric sites in Alameda County (Zone 7 2006).
Contra Costa	40 NRHP properties, 13 California Historical Landmarks, 1 CRHR property, and 12 California Points of Historical Interest (CSPOHP 2014ag).	No comprehensive inventory of prehistoric sites in Contra Costa County (Contra Costa County 2005). Up to 41 sites were identified in the Kellogg Creek Historic District near Los Vaqueros Reservoir (CCWD et al. 2009).
San Benito	12 NRHP properties, 5 California Historic Landmarks, and 2 California Points of Historical Interest (Reclamation 1997; CSPOHP 2014ah).	180 Known Prehistoric Site Types (Reclamation 1997).
Santa Clara	101 NRHP properties, 41 California Historical Landmarks, and 58 California Points of Historical Interest (CSPOHP 2014ai; Santa Clara County 1994).	Between 1912 and 1960, 43 sites were recorded in the Santa Clara Valley portion of Santa Clara County (Santa Clara 2012).

12 **17.3.4.4 Previously Recorded Cultural Resources in the Central Coast**  
 13 **and Southern California Regions**

14 The Central Coast Region includes San Luis Obispo and Santa Barbara counties.  
 15 Within the Central Coast Region, the SWP provides water supplies to portions of  
 16 San Luis Obispo and Santa Barbara counties. Within the Southern California  
 17 Region, the SWP provides water supplies to portions of Ventura, Los Angeles,  
 18 Orange, Riverside, San Bernardino, and San Diego counties. Numerous cultural  
 19 and historical resources are in the Central Coast and Southern California regions,  
 20 as summarized in Table 17.3. Most of the cultural resources are located within  
 21 areas that would not be affected by land use changes that could result from  
 22 changes in SWP water supplies.



1  
2**Table 17.3 Previously Recorded Cultural and Historical Resources of the Central Coast and Southern California Regions**

<b>County</b>	<b>Historic Site Types</b>	<b>Prehistoric Site Types</b>
San Luis Obispo	34 NRHP properties, 2 California Historical Landmarks, and 4 California Points of Historical Interest (CSPOHP 2014ao).	The San Luis Obispo County General Plan discusses several hundred prehistoric resources throughout San Luis Obispo County related to the Chumash people (San Luis Obispo County 2010).
Santa Barbara	43 NRHP properties, 16 California Historical Landmarks, and 7 California Points of Historical Interest (CSPOHP 2014ap).	The 2010 Santa Barbara Conservation Element of the Comprehensive Plan noted prehistoric resources throughout Santa Barbara County related to the Chumash people (Santa Barbara County 2010).
Los Angeles	431 NRHP properties, 90 California Historical Landmarks, 6 CRHR property, and 65 California Points of Historical Interest (CSPOHP 2014aj).	Over 4,196 prehistoric sites in Los Angeles County (SCAG 2011).
Orange	108 NRHP properties, 24 California Historical Landmarks, and 20 California Points of Historical Interest (CSPOHP 2014ak).	Over 1,710 prehistoric sites in Orange County (SCAG 2011; Orange County 2005).
Riverside	52 NRHP properties, 23 California Historical Landmarks, and 72 California Points of Historical Interest (CSPOHP 2014al).	Over 19,858 prehistoric sites in Orange County (SCAG 2011). Some of the Cahuilla, Serrano, and Luiseño communities were inundated within Lake Perris (Reclamation and DWR 2003).
San Bernardino	56 NRHP properties, 39 California Historical Landmarks, 2 CRHR property, and 119 California Points of Historical Interest (CSPOHP 2014am).	Over 29,480 prehistoric sites in San Bernardino County, including the Calico "Early Man" Site (SCAG 2011).
San Diego	130 NRHP properties, 63 California Historical Landmarks, 3 CRHR property, and 16 California Points of Historical Interest (CSPOHP 2014an).	The San Diego County General Plan discussed that there are many prehistoric sites within San Diego County; however, the number and locations are not identified to protect the resources (San Diego County 2011a).

County	Historic Site Types	Prehistoric Site Types
Ventura	34 NRHP properties, 11 California Historical Landmarks, and 4 California Points of Historical Interest (CSPOHP 2014aq).	Over 1,806 prehistoric sites in San Bernardino County (SCAG 2011).

1 **17.4 Impact Analysis**

2 This section describes the potential mechanisms for change in cultural resources  
 3 and analytical methods, results of the impact analysis, potential mitigation  
 4 measures, and potential cumulative effects.

5 **17.4.1 Potential Mechanisms for Change and Analytical Tools**

6 As described in Chapter 4, Approach to Environmental Analysis, the  
 7 environmental consequences assessment considers changes in cultural resources  
 8 conditions related to changes in CVP and SWP operations under the alternatives  
 9 as compared to the No Action Alternative and Second Basis of Comparison that  
 10 could result in land disturbance or increased exposure of cultural resources sites.

11 **17.4.1.1 Changes in the Potential for Land Disturbance**

12 Under Alternatives 1 through 5, No Action Alternative, and Second Basis of  
 13 Comparison, CVP and SWP water supplies would continue to be provided within  
 14 the currently designated service areas. Implementation of the alternatives does  
 15 not include expansion of designated service areas or increased water contract  
 16 amounts. Land use in 2030 would be consistent with existing general plan  
 17 projections under all alternatives and the Second Basis of Comparison. The CVP  
 18 and SWP water contract amounts would be the same under all alternatives and the  
 19 Second Basis of Comparison. The alternatives would not result in expansion of  
 20 municipal or agricultural lands, or associated disturbances of cultural resources  
 21 because of expansion of development or cultivated lands in addition to the  
 22 conditions projected under existing general plans. Therefore, changes in CVP and  
 23 SWP water supply availability that would result in changes in land use and  
 24 associated potential for disturbance of cultural resources are not analyzed in  
 25 this EIS.

26 **17.4.1.2 Changes in Potential Exposure of Cultural Resources at  
 27 Reservoirs that Store CVP and SWP Water**

28 Changes in CVP and SWP operations under the alternatives as compared to the  
 29 No Action Alternative and Second Basis of Comparison could result in increased  
 30 periods of time when low water elevations occur in reservoirs that store CVP and  
 31 SWP water, including the CVP and SWP reservoirs. The lowest reservoir  
 32 elevations generally occur in September in dry and critical dry years, as described  
 33 in Chapter 5, Surface Water Resources and Water Supplies. The minimum and  
 34 maximum elevations of the reservoir surface water under Alternatives 1

1 through 5, No Action Alternative, and Second Basis of Comparison would be  
2 the same as under current conditions.

3 **17.4.1.3 Effects Related to Cross Delta Water Transfers**

4 Water transfer programs have been used to provide water to existing agricultural  
5 and municipal service areas when other water supplies are not available. It is  
6 anticipated that water transfers under all alternatives and the Second Basis of  
7 Comparison would continue in this manner to provide water supplies to land uses  
8 projected under existing general plans which would not result in expansion of  
9 municipal or agricultural lands, or associated disturbances of cultural resources  
10 because of expansion of development or cultivated lands in addition to conditions  
11 projected under existing general plans. Therefore, effects related to cross Delta  
12 water transfers and associated potential for disturbance of cultural resources are  
13 not analyzed in this EIS.

14 **17.4.2 Conditions in Year 2030 without Implementation of**  
15 **Alternatives 1 through 5**

16 The impact analysis in this EIS is based upon the comparison of the alternatives to  
17 the No Action Alternative and the Second Basis of Comparison in the Year 2030.  
18 Many of the changed conditions would occur in the same manner under both the  
19 No Action Alternative and the Second Basis of Comparison (e.g., climate change,  
20 sea level rise, general plan development, and implementation of reasonable and  
21 foreseeable projects). Because of these changes, especially climate change and  
22 sea level rise, it is anticipated that reservoir elevations at the end of September  
23 would be lower, flows patterns in the rivers downstream of the reservoirs would  
24 be different than under recent condition, and CVP and SWP water deliveries  
25 would be less than under recent condition, as described in Chapter 5, Surface  
26 Water Resources and Water Supplies. In all regions, the minimum reservoir  
27 elevations under the No Action Alternative and Second Basis of Comparison  
28 would be similar to minimum elevations during recent conditions.

29 **17.4.3 Evaluation of Alternatives**

30 As described in Chapter 4, Approach to Environmental Analysis, Alternatives 1  
31 through 5 have been compared to the No Action Alternative, and the No Action  
32 Alternative and Alternatives 1 through 5 have been compared to the Second Basis  
33 of Comparison.

34 During review of the numerical modeling analyses used in this EIS, an error was  
35 determined in the CalSim II model assumptions related to the Stanislaus River  
36 operations for the Second Basis of Comparison, Alternative 1, and Alternative 4  
37 model runs. Appendix 5C includes a comparison of the CalSim II model run  
38 results presented in this chapter and CalSim II model run results with the error  
39 corrected. Appendix 5C also includes a discussion of changes in the comparison  
40 of the following alternatives analyses.

- 41 • No Action Alternative compared to the Second Basis of Comparison
- 42 • Alternative 1 compared to the No Action Alternative

- 1 • Alternative 3 compared to the Second Basis of Comparison
- 2 • Alternative 5 compared to the Second Basis of Comparison

3 **17.4.3.1 No Action Alternative**

4 As described in Chapter 4, Approach to Environmental Analysis, the No Action  
5 Alternative is compared to the Second Basis of Comparison.

6 **17.4.3.1.1 Potential Exposure of Cultural Resources at Reservoirs that Store  
7 CVP and SWP Water**

8 As described above, the minimum reservoir elevations in all regions under the No  
9 Action Alternative and the Second Basis of Comparison would be within historic  
10 ranges and would not expose lands that are not currently exposed. Therefore,  
11 conditions of cultural resources would be similar under the No Action Alternative  
12 and Second Basis of Comparison.

13 **17.4.3.2 Alternative 1**

14 Alternative 1 is identical to the Second Basis of Comparison. Alternative 1 is  
15 compared to the No Action Alternative and the Second Basis of Comparison.  
16 However, because cultural resource conditions under Alternative 1 are identical to  
17 cultural resource conditions under the Second Basis of Comparison, Alternative 1  
18 is only compared to the No Action Alternative.

19 **17.4.3.2.1 Alternative 1 Compared to the No Action Alternative**

20 *Potential Exposure of Cultural Resources at Reservoirs that Store CVP and SWP*  
21 *Water*

22 As described above, the minimum reservoir elevations in all regions under  
23 Alternative 1 as compared to the No Action Alternative would be within historic  
24 ranges and would not expose lands that are not currently exposed. Therefore,  
25 conditions of cultural resources would be similar under Alternative 1 and the No  
26 Action Alternative.

27 **17.4.3.2.2 Alternative 1 Compared to the Second Basis of Comparison**

28 Alternative 1 is identical to the Second Basis of Comparison.

29 **17.4.3.3 Alternative 2**

30 The cultural resources conditions under Alternative 2 would be identical to the  
31 conditions under the No Action Alternative; therefore, Alternative 2 is only  
32 compared to the Second Basis of Comparison.

33 **17.4.3.3.1 Alternative 2 Compared to the Second Basis of Comparison**

34 Changes to cultural resources conditions under Alternatives 2 as compared to the  
35 Second Basis of Comparison would be the same as the impacts described in  
36 Section 17.4.3.1, No Action Alternative.

1 **17.4.3.4 Alternative 3**

2 CVP and SWP operations under Alternative 3 are similar to the Second Basis of  
3 Comparison with modified Old and Middle River flow criteria and New Melones  
4 Reservoir operations.

5 **17.4.3.4.1 Alternative 3 Compared to the No Action Alternative**

6 *Potential Exposure of Cultural Resources at Reservoirs that Store CVP and SWP*  
7 *Water*

8 As described above, the minimum reservoir elevations in all regions under  
9 Alternative 3 as compared to the No Action Alternative would be within historic  
10 ranges and would not expose lands that are not currently exposed. Therefore,  
11 conditions of cultural resources would be similar under Alternative 3 as compared  
12 to the No Action Alternative.

13 **17.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison**

14 *Potential Exposure of Cultural Resources at Reservoirs that Store CVP and*  
15 *SWP Water*

16 As described above, the minimum reservoir elevations in all regions under  
17 Alternative 3 as compared to the Second Basis of Comparison would be within  
18 historic ranges and would not expose lands that are not currently exposed.  
19 Therefore, conditions of cultural resources would be similar under Alternative 3  
20 and Second Basis of Comparison.

21 **17.4.3.5 Alternative 4**

22 The cultural resources conditions under Alternative 4 would be identical to the  
23 conditions under the Second Basis of Comparison. Therefore, Alternative 4 is  
24 only compared to the No Action Alternative.

25 **17.4.3.5.1 Alternative 4 Compared to the No Action Alternative**

26 Changes in cultural resources conditions under Alternative 4 as compared to the  
27 No Action Alternative would be the same as the impacts described in  
28 Section 17.4.3.2.1, Alternative 1 Compared to the No Action Alternative.

29 **17.4.3.6 Alternative 5**

30 The CVP and SWP operations under Alternative 5 are similar to the No Action  
31 Alternative with modified Old and Middle River flow criteria and New Melones  
32 Reservoir operations.

33 **17.4.3.6.1 Alternative 5 Compared to the No Action Alternative**

34 *Potential Exposure of Cultural Resources at Reservoirs that Store CVP and*  
35 *SWP Water*

36 As described above, the minimum reservoir elevations in all regions under  
37 Alternative 5 as compared to the No Action Alternative would be within historic  
38 ranges and would not expose lands that are not currently exposed. Therefore,  
39 conditions of cultural resources would be similar under Alternative 5 as compared  
40 to the No Action Alternative.

1 **17.4.3.6.2 Alternative 5 Compared to the Second Basis of Comparison**

2 *Potential Exposure of Cultural Resources at Reservoirs that Store CVP and*  
 3 *SWP Water*

4 As described above, the minimum reservoir elevations in all regions under  
 5 Alternative 5 as compared to the Second Basis of Comparison would be within  
 6 historic ranges and would not expose lands that are not currently exposed.  
 7 Therefore, conditions of cultural resources would be similar under Alternative 5  
 8 and Second Basis of Comparison.

9 **17.4.3.7 Summary of Impact Analysis**

10 The results of the impact analysis of implementation of Alternatives 1 through 5  
 11 as compared to the No Action Alternative and the Second Basis of Comparison  
 12 are presented in Tables 17.4 and 17.5.

13 **Table 17.4 Comparison of Alternatives 1 through 5 to No Action Alternative**

<b>Alternative</b>	<b>Potential Change</b>	<b>Consideration for Mitigation Measures</b>
Alternative 1	No effects to cultural resources	None needed
Alternative 2	No effects to cultural resources	None needed
Alternative 3	No effects to cultural resources	None needed
Alternative 4	No effects to cultural resources	None needed
Alternative 5	No effects to cultural resources	None needed

14 **Table 17.5 Comparison of No Action Alternative and Alternatives 1 through 5 to**  
 15 **Second Basis of Comparison**

<b>Alternative</b>	<b>Potential Change</b>	<b>Consideration for Mitigation Measures</b>
Alternative 1	No effects to cultural resources	None needed
Alternative 2	No effects to cultural resources	None needed
Alternative 3	No effects to cultural resources	None needed
Alternative 4	No effects to cultural resources	None needed
Alternative 5	No effects to cultural resources	None needed

16 **17.4.3.8 Potential Mitigation Measures**

17 Mitigation measures are presented in this section to avoid, minimize, rectify,  
 18 reduce, eliminate, or compensate for adverse environmental effects of  
 19 Alternatives 1 through 5, as compared to the No Action Alternative. Mitigation  
 20 measures were not included to address adverse impacts under the alternatives as  
 21 compared to the Second Basis of Comparison because this analysis was included  
 22 in this EIS for information purposes only.

1 Implementation of Alternatives 1 through 5 as compared to the No Action  
 2 Alternative would not result in increased potential exposure or disturbance of  
 3 cultural resources. Therefore, there would be no adverse impacts to cultural  
 4 resources because of implementation of the alternatives; and no mitigation  
 5 measures are needed.

6 **17.4.3.9 Cumulative Effects Analysis**

7 As described in Chapter 3, the cumulative effects analysis considers projects,  
 8 programs, and policies that are not speculative and are based upon known or  
 9 reasonably foreseeable long-range plans, regulations, operating agreements, or  
 10 other information that establishes them as reasonably foreseeable.

11 The cumulative effects analysis for Alternatives 1 through 5 for Cultural  
 12 Resources are summarized in Table 17.6.

13 **Table 17.6 Summary of Cumulative Effects on Cultural Resources with**  
 14 **Implementation of Alternatives 1 through 5 as Compared to the No Action**  
 15 **Alternative**

Scenarios	Actions	Cumulative Effects of Actions
Past & Present, and Future Actions Included in All Alternatives in Year 2030	Consistent with Affected Environment conditions plus: Actions in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives), including climate change and sea level rise Actions not included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives):  - Implementation of Federal and state policies and programs, including Clean Water Act (e.g., Total Maximum Daily Loads); Safe Drinking Water Act; Clean Air Act; and flood management programs - General plans for 2030. - Trinity River Restoration Program. - Central Valley Project Improvement Act programs - Iron Mountain Mine Superfund Site	<u>These effects would be the same under all alternatives.</u> Community development would occur in accordance with general plan projections for 2030. Development within the Delta would be subject to the requirements of the Delta Protection Commission and Delta Stewardship Council. Future development projects are anticipated to potentially effect cultural resources. However, development of these future programs would include preparation of environmental documentation that would identify methods to minimize adverse impacts to cultural resources. Restoration plans for the ongoing programs would be completed. Development along river corridors in the Central Valley. Future restoration projects are anticipated to potentially affect cultural resources. However, development of these future programs would include preparation of environmental documentation that would identify methods to

Scenarios	Actions	Cumulative Effects of Actions
	<ul style="list-style-type: none"> <li>- Nimbus Fish Hatchery Fish Passage Project</li> <li>- Folsom Dam Water Control Manual Update</li> <li>- FERC Relicensing for the Middle Fork of the American River Project</li> <li>- Lower Mokelumne River Spawning Habitat Improvement Project</li> <li>- Dutch Slough Tidal Marsh Restoration</li> <li>- Suisun Marsh Habitat Management, Preservation, and Restoration Plan Implementation</li> <li>- Tidal Wetland Restoration: Yolo Ranch, Northern Liberty Island Fish Restoration Project, Prospect Island Restoration Project, and Calhoun Cut/Lindsey Slough Tidal Habitat Restoration Project</li> <li>- San Joaquin River Restoration Program</li> <li>- Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects with completed environmental documents)</li> </ul>	<p>minimize adverse impacts to cultural resources.</p> <p>Climate change and sea level rise, development under the general plans, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce availability of CVP and SWP water supplies as compared to past conditions.</p> <p>Future water supply projects are anticipated to both increase water supply reliability due to reduced surface water supplies and to accommodate planned growth in the general plans. Most of these programs were initiated prior to implementation of the 2008 USFWS BO and 2009 NMFS BO which reduced CVP and SWP water supply reliability. Future water supply projects are anticipated to potentially effect cultural resources. However, development of these future programs would include preparation of environmental documentation that would identify methods to minimize adverse impacts to cultural resources.</p>
<p>Future Actions considered as Cumulative Effects Actions in All Alternatives in Year 2030</p>	<p>Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives):</p> <ul style="list-style-type: none"> <li>- Bay-Delta Water Quality Control Plan Update</li> <li>- FERC Relicensing Projects</li> <li>- Bay Delta Conservation Plan (including the California WaterFix alternative)</li> <li>- Shasta Lake Water Resources, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations</li> </ul>	<p><u>These effects would be the same under all alternatives.</u></p> <p>Most of the future reasonably foreseeable actions are anticipated to reduce water supply impacts due to climate change, sea level rise, increased water allocated to improve habitat conditions, and future growth.</p> <p>Some of the reasonably foreseeable actions related to improved water quality and habitat conditions (e.g., Water Quality Control Plan Update and FERC Relicensing Projects), could in further</p>



<b>Scenarios</b>	<b>Actions</b>	<b>Cumulative Effects of Actions</b>
	<ul style="list-style-type: none"> <li>- El Dorado Water and Power Authority Supplemental Water Rights Project</li> <li>- Sacramento River Water Reliability Project</li> <li>- Semitropic Water Storage District Delta Wetlands</li> <li>- North Bay Aqueduct Alternative Intake</li> <li>- San Luis Reservoir Low Point Improvement Project</li> <li>- Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects that did not have completed environmental documents during preparation of the EIS)</li> </ul>	<p>reductions in CVP and SWP water deliveries.</p> <p>Future development of the cumulative projects are anticipated to potentially affect cultural resources. However, development of these future programs would include preparation of environmental documentation that would identify methods to minimize adverse impacts to cultural resources.</p>
<p>No Action Alternative with Associated Cumulative Effects Actions in Year 2030</p>	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO</p>	<p>Community development and restoration projects for the ongoing programs would be completed.</p> <p>Climate change and sea level rise, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce availability of CVP and SWP water supplies as compared to past conditions.</p> <p>Future water supply projects are anticipated to both increase water supply reliability due to reduced surface water supplies and to accommodate planned growth in the general plans.</p> <p>Future development projects are anticipated to potentially affect cultural resources. However, development of these future programs would include preparation of environmental documentation that would identify methods to minimize adverse impacts to cultural resources.</p>

Scenarios	Actions	Cumulative Effects of Actions
Alternative 1 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternative 1 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 2 with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions No implementation of structural improvements or other actions that require further study to develop a more detailed action description.	Implementation of Alternative 2 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 3 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)  Slight increase in positive Old and Middle River flows in the winter and spring months	Implementation of Alternative 3 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 4 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternative 4 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 5 with Associated Cumulative Effects Actions in Year 20530	Full implementation of the 2008 USFWS BO and 2009 NMFS BO Positive Old and Middle River flows and increased Delta outflow in spring months	Implementation of Alternative 5 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.

1

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**Chapter 18****1 Public Health****2 18.1 Introduction**

3 This chapter describes public health hazards in the study area related to changes  
4 in the environment that could occur as a result of implementing the alternatives  
5 evaluated in this Environmental Impact Statement (EIS). Implementation of the  
6 alternatives considered in this EIS could affect public health through changes in  
7 available water supplies from the Central Valley Project (CVP) and State Water  
8 Project (SWP); changes in irrigated crop acreage related to potential changes in  
9 operation of the CVP and SWP; changes in wetlands acreage related to potential  
10 changes in ecosystem restoration; and changes in water quality related to potential  
11 changes in operation of the CVP and SWP.

12 Changes in available water supplies, agricultural resources, wetlands, and water  
13 quality are described in more detail in Chapter 5, Surface Water Resources and  
14 Water Supplies; Chapter 12, Agricultural Resources; and Chapter 6, Water  
15 Quality, respectively.

**16 18.2 Regulatory Environment and Compliance**  
**17 Requirements**

18 Potential actions that could be implemented under the alternatives evaluated in  
19 this EIS could affect public health throughout the study area. Some of the actions  
20 considered in the alternatives evaluated in this EIS could include facilities located  
21 on public agency lands; or actions implemented, funded, or approved by Federal  
22 and state agencies. These actions would need to be compliant with appropriate  
23 Federal and state agency policies and regulations, as summarized in Chapter 4,  
24 Approach to Environmental Analyses.

**25 18.3 Affected Environment**

26 This section describes the following public health factors that could be potentially  
27 affected by the implementation of the alternatives considered in this EIS.

- 28 • Changes in available water supplies.
- 29 • Increases in the potential for mosquito-borne diseases due to an increase in  
30 wetlands.
- 31 • Changes in the potential for Valley Fever from disturbed soils when irrigation  
32 water supplies change.
- 33 • Changes in the potential for bioaccumulation of mercury in fish and shellfish.



1 Changes in the potential of direct or indirect exposure to high water quality  
2 concentrations of various constituents also may occur due to implementation of  
3 the alternatives. These direct changes to water quality and the related changes to  
4 drinking water safety and consumption of fish or shellfish exposed to high  
5 concentrations of constituents of concern are described in Chapter 6, Water  
6 Quality.

7 Public health effects that could occur due to construction activities are not  
8 discussed in this chapter, including increased exposure to naturally occurring  
9 asbestos, methane production from disturbance of peat soils, disturbance of oil  
10 and gas production fields, use and transport of hazardous wastes, and changes in  
11 wastewater or stormwater discharges. Although several of the alternatives  
12 include assumptions of constructed facilities, those actions will require  
13 subsequent planning and environmental documentation prior to implementation.  
14 The subsequent environmental documentation and related permits will evaluate  
15 public health effects associated with construction and implementation of those  
16 facilities.

### 17 **18.3.1 Public Health Issues Related to Available Water Supplies**

18 Water supply availability can affect public health in several ways. Potential direct  
19 effects to public health are related to reduction of municipal water supplies.  
20 Potential indirect effects to public health are related to reduction of industrial and  
21 irrigation water supplies which could affect the ability to earn an income to fund  
22 food, shelter, and other critical factors necessary for public health. Effects related  
23 to loss of jobs.

24 Availability of water supplies substantially decreased for CVP and SWP water  
25 users during recent droughts in 1976-1977, 1987-1992, and 2012-2014. In  
26 addition, as described in Chapter 5, Surface Water Resources and Water Supplies,  
27 the frequency of substantially reduced water supplies provided by the CVP and  
28 SWP have increased since the 1976-1977 drought due to changes in regulations  
29 and increased water demands by users with higher priorities for water use.

30 During the 2014 drought, CVP and SWP water supply allocations have been  
31 reduced substantially to protect future water supplies and the ability to meet  
32 existing regulations, as described in Chapter 5, Surface Water Resources and  
33 Water Supplies. The allocations were modified throughout the 2013-2014 winter  
34 with the allocations that are the most stringent in the history of the CVP and/or  
35 SWP operations, as summarized below (Reclamation 2014a, 2014b; DWR 2013,  
36 2014).

- 37 • CVP North of Delta Water Users.
  - 38 – Sacramento River Settlement Contractors – allocated 40 percent of total
  - 39 contracted water supply.
  - 40 – Sacramento Valley Refuges that use CVP water supplies – allocated
  - 41 40 percent of total contracted water supply.

- 1       – Agricultural Water Service Contractors – allocated 0 percent of total
- 2       contracted water supply.
- 3       – Municipal and Industrial Water Service Contractors – allocated 50 percent
- 4       of historic water use.
- 5       • CVP In-Delta Water Service Contractor: Contra Costa Water District –
- 6       allocated 50 percent of historic water use.
- 7       • CVP South of Delta Water Users.
- 8       – San Joaquin River Exchange and Settlement Contractors – allocated
- 9       65 percent of total contracted water supply.
- 10      – San Joaquin Valley Refuges that use CVP water supplies – allocated
- 11      65 percent of total contracted water supply.
- 12      – Agricultural Water Service Contractors – allocated 0 percent of total
- 13      contracted water supply.
- 14      – Municipal and Industrial Water Service Contractors – allocated 50 percent
- 15      of historic water use.
- 16      • CVP Friant Division Contractors – allocated 0 percent of total contracted
- 17      water supply.
- 18      • CVP Eastside Water Service Contractors: Water supplies delivered from New
- 19      Melones Reservoir – allocated 55 percent of total contracted water supply.
- 20      • SWP Water Service Contractors – 5 percent of total contracted water supply.

21 Another potential indirect effect to public health is related to reduction of stored  
 22 water in the CVP and SWP reservoirs which could affect the ability to provide  
 23 enough water for firefighting,

24 **18.3.1.1 Public Health and Safety Related to Available Municipal and**  
 25 **Industrial Water Supplies**

26 The Department of the Interior, Bureau of Reclamation (Reclamation) current  
 27 *Draft Municipal and Industrial Shortage Policy* (Reclamation 2005) describes  
 28 that the CVP water service contractors should develop public health and safety  
 29 volumes based California’s public health and safety criteria or criteria developed  
 30 in coordination with Reclamation. Currently, California does not have a uniform  
 31 set of public health and safety criteria for municipal and industrial water supplies.  
 32 At this time, most of the urban communities have not adopted specific public  
 33 health and safety criteria. However, in some of the recently completed Urban  
 34 Water Management Plans, criteria have been identified to protect public health  
 35 and safety that range from 25 to 50 percent of the total water demand, as  
 36 described in Chapter 5, Surface Water Resources and Water Supplies (CCWD  
 37 2011; City of Folsom 2011; Metropolitan 2010). The Urban Water Management  
 38 Plans indicate that during the critical periods with reductions in water supplies,  
 39 municipal and industrial water uses will be focused on inside water uses with little  
 40 or no outside irrigation water.

1 At this time, no specific volumes have been identified for public health and safety  
2 quantities for the CVP and/or SWP water users. During the 2014 drought, the  
3 Department of Water Resources (DWR) and Reclamation identified 1,500 cubic  
4 feet per second as a minimum amount of CVP and SWP Delta exports for public  
5 health and safety uses for municipal and industrial water supplies. This amount is  
6 also defined by the limitations of the CVP and SWP conveyance facilities, as  
7 described in Chapter 5, Surface Water Resources and Water Supplies.

8 As described above, in 2014, CVP and SWP water supply allocations are at  
9 historically low values. However, it is difficult to identify local public health and  
10 safety issues, non-agricultural related industrial job losses, and economic losses  
11 associated with reductions in CVP and/or SWP water supplies. The potential  
12 economic losses, socioeconomic effects, and environmental justice effects are  
13 described in Chapter 19, Socioeconomics, and Chapter 21, Environmental Justice.

14 **18.3.1.2 Public Health and Safety Related to Available Agricultural Water**  
15 **Supplies**

16 Agricultural water suppliers have developed responses to the reductions in  
17 agricultural water supplies from the CVP and SWP, as described in Chapter 12,  
18 Agricultural Resources. Historically, the number of employment opportunities  
19 that rely directly or indirectly on the availability of CVP and/or SWP water  
20 supplies for irrigation have declined in the areas where the water supplies have  
21 declined, communities within the Central Valley Region and Southern California  
22 Region, as described in Chapter 19, Socioeconomics.

23 **18.3.1.3 Public Health and Safety Related to Water Supply Availability for**  
24 **Wildland Firefighting**

25 Complex terrain, Mediterranean climate, productive natural plant communities,  
26 and ample natural and aboriginal ignition sources has caused California to be a  
27 complex wildfire-prone and fire-adapted landscape. While natural wildfires  
28 support ecosystem health and are critical to maintaining the structure and function  
29 of ecosystems, wildfires pose a significant threat to life, public health,  
30 infrastructure, properties, and natural resources.

31 In accordance with Public Resources Code sections 4201 to 4204 and  
32 Government Code sections 51175 to 51189, the California Department of  
33 Forestry and Fire Prevention (CAL FIRE) has mapped areas of significant fire  
34 hazards based on fuels, terrain, weather, and other relevant factors. The zones are  
35 referred to as Fire Hazard Severity Zones and represent the risks associated with  
36 wildland fires. Under CAL FIRE regulations, areas within very high fire-hazard  
37 risk zones must comply with specific building and vegetation requirements  
38 intended to reduce property damage and loss of life within these areas.

39 According to CAL FIRE, there is an increasing trend of acres burned statewide,  
40 with particular increase in conifer vegetation types (CAL FIRE FRAP 2010).  
41 Statewide, there are 21.3 million acres of land designated as high priority  
42 landscape. The high priority landscape areas include locations with high value  
43 water supplies and high threats of fire and large communities which should be  
44 protected to prevent wildfire threats to maintain ecosystem health, water supplies,

1 and large communities. These areas include the upper Trinity River watershed in  
 2 the Trinity River Region; the upper Shasta Lake, Lake Oroville, Folsom Lake,  
 3 New Melones Reservoir, and Millerton Lake watersheds in the Central Valley  
 4 Region; and communities in throughout the Southern California Region. Areas  
 5 designated as high priority landscape occur within 46 of 58 counties. Many rural  
 6 counties have significant numbers of communities and acreage in medium priority  
 7 landscape, including 508 communities with some high priority landscape areas.

8 CAL FIRE manages the State Responsibility Areas, and local fire districts  
 9 manage Local Responsibility Areas. First responders are typically the local fire  
 10 districts. The U.S. Forest Service provides wildland fire protection both  
 11 independently and cooperatively with the California Department of Forestry and  
 12 Fire Protection. In addition, the U.S. Department of the Interior National Park  
 13 Service and Bureau of Land Management provide resource management and fire  
 14 protection on portions of Federal lands.

15 Firefighting actions frequently involve use of water from reservoirs located close  
 16 to wildland fires in the Trinity River, Central Valley, Central Coast, and Southern  
 17 California regions, including reservoirs owned by Reclamation and DWR.

### 18 **18.3.2 Public Health Issues Related to Mosquito-Borne Diseases**

19 There are more than 50 species of mosquitos in California, including members of  
 20 the four major genera: 24 species of *Aedes*, 5 species of *Anopheles*, 11 species of  
 21 *Culex*, and 4 species of *Culiseta* (CDPH et al. 2012). Not all of these species are  
 22 known to transmit mosquito-borne viruses, as described below. There are  
 23 approximately 15 mosquito-borne viruses that occur in California; however, the  
 24 most significant viruses that cause human disease are St. Louis encephalitis virus  
 25 (SLEV), western equine encephalomyelitis (WEEV), and West Nile virus (WNV)  
 26 (CDPH et al. 2014). No cases of SLEV or WEEV have been reported in humans  
 27 over the past few years in California. Malaria also is a mosquito-borne disease  
 28 that is caused by a parasite instead of a virus.

29 The *Culex tarsalis* has been identified as part of transmission of SLEV, WEEV,  
 30 and WNV, especially in rural areas. The *Culex pipiens* and *Culex*  
 31 *quinquefasciatus* have been identified as part of the transmission of WNV and  
 32 SLEV. The *Culex stigmatosoma* has been identified as part of the transmission of  
 33 WNV and SLEV, especially among birds. The *Aedes melanimon*, *Aedes vexans*,  
 34 and *Culex erythrothorax* have been identified as species involved in transmitting  
 35 the virus between birds and mammals or between mammals.

36 Mosquitoes, especially *Culex tarsalis*, live in every area of California, and can be  
 37 a threat to the health of humans and domestic animals throughout the state. The  
 38 mosquito life cycle requires water for the egg, larva, and pupa stages. Some of  
 39 the species are more associated with irrigated agriculture, and others are more  
 40 associated with urban communities (CDPH et al. 2014). Most of the diseases are  
 41 not treatable and vaccines are not available for humans. Methods to prevent  
 42 mosquitoes from becoming adults and methods to prevent mosquitos from biting  
 43 humans are the only available and practical methods to protect public health.

1 California Health and Safety Code (Sections 2001 – 4(d); 2002; and 2060(b))  
2 describes that landowners are legally responsible to eliminate public nuisances  
3 from their properties, including mosquito breeding habitat (CDPH 2008; CDPH  
4 et al. 2012). Federal, state, and local agencies supplement the preventive  
5 activities of individual landowners toward protecting humans and domestic  
6 animals from mosquito-borne diseases. The California Department of Public  
7 Health (CDPH) monitors mosquito populations throughout the state. In 1915, the  
8 state legislature enacted the Mosquito Abatement Act to allow local mosquito  
9 abatement special districts. The local mosquito and vector control districts  
10 monitor mosquito populations and take actions such as eliminating breeding sites,  
11 using biological control (predators such as mosquitofish), and using chemical  
12 control, to reduce mosquito population size (CDPH 2013a).

### 13 **18.3.2.1 St. Louis Encephalitis Virus**

14 The SLEV is a mosquito-borne virus that circulates among birds and is  
15 transmitted to humans via mosquito bites (CALSURV 2013a; CDPH 2007).  
16 Human infection with SLE can cause mild to severe fever and headaches due to  
17 inflammation of the brain. In severe cases, the illness can cause disorientation  
18 and comas and possibly cause death. Elderly can become more severely ill than  
19 young children with SLEV as compared to WEEV.

20 Since the SLEV was first recognized in 1933 in St. Louis, Missouri, outbreaks  
21 have been reported throughout the United States, Canada, and northern Mexico,  
22 generally between August and October (CALSURV 2013a). In 1984 and 1989,  
23 29 human cases were reported in the San Joaquin Valley of the Central Valley  
24 Region. During the same time periods, 26 human cases were reported in the Los  
25 Angeles area of the Southern California Region. The last human case reported in  
26 California occurred in 1997 in Los Angeles County.

### 27 **18.3.2.2 Western Equine Encephalitis**

28 The WEEV is another mosquito-borne virus that circulates among birds and is  
29 transmitted to horses and humans by mosquitoes (CDPH 2007). Symptoms are  
30 similar to SLEV. Infants and small children are most severely afflicted with  
31 WEEV as compared to SLEV. There is a vaccine for horses, but not for humans.  
32 Historically, substantial number of horses died due to this disease as well as  
33 humans. Recently, there has not been a recorded case of WEEV in humans in  
34 California (CDPH et al. 2014).

### 35 **18.3.2.3 West Nile Virus**

36 West Nile virus (WNV) can cause mild to severe illness in human, other  
37 mammals, and birds.

38 The virus circulates among birds and is transmitted to humans primarily by *Culex*  
39 mosquitoes (CDPH et al. 2014). The WNV was first detected in North America  
40 in New York in 1999, and has subsequently spread to 48 states, Canada, and  
41 Mexico.

42 The WNV first appeared in humans in California in 2002 with the identification  
43 of one human case (CALSURV 2013b). In 2003, three human cases and one

1 equine case were reported with numerous verified findings of WNV activity  
2 among dead birds and mosquitoes. In 2004, the WNV was reported in  
3 58 counties, with 779 human cases, including 29 WNV-associated deaths  
4 (CALSURV 2013b). From 2003 through 2013, there were 4,004 reported human  
5 cases of WNV with 145 deaths; 16,299 reported bird deaths; and 1,202 reported  
6 cases involving horses (CDPH 2014a). In 2007, 2008, and between 2010 and  
7 2013, the majority of reported human cases occurred in the six counties in  
8 Southern California Region, with most of the cases reported in Los Angeles  
9 County. Between 2007 and 2013, numerous human cases were reported in Butte,  
10 Sutter, Sacramento, Stanislaus, Fresno, Tulare, and Kern counties in the Central  
11 Valley Region. During this same period, no human cases were reported in the  
12 Trinity River Region; Lassen, Plumas, and Nevada counties in the Central Valley  
13 Region; San Benito County in the San Francisco Bay Area Region; and San Luis  
14 Obispo County in the Central Coast Region.

15 In humans, WNV may not result in any symptoms or only mild viral symptoms,  
16 including mild fever, headache, body aches, skin rash, and swollen lymph glands.  
17 Symptoms in less than 1 percent of people that are infected can include headache,  
18 high fever, neck stiffness, stupor, disorientation, coma, tremors, convulsions,  
19 muscle weakness, and paralysis that are associated with meningitis or  
20 encephalitis.

#### 21 **18.3.2.4 Malaria**

22 Malaria also is a mosquito-borne disease caused by a parasite that destroys the red  
23 blood cells of its host. People with malaria often experience fever, chills, and flu-  
24 like illness which can lead to death (CDPH et al. 2012). Malaria is no longer  
25 endemic in California, as well as the rest of the United States, due to intense  
26 mosquito control efforts and anti-malarial drugs. However, the disease is  
27 diagnosed every year, especially in people who have traveled outside the United  
28 States. In 2012, 92 human cases were reported in California (CDPH 2013). Of  
29 the 92 cases, 90 patients had traveled to countries characterized as endemic with  
30 malaria during the previous three years. The *Anopheles* mosquitoes can transmit  
31 the parasite to humans and are prevalent in California (CDPH et al. 2012).

#### 32 **18.3.3 Public Health Issues Related to Valley Fever**

33 Valley fever is an illness that is caused by inhaling the spores of a fungus  
34 *Coccidioides immitis* (CDPH 2013c). This fungus lives in the top layers of some  
35 soils within 2 to 12 inches from the ground surface. When the soil is disturbed by  
36 digging, vehicles, cultivation, or wind, the fungal spores can be inhaled by  
37 persons within the area. Irrigated soils are less likely to contain the fungus than  
38 dry, previously undisturbed soils.

39 In most cases, symptoms in humans include mild cough and flu-like symptoms  
40 (CDPH 2013c). However, in about 40 percent of the reported cases, the illness  
41 can last for more than a month, make the person susceptible to pneumonia, and  
42 include cough, fever, chest pain, headache, muscle ache, rash, joint pain, and/or  
43 fatigue. In about 5 percent of the reported cases, the disease becomes

1 “disseminated Valley Fever” and can cause meningitis and/or affect bones, joints,  
2 skin, or other organs. There are no vaccines to prevent Valley Fever.

3 The *Coccidioides immitis* is endemic in many areas of the southwestern United  
4 States, Mexico, Central America, and South America. In California, the fungus is  
5 found in many areas of the San Joaquin Valley and Southern California  
6 (CDPH 2011, 2014b). In California between 2001 and 2012, there were over  
7 35,000 reported cases of Valley Fever. The number of incidences increased from  
8 1,483 cases in 2001 to 4,094 cases in 2012. The highest number of cases reported  
9 during this period occurred in Kings, Kern, Fresno, Tulare, and Madera counties  
10 in the San Joaquin Valley within the Central Valley Region; San Luis Obispo  
11 County in the Central Coast Region; and Los Angeles County in the Southern  
12 California Region.

13 In general, the people who have the highest risk of exposure to the fungus include  
14 construction workers, archeologists, geologists, wildland fighters, military  
15 personnel, mining or gas/oil extraction workers, and agricultural workers in  
16 non-irrigated areas (CDPH 2013c). Other employees also may be at risk. For  
17 example, members of the cast and crew of a television film became ill with Valley  
18 Fever after working on an outdoor set in Ventura County (CDCP 2014).

19 In 2011, Fresno, Kern, Kings, San Joaquin, San Luis Obispo, and Tulare counties  
20 conducted an analysis of information related to Valley Fever incidences (Fresno  
21 County et al. 2011). The observations included:

- 22 • More incidences were reported in the western parts of Kern, Kings, Fresno,  
23 and San Joaquin counties than in other portions of the counties.
- 24 • More incidences were reported in northern San Luis Obispo County and  
25 southern Tulare County than other portions of the counties.
- 26 • In recent years, there was increased reporting of Valley Fever in the prison  
27 populations in Fresno and Kings counties. In Kern County, 8 percent of the  
28 reported cases between 2005 and 2008 were prison inmates. In Fresno  
29 County, incidences at Pleasant Valley State Prison were 43 percent of the total  
30 cases in the county between 2004 and 2010. In Kings County, incidences at  
31 state prisons were 58 percent of the total cases in the county between 2007  
32 and 2010.

33 In 2012, the San Joaquin Valley Air Pollution Control District (SJVAPCD)  
34 evaluated causes for Valley Fever and options to reduce social and economic  
35 effects of Valley Fever in the San Joaquin Valley (SJVAPCD 2012). The analysis  
36 described that Valley Fever appears to be related to a fungus that forms in subsoil  
37 strata that are dry through a portion of the year. The analysis referred to other  
38 studies that correlated weather patterns with outbreaks of Valley Fever during dry  
39 periods following periods of heavy rainfall. The study also indicated that airborne  
40 *Coccidioides* spores do not generally come from irrigated agriculture. It appears  
41 that it is more likely that the spores are from non-irrigated lands, including  
42 undisturbed natural lands, undeveloped land, and grazing areas. The study  
43 indicated that additional monitoring or reduction of particulate matter of

1 10 microns, or PM<sub>10</sub>, did not appear to be useful in reduction of the potential for  
 2 Valley Fever. The study recommended additional funding to develop a vaccine  
 3 for Valley Fever.

4 **18.3.4 Public Health Issues Related to High Concentrations of**  
 5 **Mercury in Fish and Shellfish**

6 As described in Chapter 6, Water Quality, high concentrations of certain  
 7 substances accumulate in fish and shellfish based upon the water quality. The  
 8 California Environmental Protection Agency, Office of Environmental Health  
 9 Hazard Assessment (OEHHA) evaluates concentrations of potentially toxic  
 10 substances in edible tissues of fish and shellfish harvested in water bodies in  
 11 California (OEHHA 2014a). Based upon the evaluation, general and specific safe  
 12 eating guidelines are developed for the fish and shellfish, as summarized in  
 13 Table 18.1. For the water bodies in the study area, the primary constituents that  
 14 have triggered the development of safe eating guidelines are mercury, dieldrin,  
 15 and/or polychlorinated biphenyl (PCB). Other constituents are present, including  
 16 selenium; however, the concentrations do not exceed thresholds that would trigger  
 17 safe eating guidelines. The OEHHA develops two separate guidelines:  
 18 (1) Guidelines for Children from 1 to 17 years and Women from 18 to 45 years;  
 19 and (2) Guidelines for Women over 45 years old and Men over 17 years old. The  
 20 guidelines recommend the number of servings per week by fish or shellfish  
 21 harvested from specific waters. A “serving size” is defined as “about the size and  
 22 thickness of your hand” (OEHHA 2014a).

23 **Table 18.1 Summary of Safe Eating Guidelines for Fish and Shellfish from Water**  
 24 **Bodies in the Study Area Based on Mercury and PCB (servings per week)**

Region	Water Body	Fish and Shellfisha	Guidelines for Children and Women up to 45 Years Oldb	Guidelines for Men and Women over 45 Years Oldb
Trinity River	Trinity Lake	Rainbow Trout, Brown Trout, White Catfish	2	5
		Largemouth Bass, Smallmouth Bass	Do not eat	1
	Lewiston Lake	Trout	5	7
Central Valley	Sacramento River and Northern Delta	American Shad, Chinook Salmon, Rainbow Trout, Steelhead Trout	2 to 3	7
		Clams	7	7
		Bluegill, other sunfish, carp or goldfish, catfish, crappie, Crayfish, Hardhead, Hitch, sucker	1	3



<b>Region</b>	<b>Water Body</b>	<b>Fish and Shellfisha</b>	<b>Guidelines for Children and Women up to 45 Years Oldb</b>	<b>Guidelines for Men and Women over 45 Years Oldb</b>
<b>Central Valley (continued)</b>		Bass, Pikeminnow, White Sturgeon	Do not eat	1
		Striped Bass	Do not eat	2
	Lake Oroville	Bluegill and Green Sunfish	2	5
		Carp, Coho salmon	1	2
		Largemouth Bass, Smallmouth Bass, Redeye, or Spotted Bass; Channel Catfish; White Catfish	Do not eat	1
	Lower Feather River	American Shad, Chinook Salmon, Steelhead Trout	2 to 3	7
		Carp, sucker	1	2
		Redear, other sunfish	1	3
		Black Bass, catfish, Pikeminnow, Striped Bass, White Sturgeon	Do not eat	1
	Englebright Lake	Rainbow Trout	2	7
		Bluegill, other sunfish	1	2
		Largemouth Bass, Smallmouth Bass, Spotted Bass	Do not eat	1
	Rollins Reservoir	Catfish	1	2
	Camp Far West Reservoir	Bluegill, other sunfish	1	3
		Largemouth Bass, Smallmouth Bass, Spotted Bass, catfish	Do not eat	1
	Folsom Lake	Bluegill, Green Sunfish, or other sunfish; Rout: 16 inches or less	2	5

<b>Region</b>	<b>Water Body</b>	<b>Fish and Shellfisha</b>	<b>Guidelines for Children and Women up to 45 Years Oldb</b>	<b>Guidelines for Men and Women over 45 Years Oldb</b>
<b>Central Valley (continued)</b>		Catfish; Chinook Salmon; Largemouth Bass, Smallmouth Bass, Spotted Bass, trout: over 16 inches	Do not eat	1
	Lake Natoma	Bluegill, Green Sunfish, or other sunfish; trout: 16 inches or less	2	5
		Chinook Salmon; Largemouth Bass, Smallmouth Bass, Spotted Bass, trout: over 16 inches	Do not eat	1
		Catfish	Do not eat	Do not eat
		Lower American River	American Shad, Chinook Salmon, steelhead trout	2 to 3
		Redear or other sunfish, sucker, white catfish	1	2
		Striped Bass	Do not eat	2
		Bass, Pikeminnow	Do not eat	1
	Lower Mokelumne River	American Shad, Chinook Salmon, steelhead trout	2 to 3	7
		Clams	7	7
		Bluegill or other sunfish, Crayfish, catfish	1	2
		Striped Bass	Do not eat	2
		Bass, Pikeminnow, White Sturgeon	Do not eat	1
	San Joaquin River (Friant Dam to Port of Stockton)	Chinook Salmon, steelhead trout	2	7
		Bluegill or other sunfish	2	5
		American Shad	3	7
		Carp, catfish, sucker	1	2

<b>Region</b>	<b>Water Body</b>	<b>Fish and Shellfisha</b>	<b>Guidelines for Children and Women up to 45 Years Oldb</b>	<b>Guidelines for Men and Women over 45 Years Oldb</b>
<b>Central Valley (continued)</b>		Striped Bass	Do not eat	2
		Bass, white sturgeon	Do not eat	1
	Central and South Delta	American Shad, Chinook Salmon, Bluegill or other sunfish, steelhead trout	2	7
		Catfish, Crayfish	2	5
		Clams	7	7
		Bass, carp, crappie, sucker	1	2
		Striped Bass	Do not eat	2
		White Sturgeon	Do not eat	1
<b>San Francisco Bay Area</b>	San Francisco Bay	Chinook Salmon	2	7
		Brown Rockfish, Red Rock Crab	2	5
		Jacksmelt	2	2
		California Halibut	1	2
		White Croaker	1	1
		Sharks, Striped Bass, White Sturgeon	Do not eat	1
		Surfperches	Do not eat	Do not eat
	San Pablo Reservoir	Crappie	2	5
		Trout	5	5
		Largemouth Bass, Smallmouth Bass, Spotted Bass	Do not eat	1
		Carp, catfish	Do not eat	Do not eat
	Lafayette Reservoir	Crappie	4	7
		Bass	1	2
		Carp or Goldfish	Do not eat	1

<b>Region</b>	<b>Water Body</b>	<b>Fish and Shellfisha</b>	<b>Guidelines for Children and Women up to 45 Years Oldb</b>	<b>Guidelines for Men and Women over 45 Years Oldb</b>
<b>San Francisco Bay Area (continued)</b>	Lake Chabot	Redear or other sunfish	2	4
		Channel Catfish	1	1
		Bass	Do not eat	1
		Carp	Do not eat	Do not eat
<b>Southern California Region</b>	Pyramid Lake	Rainbow Trout	7	7
		Channel Catfish	1	2
		Largemouth Bass, Smallmouth Bass	Do not eat	1
		Bullhead	Do not eat	Do not eat
	Silverwood Lake	Rainbow Trout	7	7
		Tule Perch	1	1
		Largemouth Bass, Bluegill, Channel Catfish	Do not eat	1
		Striped Bass, Blackfish, Tui Chub	Do not eat	Do not eat
<b>Statewide</b>	All Lakes and Reservoirs without Site-Specific Advice	Rainbow trout	2	6
		Bullhead, catfish, Bluegill or other sunfish, Brown Trout: 16 inches or less	1	2
		Bass, carp, Brown Trout: over 16 inches	Do not eat	1
	All Rivers, Estuaries, and Coastal Waters without Site-Specific Advice	American Shad, Chinook Salmon, steelhead trout	2 to 3	7

Region	Water Body	Fish and Shellfisha	Guidelines for Children and Women up to 45 Years Oldb	Guidelines for Men and Women over 45 Years Oldb
Statewide (continued)		Striped Bass	Do not eat	2
		White Sturgeon	Do not eat	1

1 Sources: OEHHA 2014b, 2014c, 2014d, 2014e, 2014f, 2014g, 2014h, 2014i, 2014j,  
 2 2014k, 2014l, 2014m, 2014n, 2014o, 2014p, 2014q, 2014r, 2014s, 2014t, 2014u, 2014v,  
 3 2014w

4 Notes:

- 5 a. All fish and shellfish names are as appears in the OEHHA guidelines.  
 6 b. The OEHHA guidelines refer to the total number of servings of fish per week for one  
 7 water body, not just the total for a specific species. For example, OEHHA guidelines for  
 8 Men eating fish from Trinity Lake would include no more than 5 servings of Rainbow  
 9 Trout, Brown Trout, or White Catfish; OR 1 serving of Largemouth Bass or Smallmouth  
 10 Bass.

11 Resident Delta fish accumulate mercury primarily through dietary exposure;  
 12 larger, piscivorous (fish-eating) fish show the greatest levels of tissue mercury. In  
 13 contrast to anadromous fish (migratory species), the resident fish experience  
 14 constant exposure to local mercury sources. Resident species include larger fish  
 15 with human health exposure (such as Largemouth Bass) and smaller, forage fish  
 16 (such as Inland Silversides). Fish tissues are the ultimate route of exposure to  
 17 mercury for humans who consume locally caught fish.

18 Historically, substantial levels of mercury contamination have occurred in fish  
 19 throughout the Delta. Mercury concentrations in tissue of the larger piscivorous  
 20 fish are lower in for fish in the central Delta as compared to fish from the  
 21 Mokelumne, Cosumnes, Sacramento, and San Joaquin rivers (CVRWQCB 2010a,  
 22 2010b). Larger, piscivorous resident fish, in general, provide a good record of  
 23 fish tissue mercury as a baseline condition for the Delta. Largemouth Bass were  
 24 chosen because they are popular sport fish, top predators, live for several years,  
 25 and tend to stay in the same area (exhibit high site fidelity). Consequently, they  
 26 are excellent indicators of long-term average mercury exposure, risk, and spatial  
 27 pattern for ecological and human health. Mercury in sport fish from the Delta  
 28 region was reported for Largemouth Bass as a median tissue mercury  
 29 concentration of 0.53 mg mercury per kilogram (Hg/kg) wet weight (Davis et al.  
 30 2003). Current fish tissue concentrations thus exceed both adopted regulatory  
 31 standards and guidance from the U.S. Environmental Protection Agency  
 32 (USEPA). In the 2010 Delta TMDL for methylmercury, the Central Valley  
 33 Regional Water Quality Control Board (Central Valley RWQCB) established a  
 34 fish tissue threshold (fillet concentrations, wet weight mercury) of 0.24 mg Hg/kg  
 35 wet weight in trophic level 4 fish (adult, top predatory sport fish, such as  
 36 Largemouth Bass) (Central Valley Water Board 2010a). These values are slightly  
 37 lower than USEPA’s national recommended water quality criterion for fish tissue  
 38 of 0.3 mg Hg/kg wet weight for protection of human health and wildlife (USEPA

1 2001). Therefore, the Delta average for Largemouth Bass fillet concentrations in  
 2 the study by Davis et al. exceeds both recommended safe consumption guidelines.

### 3 **18.4 Impact Analysis**

4 This section describes the potential mechanisms for change in conditions and  
 5 analytical methods; results of impact analyses; potential mitigation measures; and  
 6 cumulative effects.

#### 7 **18.4.1 Potential Mechanisms for Change and Analytical Methods**

8 As described in Chapter 4, Approach to Environmental Analysis, the impact  
 9 analysis considers changes in public health factors related to changes in CVP and  
 10 SWP operations under the alternatives as compared to the No Action Alternative  
 11 and Second Basis of Comparison.

12 Changes in CVP and SWP operations under the alternatives as compared to the  
 13 No Action Alternative and Second Basis of Comparison could change public  
 14 health factors affected by CVP and SWP operations.

##### 15 **18.4.1.1 Changes in Public Health Factors Related to Available CVP and** 16 **SWP Agricultural Water Supplies**

17 Changes in water supply availability to agricultural water users could result in  
 18 reductions of irrigated acreage and related jobs. The availability of jobs can affect  
 19 public health, as described in Section 18.3.2, Public Health Issues Related to  
 20 Available Water Supplies. As described in Chapter 12, Agricultural Resources,  
 21 agricultural acreage would be similar under Alternatives 1 through 5, No Action  
 22 Alternative, and Second Basis of Comparison. Therefore, the change in public  
 23 health conditions would be the same under all of the alternatives and the Second  
 24 Basis of Comparison; and is not analyzed in this EIS.

##### 25 **18.4.1.2 Changes in Public Health Factors Related to Available Municipal** 26 **Water Supplies**

27 As described in Section 18.3.2, Public Health Issues Related to Available Water  
 28 Supplies, water supply availability can affect public health related to direct use  
 29 within the household and indirect effects related to adequate water supplies for  
 30 industrial and commercial water users that provide employment. As described in  
 31 Chapter 5, Surface Water Resources and Water Supplies, and Chapter 18,  
 32 Socioeconomics, municipal and industrial water users would rely upon alternate  
 33 water supplies to meet water demands in 2030. Therefore, public health  
 34 conditions related to availability of municipal and industrial water supplies would  
 35 be the same under all of the alternatives and the Second Basis of Comparison; and  
 36 is not analyzed in this EIS.

##### 37 **18.4.1.3 Changes in Public Health Factors Related to Wildland** 38 **Firefighting and CVP and SWP Reservoir Storage**

39 Stored water in water supply reservoirs is used for wildland firefighting in the  
 40 California foothills and mountains, including water stored in CVP and SWP

1 reservoirs. During drier periods, reduced storage levels could affect the  
2 availability of water for wildlife firefighting, as indicated in changes in CVP and  
3 SWP reservoir at the end of September in critical dry water years, as described in  
4 Chapter 5, Surface Water Resources and Water Supplies.

5 Reservoirs that store water in the San Francisco Bay Area, Central Coast, and  
6 Southern California regions are managed to store water supplies as part of short-  
7 term conveyance management or storage for regional and local water supplies  
8 using water from numerous sources and water for wildland firefighting is not  
9 known; and therefore, are not analyzed in this EIS.

10 **18.4.1.4 Changes in Public Health Factors Related to Wetlands**  
11 **Restoration and Mosquito-Borne Diseases**

12 Wetlands provide habitat for mosquito breeding, especially in tidally-influenced  
13 wetlands with slow moving water and floodplains after the majority of the water  
14 recedes. Management practices (e.g., designing wetlands to provide flushing  
15 flows, use of biological controls) can reduce the nuisance and public health  
16 aspects of mosquito populations. The extent of seasonal floodplains and tidally-  
17 influenced wetlands in Yolo Bypass, Cache Slough, and Suisun Marsh areas  
18 would increase in a similar manner under all of the alternatives and the Second  
19 Basis of Comparison, as described in Chapter 3, Description of Alternatives.  
20 Therefore, the potential for changes in public health conditions related to  
21 mosquito populations would be the same under all of the alternatives and the  
22 Second Basis of Comparison; and is not analyzed in this EIS.

23 **18.4.1.5 Changes in Public Health Factors Related to Potential**  
24 **Valley Fever**

25 As described above, recent studies have indicated that valley fever exposure  
26 appears to be related to cultivated lands, including lands that are idled due to  
27 agricultural practices or reduced water supply availability. Changes in CVP and  
28 SWP operations under the alternatives and the Second Basis of Comparison  
29 would not affect the extent of non-irrigated lands. Therefore, the potential for  
30 changes in public health conditions related to Valley Fever would be the same  
31 under all of the alternatives and the Second Basis of Comparison; and is not  
32 analyzed in this EIS.

33 **18.4.1.6 Changes in Public Health Factors Related to Mercury in Fish**  
34 **used for Human Consumption**

35 As described above, fish used for human consumption in the Delta have mercury  
36 levels that exceed OEHHA guidelines. Changes in CVP and SWP operations  
37 under the alternatives and the Second Basis of Comparison would change the  
38 accumulated mercury concentrations in fish in the Delta. As described in Chapter  
39 6, Surface Water Quality, the bioavailability and toxicity of mercury is enhanced  
40 through the natural, bacterial conversion of mercury to methylmercury in  
41 marshlands or wetlands. These stagnant locations with reduced oxygen  
42 concentrations promote chemical reduction processes that make methylation  
43 possible. The methylmercury model is based upon the Total Maximum Daily  
44 Load translation equation for mercury developed by the Central Valley Regional

1 Water Quality Control Board. The model estimates fish tissue concentrations  
 2 from waterborne concentrations of mercury in the Delta and evaluates the  
 3 potential to cause exceedances of water quality or tissue benchmarks. The tissue  
 4 concentrations associated with the Alternatives 1 through 5 were compared to the  
 5 No Action Alternative and the Second Basis of Comparison.

#### 6 **18.4.2 Conditions in Year 2030 without Implementation of** 7 **Alternatives 1 through 5**

8 This EIS includes two bases of comparison, as described in Chapter 3,  
 9 Description of Alternatives: the No Action Alternative and the Second Basis of  
 10 Comparison. Both of these bases are evaluated at 2030 conditions. Changes that  
 11 would occur over the next 15 years without implementation of the alternatives are  
 12 not analyzed in this EIS. However, the changes to public health that are assumed  
 13 to occur by 2030 under the No Action Alternative and the Second Basis of  
 14 Comparison are summarized in this section. Many of the changed conditions  
 15 would occur in the same manner under both the No Action Alternative and the  
 16 Second Basis of Comparison.

##### 17 **18.4.2.1 Common Changes in Conditions under the No Action Alternative** 18 **and Second Basis of Comparison**

19 Conditions in 2030 would be different than existing conditions due to:

- 20 • Climate change and sea level rise
- 21 • General plan development throughout California, including increased water  
 22 demands in portions of Sacramento Valley
- 23 • Implementation of reasonable and foreseeable water resources management  
 24 projects to provide water supplies

25 It is anticipated that climate change would result in more short-duration high-  
 26 rainfall events and less snowpack in the winter and early spring months. The  
 27 reservoirs would be full more frequently by the end of April or May by 2030 than  
 28 in recent historical conditions. However, as the water is released in the spring,  
 29 there would be less snowpack to refill the reservoirs. This condition would  
 30 reduce reservoir storage and available water supplies to downstream uses in the  
 31 summer. The reduced end of September storage also would reduce the ability to  
 32 release stored water to downstream regional reservoirs. These conditions would  
 33 occur for all reservoirs in the California foothills and mountains, including  
 34 non-CVP and SWP reservoirs.

35 These changes would result in a decline of the long-term average CVP and SWP  
 36 water supply deliveries by 2030 as compared to recent historical long-term  
 37 average deliveries under the No Action Alternative and the Second Basis of  
 38 Comparison. However, the CVP and SWP water deliveries would be less under  
 39 the No Action Alternative as compared to the Second Basis of Comparison, as  
 40 described in Chapter 5, Surface Water Resources and Water Supplies. Due to  
 41 climate change and related lower snowfall, end of September low reservoir  
 42 storage would be lower in critical dry years by 2030 as compared to recent



1 historical conditions in Shasta Lake, Lake Oroville, Folsom Lake, New Melones  
2 Reservoir, and San Luis Reservoir. Therefore, the potential for reduced reservoir  
3 water supplies for wildland firefighting would be greater under the No Action  
4 Alternative and Second Basis of Comparison as compared to recent historical  
5 conditions.

6 Under the No Action Alternative and the Second Basis of Comparison, land uses  
7 in 2030 would occur in accordance with adopted general plans.

8 The No Action Alternative and the Second Basis of Comparison assumes  
9 completion of water resources management and environmental restoration  
10 projects that would have occurred without implementation of Alternatives 1  
11 through 5, including regional and local recycling projects, surface water and  
12 groundwater storage projects, conveyance improvement projects, and desalination  
13 projects, as described in Chapter 3, Description of Alternatives. The No Action  
14 Alternative and the Second Basis of Comparison also assumes implementation of  
15 actions included in the 2008 U.S. Fish and Wildlife Service (USFWS) Biological  
16 Opinion (BO) and 2009 National Marine Fisheries Service (NMFS) BO that  
17 would have been implemented without the BOs by 2030, as described in  
18 Chapter 3, Description of Alternatives.

19 Under the No Action Alternative and Second Basis of Comparison, it is  
20 anticipated that mercury concentrations in fish tissue within the Delta will be  
21 either similar or greater than recent historical conditions. Phase 1 of the Delta  
22 Mercury Program mandated by the Central Valley RWQCB is currently being  
23 completed to protect people eating one meal per week of larger fish from the  
24 Delta, including Largemouth Bass. Phase 1 is focused on studies and pilot  
25 projects to develop and evaluate management practices to control methylmercury  
26 from mercury sources in the Delta and Yolo Bypass; and to reduce total mercury  
27 loading to the San Francisco Bay. Following completion of Phase 1 in 2019,  
28 Phase 2 will be implemented through 2030. Phase 2 will focus on methylmercury  
29 control programs and reduction programs for total inorganic mercury. Due to the  
30 extent of these studies, it is not anticipated that changes in methylmercury or total  
31 mercury concentrations in fish tissue will be reduced by 2030. Future mercury  
32 reduction and control programs will reduce mercury sources and related fish  
33 tissue concentrations; however, that will occur after 2030.

### 34 **18.4.3 Evaluation of Alternatives**

35 As described in Chapter 4, Approach to Environmental Analysis, Alternatives 1  
36 through 5 have been compared to the No Action Alternative; and the No Action  
37 Alternative and Alternatives 1 through 5 have been compared to the Second Basis  
38 of Comparison.

39 During review of the numerical modeling analyses used in this EIS, an error was  
40 determined in the CalSim II model assumptions related to the Stanislaus River  
41 operations for the Second Basis of Comparison, Alternative 1, and Alternative 4  
42 model runs. Appendix 5C includes a comparison of the CalSim II model run  
43 results presented in this chapter and CalSim II model run results with the error

1 corrected. Appendix 5C also includes a discussion of changes in the comparison  
2 of groundwater conditions for the following alternative analyses.

- 3 • No Action Alternative compared to the Second Basis of Comparison
- 4 • Alternative 1 compared to the No Action Alternative
- 5 • Alternative 3 compared to the Second Basis of Comparison
- 6 • Alternative 5 compared to the Second Basis of Comparison

#### 7 **18.4.3.1 No Action Alternative**

8 The No Action Alternative is compared to the Second Basis of Comparison.

##### 9 **18.4.3.1.1 Trinity River Region**

###### 10 *Changes in Public Health Factors Related to Wildland Firefighting and CVP and* 11 *SWP Reservoir Storage*

12 Changes in CVP water supplies and operations under the No Action Alternative  
13 as compared to the Second Basis of Comparison would result in similar end of  
14 September reservoir elevations in critical dry years (changes within 5 percent) at  
15 Trinity Lake, as described in Chapter 5, Surface Water Resources and Water  
16 Supplies. Therefore, the potential for water availability for wildland firefighting  
17 would be similar under the No Action Alternative as compared to the Second  
18 Basis of Comparison.

##### 19 **18.4.3.1.2 Central Valley Region**

###### 20 *Changes in Public Health Factors Related to Wildland Firefighting and CVP and* 21 *SWP Reservoir Storage*

22 Changes in CVP water supplies and operations under the No Action Alternative  
23 as compared to the Second Basis of Comparison would result in similar end of  
24 September reservoir elevations in critical dry years (changes within 5 percent) at  
25 Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir, as  
26 described in Chapter 5, Surface Water Resources and Water Supplies. Therefore,  
27 the potential for water availability for wildland firefighting would be similar  
28 under the No Action Alternative as compared to the Second Basis of Comparison.

29 End of September surface water elevations at San Luis Reservoir in critical dry  
30 years would be 6 percent lower under the No Action Alternative as compared to  
31 the Second Basis of Comparison. Therefore, the potential for water availability  
32 for wildland firefighting would be reduced at San Luis Reservoir under the No  
33 Action Alternative as compared to the Second Basis of Comparison.

###### 34 *Changes in Public Health Factors Related to Mercury in Fish used for Human* 35 *Consumption*

36 Mercury concentrations in Largemouth Bass would be similar (within 5 percent  
37 change) in most locations in the Delta, except for Rock Slough, San Joaquin River  
38 near Antioch, and Montezuma Slough in Suisun Marsh. In these areas, the  
39 mercury concentrations would increase by 7 percent over long-term conditions  
40 under the No Action Alternative as compared to the Second Basis of Comparison.

1 Under dry and critical dry years, mercury concentrations would increase by 7 to  
2 8 percent at Rock Slough, intakes of the Banks and Jones pumping plants, and  
3 Victoria Canal. All values exceed the threshold of 0.24 mg/kg ww for mercury.

#### 4 **18.4.3.2 Alternative 1**

5 Alternative 1 is identical to the Second Basis of Comparison. Alternative 1 is  
6 compared to the No Action Alternative and the Second Basis of Comparison.  
7 However, because CVP and SWP operations under Alternative 1 are identical to  
8 conditions under the Second Basis of Comparison; Alternative 1 is only compared  
9 to the No Action Alternative.

#### 10 **18.4.3.2.1 Alternative 1 Compared to the No Action Alternative**

##### 11 *Trinity River Region*

##### 12 *Changes in Public Health Factors Related to Wildland Firefighting and CVP* 13 *and SWP Reservoir Storage*

14 Changes in CVP water supplies and operations under Alternative 1 as compared  
15 to the No Action Alternative would result in similar end of September reservoir  
16 elevations in critical dry years at Trinity Lake, as described in Chapter 5, Surface  
17 Water Resources and Water Supplies. Therefore, the potential for water  
18 availability for wildland firefighting would be similar under Alternative 1 as  
19 compared to the No Action Alternative.

##### 20 *Central Valley Region*

##### 21 *Changes in Public Health Factors Related to Wildland Firefighting and CVP* 22 *and SWP Reservoir Storage*

23 Changes in CVP water supplies and operations under Alternative 1 as compared  
24 to the No Action Alternative would result in similar end of September reservoir  
25 elevations in critical dry years at Shasta Lake, Lake Oroville, Folsom Lake, and  
26 New Melones Reservoir, as described in Chapter 5, Surface Water Resources and  
27 Water Supplies. Therefore, the potential for water availability for wildland  
28 firefighting would be similar under Alternative 1 as compared to the No Action  
29 Alternative.

30 End of September surface water elevations at San Luis Reservoir in critical dry  
31 years would be 7 percent higher under Alternative 1 as compared to the No  
32 Action Alternative. Therefore, the potential for water availability for wildland  
33 firefighting would be increased at San Luis Reservoir under Alternative 1 as  
34 compared to the No Action Alternative.

##### 35 *Changes in Public Health Factors Related to Mercury in Fish used for Human* 36 *Consumption*

37 Mercury concentrations in Largemouth Bass would be similar in most locations in  
38 the Delta, except for Rock Slough, San Joaquin River near Antioch, and  
39 Montezuma Slough in Suisun Marsh. In these areas, the mercury concentrations  
40 would decrease by 6 percent over the long-term conditions under Alternative 1 as  
41 compared to the No Action Alternative. Under dry and critical dry years, mercury  
42 concentrations would decrease by 6 to 8 percent at Rock Slough, intakes of the

1 Banks and Jones pumping plants, and Victoria Canal. All values exceed the  
2 threshold of 0.24 mg/kg ww for mercury.

### 3 **18.4.3.2.2 Alternative 1 Compared to the Second Basis of Comparison**

4 Alternative 1 is identical to the Second Basis of Comparison.

### 5 **18.4.3.3 Alternative 2**

6 The CVP and SWP operations under Alternative 2 are identical to the CVP and  
7 SWP operations under the No Action Alternative; therefore, Alternative 2 is only  
8 compared to the Second Basis of Comparison.

### 9 **18.4.3.3.1 Alternative 2 Compared to the Second Basis of Comparison**

10 The CVP and SWP operations under Alternative 2 are identical to the CVP and  
11 SWP operations under the No Action Alternative. Therefore, changes to public  
12 health conditions under Alternatives 2 as compared to the Second Basis of  
13 Comparison would be the same as the impacts described in Section 18.4.3.1,  
14 No Action Alternative.

### 15 **18.4.3.4 Alternative 3**

16 As described in Chapter 3, Description of Alternatives, CVP and SWP operations  
17 under Alternative 3 are similar to the Second Basis of Comparison with modified  
18 Old and Middle River flow criteria and New Melones Reservoir operations.

19 As described in Chapter 4, Approach to Environmental Analysis, Alternative 3 is  
20 compared to the No Action Alternative and the Second Basis of Comparison.

### 21 **18.4.3.4.1 Alternative 3 Compared to the No Action Alternative**

#### 22 *Trinity River Region*

#### 23 *Changes in Public Health Factors Related to Wildland Firefighting and CVP* 24 *and SWP Reservoir Storage*

25 Changes in CVP water supplies and operations under Alternative 3 as compared  
26 to the No Action Alternative would result in similar end of September reservoir  
27 elevations in critical dry years at Trinity Lake, as described in Chapter 5, Surface  
28 Water Resources and Water Supplies. Therefore, the potential for water  
29 availability for wildland firefighting would be similar under Alternative 3 as  
30 compared to the No Action Alternative.

#### 31 *Central Valley Region*

#### 32 *Changes in Public Health Factors Related to Wildland Firefighting and CVP* 33 *and SWP Reservoir Storage*

34 Changes in CVP water supplies and operations under Alternative 3 as compared  
35 to the No Action Alternative would result in similar end of September reservoir  
36 elevations in critical dry years at Shasta Lake, Lake Oroville, Folsom Lake, New  
37 Melones Reservoir, and San Luis Reservoir, as described in Chapter 5, Surface  
38 Water Resources and Water Supplies. Therefore, the potential for water  
39 availability for wildland firefighting would be similar under Alternative 3 as  
40 compared to the No Action Alternative.

1        *Changes in Public Health Factors Related to Mercury in Fish used for Human*  
2        *Consumption*

3 Mercury concentrations in Largemouth Bass would be similar (within 5 percent  
4 change) in most locations in the Delta, except for San Joaquin River near Antioch  
5 and Montezuma Slough in Suisun Marsh. In these areas, the mercury  
6 concentrations would decrease by 6 percent over the long-term conditions under  
7 Alternative 3 as compared to the No Action Alternative. Mercury concentrations  
8 under the dry and critical dry years would be similar throughout the Delta. All  
9 values exceed the threshold of 0.24 mg/kg ww for mercury.

10    **18.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison**

11    *Trinity River Region*

12        *Changes in Public Health Factors Related to Wildland Firefighting and CVP*  
13        *and SWP Reservoir Storage*

14 Changes in CVP water supplies and operations under Alternative 3 as compared  
15 to the Second Basis of Comparison would result in similar end of September  
16 reservoir elevations in critical dry years at Trinity Lake, as described in Chapter 5,  
17 Surface Water Resources and Water Supplies. Therefore, the potential for water  
18 availability for wildland firefighting would be similar under Alternative 3 as  
19 compared to the Second Basis of Comparison.

20    *Central Valley Region*

21        *Changes in Public Health Factors Related to Wildland Firefighting and CVP*  
22        *and SWP Reservoir Storage*

23 Changes in CVP water supplies and operations under Alternative 3 as compared  
24 to the Second Basis of Comparison would result in similar end of September  
25 reservoir elevations in critical dry years at Shasta Lake, Lake Oroville, Folsom  
26 Lake, New Melones Reservoir, and San Luis Reservoir, as described in Chapter 5,  
27 Surface Water Resources and Water Supplies. Therefore, the potential for water  
28 availability for wildland firefighting would be similar under Alternative 3 as  
29 compared to the Second Basis of Comparison.

30        *Changes in Public Health Factors Related to Mercury in Fish used for Human*  
31        *Consumption*

32 Mercury concentrations in Largemouth Bass would be similar throughout the  
33 Delta under Alternative 3 as compared to the Second Basis of Comparison, as  
34 summarized in Chapter 6, Surface Water Quality. All values exceed the threshold  
35 of 0.24 mg/kg ww for mercury.

36    **18.4.3.5 Alternative 4**

37 The public health conditions under Alternative 4 would be identical to the  
38 conditions under the Second Basis of Comparison; therefore, Alternative 4 is only  
39 compared to the No Action Alternative.

1 **18.4.3.5.1 Alternative 4 Compared to the No Action Alternative**

2 The CVP and SWP operations under Alternative 4 are identical to the CVP and  
 3 SWP operations under the Second Basis of Comparison and Alternative 1.  
 4 Therefore, changes in public health conditions under Alternative 4 as compared to  
 5 the No Action Alternative would be the same as the impacts described in  
 6 Section 12.4.4.2.1, Alternative 1 Compared to the No Action Alternative.

7 **18.4.3.6 Alternative 5**

8 As described in Chapter 3, Description of Alternatives, CVP and SWP operations  
 9 under Alternative 5 are similar to the No Action Alternative with modified Old  
 10 and Middle River flow criteria and New Melones Reservoir operations. As  
 11 described in Chapter 4, Approach to Environmental Analysis, Alternative 5 is  
 12 compared to the No Action Alternative and the Second Basis of Comparison.

13 **18.4.3.6.1 Alternative 5 Compared to the No Action Alternative**

14 *Trinity River Region*

15 *Changes in Public Health Factors Related to Wildland Firefighting and CVP*  
 16 *and SWP Reservoir Storage*

17 Changes in CVP water supplies and operations under Alternative 5 as compared  
 18 to the No Action Alternative would result in similar end of September reservoir  
 19 elevations in critical dry years at Trinity Lake, as described in Chapter 5, Surface  
 20 Water Resources and Water Supplies. Therefore, the potential for water  
 21 availability for wildland firefighting would be similar under Alternative 5 as  
 22 compared to the No Action Alternative.

23 *Central Valley Region*

24 *Changes in Public Health Factors Related to Wildland Firefighting and CVP*  
 25 *and SWP Reservoir Storage*

26 Changes in CVP water supplies and operations under Alternative 5 as compared  
 27 to the No Action Alternative would result in similar end of September reservoir  
 28 elevations in critical dry years at Shasta Lake, Lake Oroville, Folsom Lake, New  
 29 Melones Reservoir, and San Luis Reservoir, as described in Chapter 5, Surface  
 30 Water Resources and Water Supplies. Therefore, the potential for water  
 31 availability for wildland firefighting would be similar under Alternative 5 as  
 32 compared to the No Action Alternative.

33 *Changes in Public Health Factors Related to Mercury in Fish used for Human*  
 34 *Consumption*

35 Mercury concentrations in Largemouth Bass would be similar throughout the  
 36 Delta under Alternative 5 as compared to the No Action Alternative, as  
 37 summarized in Chapter 6, Surface Water Quality. All values exceed the threshold  
 38 of 0.24 mg/kg ww for mercury.

1 **18.4.3.6.2 Alternative 5 Compared to the Second Basis of Comparison**

2 *Trinity River Region*

3 *Changes in Public Health Factors Related to Wildland Firefighting and CVP*  
4 *and SWP Reservoir Storage*

5 Changes in CVP water supplies and operations under Alternative 5 as compared  
6 to the Second Basis of Comparison would result in similar end of September  
7 reservoir elevations in critical dry years at Trinity Lake, as described in Chapter 5,  
8 Surface Water Resources and Water Supplies. Therefore, the potential for water  
9 availability for wildland firefighting would be similar under Alternative 5 as  
10 compared to the Second Basis of Comparison.

11 *Central Valley Region*

12 *Changes in Public Health Factors Related to Wildland Firefighting and CVP*  
13 *and SWP Reservoir Storage*

14 Changes in CVP water supplies and operations under Alternative 5 as compared  
15 to the Second Basis of Comparison would result in similar end of September  
16 reservoir elevations in critical dry years at Shasta Lake, Lake Oroville, Folsom  
17 Lake, and New Melones Reservoir, as described in Chapter 5, Surface Water  
18 Resources and Water Supplies. Therefore, the potential for water availability for  
19 wildland firefighting would be similar under Alternative 5 as compared to the  
20 Second Basis of Comparison.

21 End of September surface water elevations at San Luis Reservoir in critical dry  
22 years would be 9 percent lower under Alternative 5 as compared to the Second  
23 Basis of Comparison. Therefore, the potential for water availability for wildland  
24 firefighting would be reduced at San Luis Reservoir under Alternative 5 as  
25 compared to the Second Basis of Comparison.

26 *Changes in Public Health Factors Related to Mercury in Fish used for*  
27 *Human Consumption*

28 Mercury concentrations in Largemouth Bass would be similar in most locations in  
29 the Delta, except for Rock Slough, San Joaquin River near Antioch, and  
30 Montezuma Slough in Suisun Marsh. In these areas, the mercury concentrations  
31 would increase by 7 to 8 percent over long-term conditions under Alternative 5 as  
32 compared to the Second Basis of Comparison. During dry and critical dry years,  
33 mercury concentrations also would increase by 7 percent at intakes to Banks  
34 Pumping Plant and Jones Pumping Plant; and 13 percent at Rock Slough. All  
35 values exceed the threshold of 0.24 mg/kg ww for mercury.

36 **18.4.3.7 Summary of Environmental Consequences**

37 The results of the environmental consequences of implementation of  
38 Alternatives 1 through 5 as compared to the No Action Alternative and the  
39 Second Basis of Comparison are presented in Tables 18.2 and 18.3, respectively.

1 **Table 18.2 Comparison of Alternatives 1 through 5 to No Action Alternative**

<b>Alternative</b>	<b>Potential Change</b>	<b>Consideration for Mitigation Measures</b>
Alternative 1	<p>Similar water supply availability for wildland firefighting at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir; and a 7 percent increase at San Luis Reservoir.</p> <p>Similar mercury concentrations in Largemouth Bass in the most of the Delta; and a 6 percent decrease near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough over the long-term conditions.</p>	None needed
Alternative 2	No effects on public health issues.	None needed
Alternative 3	<p>Similar water supply availability for wildland firefighting at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, New Melones Reservoir, and San Luis Reservoir.</p> <p>Similar mercury concentrations in Largemouth Bass in the most of the Delta; and a 6 percent decrease near San Joaquin River at Antioch and Montezuma Slough over the long-term conditions.</p>	None needed
Alternative 4	Same effects as described for Alternative 1 compared to the No Action Alternative.	None needed
Alternative 5	<p>Similar water supply availability for wildland firefighting at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, New Melones Reservoir, and San Luis Reservoir.</p> <p>Similar mercury concentrations in Largemouth Bass throughout the Delta.</p>	None needed

2 Note: Due to the limitations and uncertainty in the CalSim II monthly model and other  
 3 analytical tools, incremental differences of 5 percent or less between alternatives and the  
 4 Second Basis of Comparison are considered to be “similar.”

5



1 **Table 18.3 Comparison of No Action Alternative and Alternatives 1 through 5 to**  
 2 **Second Basis of Comparison**

Alternative	Potential Change	Consideration for Mitigation Measures
No Action Alternative	Similar water supply availability for wildland firefighting at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir; and a 6 percent decrease at San Luis Reservoir. Similar mercury concentrations in Largemouth Bass in the most of the Delta; and a 7 percent increase near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough over the long-term conditions.	Not considered for this comparison.
Alternative 1	No effects on public health issues.	Not considered for this comparison.
Alternative 2	Same effects as described for No Action Alternative as compared to the Second Basis of Comparison.	Not considered for this comparison.
Alternative 3	Similar water supply availability for wildland firefighting at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, New Melones Reservoir, and San Luis Reservoir. Similar mercury concentrations in Largemouth Bass throughout the Delta.	Not considered for this comparison.
Alternative 4	No effects on public health issues.	Not considered for this comparison.
Alternative 5	Similar water supply availability for wildland firefighting at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir; and a 9 percent decrease at San Luis Reservoir. Similar mercury concentrations in Largemouth Bass in the most of the Delta; and a 7 percent increase near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough over the long-term conditions.	Not considered for this comparison.

3 Note: Due to the limitations and uncertainty in the CalSim II monthly model and other  
 4 analytical tools, incremental differences of 5 percent or less between alternatives and the  
 5 Second Basis of Comparison are considered to be “similar.”

#### 6 **18.4.3.8 Potential Mitigation Measures**

7 Mitigation measures are presented in this section to avoid, minimize, rectify,  
 8 reduce, eliminate, or compensate for adverse environmental effects of  
 9 Alternatives 1 through 5 as compared to the No Action Alternative. Mitigation

1 measures were not included to address adverse impacts under the alternatives as  
 2 compared to the Second Basis of Comparison because this analysis was included  
 3 in this EIS for information purposes only.

4 Changes in CVP and SWP operations under Alternatives 1 through 5 as compared  
 5 to the No Action Alternative would not result in changes in public health factors.  
 6 Therefore, there would be no adverse impacts to public health factors; and no  
 7 mitigation measures are required.

8 **18.4.3.9 Cumulative Effects Analysis**

9 As described in Chapter 3, the cumulative effects analysis considers projects,  
 10 programs, and policies that are not speculative; and are based upon known or  
 11 reasonably foreseeable long-range plans, regulations, operating agreements, or  
 12 other information that establishes them as reasonably foreseeable.

13 The cumulative effects analyses for Alternatives 1 through 5 for Public Health are  
 14 summarized in Table 18.4.

15 **Table 18.4 Summary of Cumulative Effects on Public Health with Implementation of**  
 16 **Alternatives 1 through 5 as Compared to the No Action Alternative**

Scenarios	Actions	Cumulative Effects of Actions
Past & Present, and Future Actions included in the No Action Alternative in All Alternatives in Year 2030	Consistent with Affected Environment conditions plus: Actions in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives), including climate change and sea level rise Actions not included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives):  - Implementation of Federal and state policies and programs, including Clean Water Act (e.g., Total Maximum Daily Loads); Safe Drinking Water Act; Clean Air Act; and flood management programs - General plans for 2030. - Trinity River Restoration Program. - Central Valley Project Improvement Act programs	These effects would be the same under all alternatives. Climate change and sea level rise, development under the general plans, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce end of September storage in CVP and SWP reservoirs. Mercury concentrations in fish tissue within the Delta will be either similar or greater than recent historical conditions because Phases 1 and 2 of the Delta Mercury Program would be completed by 2030, as mandated by the Central Valley RWQCB, including methylmercury control programs and reduction programs for total inorganic mercury. Due to the extent of these programs, it is anticipated that the programs would be initiated; however, future reductions in mercury sources and related reductions of mercury and

Scenarios	Actions	Cumulative Effects of Actions
	<ul style="list-style-type: none"> <li>- Folsom Dam Water Control Manual Update</li> <li>- FERC Relicensing for the Middle Fork of the American River Project</li> <li>- Lower Mokelumne River Spawning Habitat Improvement Project</li> <li>- Dutch Slough Tidal Marsh Restoration</li> <li>- Suisun Marsh Habitat Management, Preservation, and Restoration Plan Implementation</li> <li>- Tidal Wetland Restoration: Yolo Ranch, Northern Liberty Island Fish Restoration Project, Prospect Island Restoration Project, and Calhoun Cut/Lindsey Slough Tidal Habitat Restoration Project</li> <li>- San Joaquin River Restoration Program</li> <li>- Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects with completed environmental documents)</li> </ul>	<p>methylmercury concentrations in fish tissue would actually occur after 2030.</p>
<p>Future Actions considered as Cumulative Effects Actions in All Alternatives in Year 2030</p>	<p>Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives):</p> <ul style="list-style-type: none"> <li>- Bay-Delta Water Quality Control Plan Update</li> <li>- FERC Relicensing Projects</li> <li>- Bay Delta Conservation Plan (including the California WaterFix alternative)</li> <li>- Shasta Lake Water Resources, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations</li> <li>- El Dorado Water and Power Authority Supplemental Water Rights Project</li> <li>- Sacramento River Water Reliability Project</li> <li>- Semitropic Water Storage District Delta Wetlands</li> </ul>	<p>These effects would be the same under all alternatives. Reasonably foreseeable storage projects would increase reservoir storage at Shasta Lake and Los Vaqueros Reservoir, and provide new reservoir storage at North-of-the-Delta Offstream Storage, Upper San Joaquin River Basin Storage, and Delta Wetlands.</p>

<b>Scenarios</b>	<b>Actions</b>	<b>Cumulative Effects of Actions</b>
	<ul style="list-style-type: none"> <li>- North Bay Aqueduct Alternative Intake</li> <li>- San Luis Reservoir Low Point Improvement Project</li> <li>- Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects that did not have completed environmental documents during preparation of the EIS)</li> </ul>	
No Action Alternative with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO	Climate change and sea level rise, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce end of September CVP and SWP reservoir storage as compared to past conditions. Mercury and methylmercury concentrations in fish tissue would be similar or greater than past conditions.
Alternative 1 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternative 1 with future reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 2 with Associated Cumulative Effects Actions in Year 2030	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions</p> <p>No implementation of structural improvements or other actions that require further study to develop a more detailed action description.</p>	Implementation of Alternative 2 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 3 with Associated Cumulative Effects Actions in Year 2030	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)</p> <p>Slight increase in positive Old and Middle River flows in the winter and spring months</p>	Implementation of Alternative 3 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.

Scenarios	Actions	Cumulative Effects of Actions
Alternative 4 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternative 4 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 5 with Associated Cumulative Effects Actions in Year 20530	Full implementation of the 2008 USFWS BO and 2009 NMFS BO Positive Old and Middle River flows and increased Delta outflow in spring months	Implementation of Alternative 5 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.

1

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**Chapter 19****1 Socioeconomics****2 19.1 Introduction**

3 This Chapter describes socioeconomic conditions in the Study Area; and potential  
4 changes that could occur as a result of implementing the alternatives evaluated in  
5 this Environmental Impact Statement (EIS). Implementation of the alternatives  
6 could affect socioeconomic conditions through potential changes in operation of  
7 the Central Valley Project (CVP) and State Water Project (SWP) that would  
8 change CVP and SWP water supply availability to agricultural water users and  
9 municipal and industrial (M&I) water users. Changes in CVP and SWP  
10 operations also would result in changes to recreational resources at reservoirs that  
11 store CVP and SWP water.

12 Changes in agricultural production, including costs to provide Alternative water  
13 supplies when CVP and SWP water supplies are not available, are presented in  
14 Chapter 12, Agricultural Resources. Changes in reservoir recreational  
15 opportunities that would occur due to reduction in reservoir storage elevations are  
16 presented in Chapter 15, Recreational Resources. The results of these analyses  
17 are summarized in Section 19.4, Environmental Consequences, of this  
18 Chapter and considered in the determination of regional socioeconomics effects.

**19 19.2 Regulatory Environment and Compliance  
20 Requirements**

21 Potential actions that could be implemented under the alternatives evaluated in  
22 this EIS could affect socioeconomic conditions in portions of the Study Area  
23 affected by or served by CVP and SWP water supplies. Actions located on public  
24 agency lands; or implemented, funded, or approved by Federal and state agencies  
25 would need to be compliant with appropriate Federal and state agency policies  
26 and regulations, as summarized in Chapter 4, Approach to Environmental  
27 Analyses.

**28 19.3 Affected Environment**

29 This section describes socioeconomic conditions that could be potentially affected  
30 by implementation of the alternatives considered in this EIS. The socioeconomic  
31 conditions described in this Chapter are related to population, employment,  
32 income, and taxes.

33 Housing information is not described in this Chapter because implementation of  
34 the No Action Alternative, Second Basis of Comparison, and Alternatives 1  
35 through 5 would not result in changes to land use that would displace or relocate

1 housing stocks. Land use would be the same under the No Action Alternative,  
2 Second Basis of Comparison, and Alternatives 1 through 5, as described in  
3 Chapter 13, Land Use. The only changes in land use between recent historical  
4 conditions and conditions in 2030 for the No Action Alternative, Second Basis of  
5 Comparison, and Alternatives 1 through 5 would occur due to ecosystem  
6 restoration on agricultural lands, open space, and public lands that do not support  
7 housing units.

### 8 **19.3.1 Characterization of Socioeconomic Conditions**

9 Characterization of the socioeconomic conditions within the Study Area is based  
10 upon publically available data sources. The data sources used include the U.S.  
11 Census Bureau, U.S. Bureau of Economic Analysis, U.S. Bureau of Labor  
12 Statistics, California Department of Finance, California Employment  
13 Development Department, and California Board of Equalization. The data were  
14 summarized and used to compare historical and current trends in the  
15 socioeconomic conditions in the Study Area.

16 Population and income data used to characterize the socioeconomic conditions are  
17 reported from 2000 to 2012 by the California Department of Finance.

18 The employment data presented in this Chapter are reported from 2001 to 2008  
19 and from 2008 to 2012 (the latest values from consistent data sources). The first  
20 period from 2001 to 2008 represents a period of time prior to implementation of  
21 the 2008 U.S. Fish and Wildlife Service (USFWS) Biological Opinion (BO) and  
22 the 2009 National Marine Fisheries Service (NMFS) BO. The second period  
23 from 2008 to 2012 represents a period of time following implementation of the  
24 2008 USFWS BO and 2009 NMFS BO.

25 There are two estimates of employment that are typically used to describe  
26 employment. The civilian labor force employment data compiled by the Bureau  
27 of Labor Statistics reflect the employment status of individuals that are covered  
28 by unemployment insurance by “place of residence,” and includes the self-  
29 employed, employees on unpaid leave of absence, unpaid family workers, and  
30 household workers. These data do not include sole proprietors, some self-  
31 employed, and some farm workers and domestic workers. Employment by  
32 industry data compiled by the Bureau of Economic Analysis, including farm  
33 employment, reflect jobs by “place of work” and include sole proprietors and  
34 active partners, self-employed, farm workers, and domestic workers. Individuals  
35 with more than one job are counted only once in civilian labor force data and  
36 counted in each job in the employment by industry data. Therefore, the  
37 employment by industry data are greater than the civilian labor force data.

### 38 **19.3.2 Trinity River Region**

39 The Trinity River Region includes the area in Trinity County along the Trinity  
40 River from Trinity Lake to the confluence with the Klamath River; and in  
41 Humboldt and Del Norte counties along the lower Klamath River from the  
42 confluence with the Trinity River to the Pacific Ocean. Tribal lands along the  
43 Trinity or lower Klamath River within the Trinity River Region include the

1 Hoopa Valley Indian Reservation, Yurok Indian Reservation, and Resighini  
2 Rancheria.

3 Trinity County includes extensive trails, lakes, and the Trinity River Scenic  
4 Byway, providing several venues for outdoor enthusiasts and travelers. The  
5 recreation and tourism industries are major contributors to the local economy of  
6 Trinity County (EDD 2013).

7 Humboldt County is the largest and most populous of the north coast counties. Its  
8 2012 population of 134,728 ranked 35th among the 58 counties in California  
9 (EDD 2014a). Humboldt County encompasses 2.3 million acres, 80 percent of  
10 which is forestlands, protected redwoods and recreation areas (Humboldt County  
11 2014). Humboldt County is the leading timber producing county in the state  
12 (CDFA 2014). As described in Chapter 13, Land Use, the portion of Humboldt  
13 County in the Trinity River Region evaluated in this EIS is located along the  
14 Trinity and Klamath rivers. This portion of the county includes the communities  
15 of Willow Creek and Orleans within Humboldt County; Hoopa in the Hoopa  
16 Valley Indian Reservation; and the communities of Weitchpec, Cappell, Pecwan,  
17 and Johnson's in the Yurok Tribe Indian Reservation (Humboldt County 2012).

18 Del Norte County is the northernmost county in California. The county includes  
19 Redwood National Park and other state parks making tourism a natural industry in  
20 the county (EDD 2014b). As described in Chapter 13, Land Use, the portion of  
21 Del Norte County in the Trinity River Region evaluated in this EIS is located  
22 along the lower Klamath River. Most of this area is located within the Yurok  
23 Indian Reservation, and includes the communities of Requa and Klamath (Del  
24 Norte County 2003).

### 25 **19.3.2.1 Population**

26 Population in the Trinity River Region, by county and for the region as a whole, is  
27 presented in Table 19.1. The population of Trinity River Region has increased,  
28 although at a small average annual growth rate for the period shown.

29 **Table 19.1 Population Characteristics in Trinity River Region**

Area	Population 2000	Population 2012	Average Annual Growth Rate (percent) 2000-2012
Trinity County	13,022	13,471	0.3
Humboldt County	126,518	134,728	0.5
Del Norte County	27,507	28,527	0.3
Total Trinity River Region	167,047	176,726	0.5
<b>STATE OF CALIFORNIA</b>	<b>33,873,086</b>	<b>37,427,946</b>	<b>0.9</b>

30 Sources: DOF 2013a, 2013b, 2014

31 Tribal enrollment for the Hoopa Valley Tribe, Yurok Tribe, Karuk Tribe, and  
32 Resighini Rancheria as reported by the Bureau of Indian Affairs is presented in  
33 Table 19.2. These values do not necessarily include all members that live within  
34 the area, and should be considered as representative of trends. Values were only  
35 available for the years of 2001, 2003, 2005, and 2013.

1 **Table 19.2 Tribal Enrollment in Trinity River Region**

Tribe	2001	2003	2005	2013
Hoopa Valley Tribe	1,893	1,893	1,893	1,719 <sup>a</sup>
Yurok Tribe	4,466	4,466	4,912	Not available
Karuk Tribe	3,165	3,165	3,427	Not available
Resighini Rancheria	90	175	111	Not available
<b>TOTAL</b>	<b>9,614</b>	<b>9,699</b>	<b>10,343</b>	–

2 Sources: BIA 2003, 2006, 2008, 2014

3 Note:

4 a. Value is reported as population, not enrollment, for Hoopa Valley Tribe in 2013.

5 **19.3.2.2 Employment**

6 Civilian labor force characteristics for the Trinity River Region are presented in  
 7 Table 19.3. The civilian labor force (composed of employment and  
 8 unemployment) in the Trinity River Region increased between 2001 and 2008 and  
 9 between 2008 and 2012 (BLS 2014).

10 **Table 19.3 Civilian Labor Force and Unemployment Rates in Trinity River Region**

Area	Civilian Labor Force (subject to unemployment insurance)			Unemployment Rate (percent)		
	2001	2008	2012	2001	2008	2012
Trinity County	5,394	4,855	5,019	9.3	12.7	15.8
Humboldt County	60,443	60,039	60,144	6.0	7.2	10.5
Del Norte County	10,221	11,376	11,381	8.0	8.8	13.4
Total Trinity River Region	76,058	76,270	76,544	6.5	7.8	11.2
<b>STATE OF CALIFORNIA</b>	<b>17,152,106</b>	<b>18,392,000</b>	<b>18,494,881</b>	<b>5.4</b>	<b>7.2</b>	<b>10.5</b>

11 Source: BLS 2014

12 Available labor force and unemployment rates for members of the tribes in the  
 13 Trinity River Region are presented in Table 19.4. These individuals may or may  
 14 not be included in the values presented in Table 19.3 because different sources are  
 15 used for each table.

16 **Table 19.4 Available Labor Force and Unemployment Rates Related to the Tribes in**  
 17 **Trinity River Region**

Area	Civilian Labor Force				Unemployment Rate (percent)			
	2001	2003	2005	2013	2001	2003	2005	2013
Hoopa Valley Tribe	1,043	1,043	1,043	NA	40	40	40	42
Yurok Tribe	2,151	2,151	1,096	NA	74	74	74	38
Karuk Tribe	3,307	3,307	915	NA	14	14	63	29
Resighini Rancheria	37	44	45	NA	57	59	60	NA

18 Sources: BIA 2003, 2006, 2008, 2014

19 Note:

20 NA = Not Available

1 Total employment and the farm employment in 2001, 2008 and 2012 in the  
 2 Trinity River Region counties are presented in Table 19.5. The Trinity River  
 3 Region farm employment represents less than 1 percent of farm employment in  
 4 the state and the lowest amount of farm employment in counties within the Study  
 5 Area, as indicated in Figure 19.1.

6 **Table 19.5 Employment in Trinity River Region**

Area	Total Employment			Farm Employment <sup>a</sup>		
	2001	2008	2012	2001	2008	2012
Trinity County	4,878	4,930	4,788	155	161	165
Humboldt County	68,596	71,552	68,861	1,662	1,383	1,227
Del Norte County	10,266	11,531	10,720	384	309	231
Total Trinity River Region	83,740	88,013	84,369	2,201	1,853	1,623
<b>STATE OF CALIFORNIA</b>	<b>19,411,367</b>	<b>20,820,306</b>	<b>20,653,860</b>	<b>479,283</b>	<b>438,013</b>	<b>443,764</b>

7 Source: BEA 2014a.

8 Note:

9 a. Farm employment includes employment numbers in forestry, fishing, and related activities.

### 10 **19.3.2.3 Income**

11 Per capita personal income for the Trinity River Region counties for 2000, 2008,  
 12 and 2012 is presented in Table 19.6. Humboldt County had the highest per capita  
 13 income, and Del Norte County had the lowest.

14 **Table 19.6 Per Capita Personal Income in Trinity River Region**

Area	Per Capita Personal Income			Average Annual Growth Rate (percent)	
	2000	2008	2012	2000-2008	2008-2012
Trinity County	\$20,489	\$28,861	\$34,027	4.4	4.2
Humboldt County	\$23,980	\$32,859	\$35,681	4.0	2.1
Del Norte County	\$18,563	\$26,420	\$30,016	4.5	3.2
Total Trinity River Region	\$22,818	\$31,497	\$34,647	4.1	2.4
<b>STATE OF CALIFORNIA</b>	<b>\$33,404</b>	<b>\$44,003</b>	<b>\$43,647</b>	<b>3.5</b>	<b>1.4</b>

15 Source: BEA 2014e

### 16 **19.3.2.4 Local Government Finances**

17 The sales tax rates, as of April 1, 2014, were 7.5 percent in all three counties in  
 18 the Trinity River Region (BOE 2014). Total annual taxable sales within the  
 19 Trinity River Region in 2000, 2008, and 2012 are presented in Table 19.7. The  
 20 region's total taxable sales represents less than one tenth of one percent of total  
 21 annual state taxable sales.



1 **Table 19.7 Total Taxable Sales in Trinity River Region**

Area	Total Taxable Sales (millions)			Average Annual Growth Rate (percent)	
	2000	2008	2012	2000-2008	2008-2012
Trinity County	\$61	\$74	\$87	2.6	3.9
Humboldt County	\$1,293	\$1,693	\$1,768	3.4	1.1
Del Norte County	\$176	\$232	\$226	3.5	-0.6
Total Trinity River Region	\$1,530	\$1,999	\$2,081	3.4	1.0
<b>STATE OF CALIFORNIA</b>	<b>\$441,854</b>	<b>\$531,654</b>	<b>\$407,714</b>	<b>2.3</b>	<b>-6.4</b>

2 Sources: BOE 2000, 2008, 2012

3 Total property tax charges (secured and unsecured) within the Trinity River  
4 Region in Fiscal Year 2011-2012 were \$160.2 million (California State Controller  
5 2012). The Humboldt County share of the total property tax revenues was the  
6 largest at \$126 million. The Del Norte and Trinity counties contributions to the  
7 total were \$19 million and \$13 million, respectively.

8 **19.3.3 Central Valley Region**

9 The Central Valley Region extends from above Shasta Lake to the Tehachapi  
10 Mountains, and includes the Sacramento Valley, San Joaquin Valley, and Delta  
11 and Suisun Marsh subregions.

12 **19.3.3.1 Sacramento Valley**

13 The Sacramento Valley includes the counties of Shasta, Plumas, Tehama, Glenn,  
14 Colusa, Butte, Sutter, Yuba, Nevada, Placer, and El Dorado counties.  
15 Sacramento, Yolo, and Solano counties also are located within the Sacramento  
16 Valley; however, these counties are discussed below as part of the Delta and  
17 Suisun Marsh subsection. Other counties in Sacramento Valley are not  
18 anticipated to be affected by changes in CVP and SWP operations, and are not  
19 discussed here, including: Alpine, Sierra, Lassen, and Amador counties.

20 The Sacramento Valley includes major agricultural counties, including Glenn,  
21 Colusa, Sutter and Placer counties, as described in Chapter 12, Agricultural  
22 Resources. The region also includes some of the leading major timber producing  
23 counties of the state. Shasta County is the second and Plumas County is the fifth  
24 among the leading timber producing counties in the state.

25 **19.3.3.1.1 Population**

26 Population characteristics in the Sacramento Valley portion of the Central Valley  
27 Region are presented in Table 19.8. Among the counties evaluated in the  
28 Sacramento Valley portion of the Central Valley Region, Placer County had the  
29 highest average annual population growth rate between 2000 and 2012; and  
30 Plumas County was the only county with a reduction in population.

1 **Table 19.8 Population Characteristics in Central Valley Region – Sacramento Valley**

Area	Population		Average Annual Growth Rate (percent)
	2000	2012	2000-2012
Shasta County	163,256	177,516	0.8
Plumas County	20,824	19,901	-0.4
Tehama County	56,039	62,985	1.1
Glenn County	26,453	28,105	0.6
Colusa County	18,804	21,552	1.2
Butte County	203,171	220,465	0.7
Yuba County	60,219	72,642	1.6
Nevada County	92,033	97,366	0.5
Sutter County	78,930	94,620	1.7
Placer County	248,399	351,463	3.2
El Dorado County	156,299	180,483	1.3
Sacramento Valley Subtotal	1,124,427	1,333,615	1.4
Total Central Valley Region	6,214,316	7,408,750	1.5
<b>STATE OF CALIFORNIA</b>	<b>33,873,086</b>	<b>37,668,804</b>	<b>0.9</b>

2 Sources: DOF 2013a, 2013b, 2014

3 **19.3.3.1.2 Employment**

4 Civilian labor force characteristics for the counties in the Sacramento Valley  
5 portion of the Central Valley Region are presented in Table 19.9. The civilian  
6 labor force increased between 2001 and 2012. The data for 2008 represents the  
7 employment situation immediately following the recent economic recession that  
8 started in 2007. The average unemployment rate in the civilian labor force  
9 increased from 2001 to 2012. The average unemployment rate in the Sacramento  
10 Valley portion of the Central Valley Region between 2001 and 2012 has been  
11 higher than the state unemployment rate; and lower than for the counties in the  
12 Central Valley Region.

1 **Table 19.9 Civilian Labor Force and Unemployment Rates in Central Valley**  
 2 **Region – Sacramento Valley**

Area	Civilian Labor Force (subject to unemployment insurance)			Unemployment Rate (percent)		
	2001	2008	2012	2001	2008	2012
Shasta County	77,647	82,675	81,245	6.3	10.0	13.4
Plumas County	9,958	9,824	9,478	7.6	10.5	14.7
Tehama County	24,574	25,185	25,251	6.5	9.2	13.9
Glenn County	11,239	12,196	12,841	8.8	10.4	14.7
Colusa County	9,130	10,505	11,860	12.8	13.7	20.0
Butte County	95,216	102,952	102,063	6.6	8.4	12.2
Yuba County	24,862	27,729	27,772	8.5	11.8	16.9
Nevada County	46,947	50,428	50,742	4.4	6.5	9.4
Sutter County	38,457	41,100	42,810	9.7	12.3	17.6
Placer County	139,106	177,243	178,818	4.0	6.4	9.4
El Dorado County	84,064	90,732	90,525	4.3	6.9	10.4
Sacramento Valley Subtotal	561,200	630,569	633,405	5.8	8.3	12.0
Total Central Valley Region	3,519,870	3,885,435	3,990,083	6.8	8.7	12.6
<b>STATE OF CALIFORNIA</b>	<b>17,152,106</b>	<b>18,392,000</b>	<b>18,494,881</b>	<b>4.9</b>	<b>7.2</b>	<b>10.5</b>

3 Source: BLS 2014

4 Total employment and farm employment in 2001, 2008, and 2012 in the  
 5 Sacramento Valley portion of the Central Valley Region are presented in  
 6 Table 19.10. The contribution of farm employment to the total employment in the  
 7 Sacramento Valley portion of the Central Valley Region declined between 2001  
 8 and 2008 and increased slightly by 2012.

1 **Table 19.10 Employment in Central Valley Region – Sacramento Valley**

Area	Total Employment			Farm Employment		
	2001	2008	2012	2001	2008	2012
Shasta County	85,937	91,883	86,696	1,821	1,781	1,751
Plumas County	10,813	10,524	9,493	288	140	138
Tehama County	23,760	24,284	22,669	2,716	2,332	3,042
Glenn County	11,526	11,987	11,856	2,873	1,927	2,049
Colusa County	9,770	10,863	11,266	2,943	1,954	1,831
Butte County	99,757	105,703	101,805	5,293	4,618	4,527
Yuba County	26,162	26,473	26,861	2,494	1,722	1,623
Nevada County	51,323	57,968	55,898	1,161	1,153	1,089
Sutter County	39,489	43,764	43,329	5,454	4,165	4,427
Placer County	158,070	192,171	188,729	2,064	1,925	1,844
El Dorado County	78,052	95,608	90,435	1,937	1,849	1,737
Sacramento Valley Subtotal	594,659	671,228	649,037	29,044	23,566	24,058
Total Central Valley Region	3,616,241	3,997,557	3,923,230	256,672	226,321	230,832
<b>STATE OF CALIFORNIA</b>	<b>19,411,367</b>	<b>20,820,306</b>	<b>20,653,860</b>	<b>479,283</b>	<b>438,013</b>	<b>443,764</b>

2 Source: BEA 2014a

3 Note:

4 Farm employment includes employment numbers in forestry, fishing, and related activities.

5 The annual farm employment for the Sacramento Valley portion of the Central  
6 Valley Region declined in 2004 and remained relatively stable through 2012, as  
7 shown in Figure 19.2. The overall trend in farm employment is influenced by the  
8 farm employment trends in Butte, Sutter, Tehama, Colusa, and Glenn counties, as  
9 shown in Figure 19.3. The decrease in farm employment is related to the  
10 reduction in cultivated acreage during this period, as described in Chapter 12,  
11 Agricultural Resources.

12 The farm employment numbers presented in Table 19.10 include only workers  
13 directly involved in farming, forestry, and fishing activities. However, farming is  
14 one of the most important basic industries in the Central Valley Region; and  
15 supports many other businesses including farm inputs (e.g., fertilizer, seed,  
16 machinery, and fuel) and processing of food and fiber grown on farms. As a  
17 result, employment both directly on farm and indirectly dependent on farming is  
18 higher than the values displayed in Table 19.10.

1 **19.3.3.1.3 Income**

2 The average per capita personal incomes for the counties in the Sacramento  
 3 Valley portion of the Central Valley Region are presented in Table 19.11. Per  
 4 capita personal incomes increased by an average annual rate of between 3 and  
 5 6 percent from 2000 to 2008. Following the economic downturn that started in  
 6 2007, the average annual growth in per capita personal income slowed between  
 7 2008 and 2012, except in Tehama County.

8 **Table 19.11 Per Capita Personal Income in Central Valley Region –**  
 9 **Sacramento Valley**

Area	Per Capita Personal Income			Average Annual Growth Rate (percent)	
	2000	2008	2012	2000-2008	2008-2012
Shasta County	\$25,385	\$34,995	\$37,593	4.1	1.8
Plumas County	\$26,415	\$38,401	\$43,085	4.8	2.9
Tehama County	\$19,461	\$25,805	\$30,094	3.6	3.9
Glenn County	\$20,210	\$32,054	\$38,568	5.9	4.7
Colusa County	\$24,656	\$39,568	\$45,800	6.1	3.7
Butte County	\$23,143	\$32,379	\$35,696	4.3	2.5
Yuba County	\$19,537	\$27,655	\$32,835	4.4	4.4
Nevada County	\$32,253	\$44,960	\$47,924	4.2	1.6
Sutter County	\$25,581	\$33,117	\$36,243	3.3	2.3
Placer County	\$38,034	\$49,436	\$52,544	3.3	1.5
El Dorado County	\$37,397	\$50,052	\$54,533	3.7	2.2
Average in Sacramento Valley Counties	\$29,317	\$40,177	\$43,873	4.0	2.2
Central Valley Region	\$28,163	\$37,207	\$40,619	3.5	2.2
<b>STATE OF CALIFORNIA</b>	<b>\$33,404</b>	<b>\$44,003</b>	<b>\$46,477</b>	<b>3.5</b>	<b>1.4</b>

10 Source: BEA 2014e

11 **19.3.3.1.4 Local Government Finances**

12 As of April 1, 2014, the county sales tax rates in the counties within the  
 13 Sacramento Valley portion of the Central Valley Region was 7.5 percent for all  
 14 counties except Nevada County (BOE 2014). The Nevada County sales tax rate  
 15 was 7.625 percent. These rates include the state, county, local and district taxes.

16 The total annual taxable sales in the Sacramento Valley portion of the Central  
 17 Valley Region in 2000, 2008, and 2012 are presented in Table 19.12. The total  
 18 taxable sales represent about 3 percent of total annual state taxable sales. The  
 19 lower rates of growth for the period 2008 to 2012 may be attributable to the  
 20 effects of the recession that started in 2007 and a decline in employment, as  
 21 discussed above.

1 **Table 19.12 Total Taxable Sales in Central Valley Region – Sacramento Valley**

Area	Total Taxable Sales (millions)			Average Annual Growth Rate	
	2000	2008	2012	2000-2008	2008-2012
Shasta County	\$2,055	\$2,641	\$2,642	3.2	0.0
Plumas County	\$187	\$222	\$197	2.1	-2.9
Tehama County	\$470	\$684	\$748	4.8	2.3
Glenn County	\$231	\$318	\$327	4.1	0.7
Colusa County	\$223	\$329	\$337	5.0	0.6
Butte County	\$2,039	\$2,678	\$2,714	3.5	0.3
Yuba County	\$392	\$515	\$486	3.5	-1.4
Nevada County	\$997	\$1,187	\$1,105	2.2	-1.8
Sutter County	\$1,021	\$1,287	\$1,367	2.9	1.5
Placer County	\$4,742	\$6,635	\$7,066	4.3	1.6
El Dorado County	\$1,324	\$1,788	\$1,740	3.8	-0.7
Sacramento Valley Subtotal	\$13,680	\$18,283	\$18,729	3.7	0.6
Central Valley Region	\$83,363	\$109,401	\$114,959	3.5	1.2
<b>STATE OF CALIFORNIA</b>	<b>\$441,854</b>	<b>\$531,654</b>	<b>\$407,714</b>	<b>2.3</b>	<b>-6.4</b>

2 Sources: BOE 2000, 2008, 2012

3 Combined (secured and unsecured) property tax revenues in each of the counties  
4 in the Sacramento Valley portion of the Central Valley Region for Fiscal Year  
5 2011-2012 are presented in Table 19.13. Total property tax revenues from these  
6 counties accounted for about 3 percent of the total state property tax revenues.

7 **Table 19.13 Property Tax Revenues, Fiscal Year 2011-2012,**  
8 **in Central Valley Region – Sacramento Valley**

Area	Property Tax Revenues (millions)
Shasta County	\$168
Plumas County	\$41
Tehama County	\$48
Glenn County	\$30
Colusa County	\$36
Butte County	\$203
Yuba County	\$62
Nevada County	\$183
Sutter County	\$103
Placer County	\$692
El Dorado County	\$300
Sacramento Valley Subtotal	\$1,866
Central Valley Region	\$9,874
<b>STATE OF CALIFORNIA</b>	<b>\$55,459</b>

9 Source: California State Controller 2012

1 **19.3.3.2 San Joaquin Valley**

2 The San Joaquin Valley includes the counties of Stanislaus, Merced, Madera,  
 3 Fresno, Kings, Tulare, and Kern counties. San Joaquin County also is located  
 4 within the San Joaquin Valley; however, this county is discussed below as part of  
 5 the Delta and Suisun Marsh subsection. Other counties in the San Joaquin Valley  
 6 are not anticipated to be affected by changes in CVP and SWP operations, and are  
 7 not discussed here, including: Calaveras, Mariposa, and Tuolumne counties.

8 The San Joaquin Valley includes the major agricultural counties, of Fresno, Kern,  
 9 Kings and Tulare, as described in Chapter 12, Agricultural Resources.

10 **19.3.3.2.1 Population**

11 Population characteristics in the San Joaquin Valley portion of the Central Valley  
 12 Region are presented in Table 19.14. Among the counties in the San Joaquin  
 13 Valley portion of the Central Valley Region, Kern County had the highest average  
 14 annual population growth rate between 2000 and 2012; and Stanislaus and Kings  
 15 counties had the lowest growth rate.

16 **Table 19.14 Population Characteristics in Central Valley – San Joaquin Valley**

Area	Population		Average Annual Growth Rate (percent)
	2000	2012	2000-2012
Stanislaus County	446,997	519,339	1.3
Madera County	123,109	152,325	1.8
Merced County	210,554	260,029	1.8
Fresno County	799,407	943,493	1.4
Tulare County	368,021	451,540	1.7
Kings County	129,461	151,774	1.3
Kern County	661,653	849,977	2.1
San Joaquin Valley Subtotal	2,739,202	3,328,477	1.6
Total Central Valley Region	6,062,064	7,238,742	1.5
<b>STATE OF CALIFORNIA</b>	<b>33,873,086</b>	<b>37,668,804</b>	<b>0.9</b>

17 Sources: DOF 2013a, 2013b, 2014

18 **19.3.3.2.2 Employment**

19 Civilian labor force characteristics for the counties in the San Joaquin Valley  
 20 portion of the Central Valley Region are presented in Table 19.15. The civilian  
 21 labor force increased between 2001 and 2012. The data for 2008 represents the  
 22 employment situation immediately following the recession that started in 2007.  
 23 The average unemployment rate in the civilian labor force increased from 2001 to  
 24 2012. The average unemployment rates for the San Joaquin Valley portion of the  
 25 Central Valley Region between 2001 and 2012 have been higher than for the  
 26 entire Central Valley Region and the state.

1 **Table 19.15 Civilian Labor Force and Unemployment Rates in Central Valley**  
 2 **Region – San Joaquin Valley**

Area	Civilian Labor Force (subject to unemployment insurance)			Unemployment Rate (percent)		
	2001	2008	2012	2001	2008	2012
Stanislaus County	214,292	231,965	239,461	8.3	11.0	15.2
Madera County	53,956	65,100	68,167	9.6	9.4	13.6
Merced County	91,825	102,251	111,322	10.1	12.5	17.0
Fresno County	389,805	430,163	442,453	10.7	10.5	15.2
Tulare County	175,357	199,124	207,634	11.4	10.8	15.8
Kings County	50,233	58,801	60,886	10.7	10.5	15.3
Kern County	297,982	359,573	396,657	8.6	9.8	13.3
San Joaquin Valley Subtotal	1,273,450	1,446,977	1,526,580	9.8	10.5	14.9
Total Central Valley Region	3,448,061	3,807,278	3,911,569	6.8	8.7	12.6
<b>STATE OF CALIFORNIA</b>	<b>17,152,106</b>	<b>18,392,000</b>	<b>18,494,881</b>	<b>4.9</b>	<b>7.2</b>	<b>10.5</b>

3 Source: BLS 2014

4 Total employment and farm employment in 2001, 2008 and 2012 in the San  
 5 Joaquin Valley portion of the Central Valley Region are presented in Table 19.16.  
 6 The contribution of farm employment to the total employment declined between  
 7 2001 and 2008, and then increased slightly in 2012, except in Tulare County. In  
 8 Tulare County, farm employment increased between 2001 and 2008 and  
 9 decreased between 2008 and 2012.

10 **Table 19.16 Employment in Central Valley Region – San Joaquin Valley**

Area	Total Employment			Farm Employment		
	2001	2008	2012	2001	2008	2012
Stanislaus County	208,016	221,632	214,446	18,708	16,000	15,784
Madera County	50,975	59,354	59,027	6,296	4,750	5,186
Merced County	82,803	92,891	93,766	14,147	12,029	8,075
Fresno County	401,025	446,939	437,934	56,655	50,798	51,277
Tulare County	168,523	191,195	186,875	42,851	38,080	36,369
Kings County	48,960	57,513	55,008	4,705	4,061	6,620
Kern County	311,946	369,152	386,642	46,307	47,661	52,583
San Joaquin Valley Subtotal	1,272,248	1,438,676	1,433,698	189,669	173,379	175,894
Total Central Valley Region	3,616,241	3,997,557	3,923,230	256,672	226,321	230,832
<b>STATE OF CALIFORNIA</b>	<b>19,411,367</b>	<b>20,820,306</b>	<b>20,653,860</b>	<b>479,283</b>	<b>438,013</b>	<b>443,764</b>

11 Source: BEA 2014a

12 Note:

13 Farm employment includes employment numbers in forestry, fishing, and related activities.



1 Annual farm employment for the San Joaquin Valley portion of the Central  
2 Valley Region declined in 2004 and continued to fluctuate through 2012, as  
3 shown in Figure 19.2. Farm employment in the San Joaquin Valley portion of the  
4 Central Valley Region represents a major portion of the overall farm employment  
5 in the Central Valley.

6 Within the counties in the San Joaquin Valley portion of the Central Valley  
7 Region, farm employment declined between 2003 and 2006 and remained about  
8 the same between 2007 and 2012. The overall trend in farm employment is  
9 influenced by the farm employment trends in Fresno, Kern, and Tulare counties,  
10 as shown in Figure 19.4. The decrease in farm employment is related to the  
11 reduction in cultivated acreage during this period, as described in Chapter 12,  
12 Agricultural Resources.

13 The farm employment numbers presented in Table 19.16 include only workers  
14 directly involved in farming, forestry, and fishing activities. However, farming is  
15 one of the most important basic industries in the Central Valley; and supports  
16 many other businesses including farm inputs (e.g., fertilizer, seed, machinery, and  
17 fuel) and processing of food and fiber grown on farms. As a result, employment  
18 both directly on farm and indirectly dependent on farming is higher than the  
19 values displayed in Table 19.16.

20 Total farm-dependent employment is not reported in the U.S. Bureau of  
21 Economic Analysis or the U.S. Bureau of Labor Statistics; however, the  
22 employment values can be estimated by studies of local economies. A study of  
23 the local economy in four counties of the San Joaquin Valley found that, for every  
24 on-farm job, about two and one-half additional jobs are supported because of  
25 inputs purchased for farming operations (NEA 1997). This estimate includes the  
26 associated effects of workers on those farms and businesses spending their  
27 incomes on other purchases; however, the estimated values do not include  
28 employment in the processing sector. Another study indicated that the  
29 employment multiplier of the agricultural production and processing industry is  
30 1.92, or that for every 100 agricultural production and processing jobs in the  
31 San Joaquin Valley, 92 other jobs were created in the San Joaquin Valley  
32 (UCAIC 2009).

33 San Joaquin Valley employment also includes employment associated with adult  
34 prison facilities. The San Joaquin Valley portion of the Central Valley Region  
35 includes eight (or about 24 percent) of the 33 adult prison facilities operated by  
36 the California Department of Corrections and Rehabilitation. These prisons are  
37 home to about a quarter of the total prison population in the state and employ  
38 about a quarter of the total prison staff in the state. Employment for these prisons  
39 is summarized in Table 19.17.

1 **Table 19.17 California State Prisons in Central Valley Region - San Joaquin Valley**

Prison Facility	Location	Staff
Central California Women's Facility	Chowchilla, Madera County	1,064
Valley State Prison	Chowchilla, Madera County	1,021
Pleasant Valley State Prison	Coalinga, Fresno County	1,357
Avenal State Prison	Avenal, Kings County	1,475
California State Prison	Corcoran, Kings County	2,003
Wasco State Prison	Wasco, Kern County	1,523
North Kern State Prison	Delano, Kern County	1,393
Kern Valley State Prison	Delano, Kern County	1,545

2 Sources: CDCR 2014a, 2014b, 2014c, 2014d, 2014e, 2014f, 2014g, 2014h

3 Federal prisons are located at Atwater in Merced County, Mendota in Fresno  
4 County, and Taft in Kern County within the San Joaquin Valley portion of the  
5 Central Valley Region (BOP 2014).

6 **19.3.3.2.3 Income**

7 The average per capita personal income in the San Joaquin Valley portion of the  
8 Central Valley Region was lower than that for the entire Central Valley Region,  
9 as presented in Table 19.18. The average per capita personal income in the San  
10 Joaquin Valley portion of the Central Valley Region was a little more than two-  
11 thirds of the average per capita personal income in the Central Valley Region and  
12 the state. With the exception of Stanislaus County, most counties in the San  
13 Joaquin Valley portion of the Central Valley Region had higher annual average  
14 growth in per capita personal income between 2000 and 2008 than the entire  
15 Central Valley Region and the state.

16 **Table 19.18 Per Capita Personal Income in Central Valley Region –**  
17 **San Joaquin Valley**

Area	Per Capita Personal Income			Average Annual Growth Rate (percent)	
	2000	2008	2012	2000-2008	2008-2012
Stanislaus County	\$24,284	\$31,093	\$34,138	3.1	2.4
Madera County	\$18,983	\$26,693	\$31,169	4.4	4.0
Merced County	\$19,976	\$26,963	\$30,630	3.8	3.2
Fresno County	\$23,001	\$30,977	\$34,074	3.8	2.4
Tulare County	\$20,070	\$28,035	\$31,307	4.3	2.8
Kings County	\$16,912	\$26,339	\$31,835	5.7	4.9
Kern County	\$21,507	\$29,527	\$34,453	4.0	3.9
Average in San Joaquin Valley Counties	\$21,755	\$29,505	\$33,303	3.9	3.1
Central Valley Region	\$28,183	\$37,198	\$40,601	3.5	2.2
<b>STATE OF CALIFORNIA</b>	<b>\$33,404</b>	<b>\$44,003</b>	<b>\$46,477</b>	<b>3.5</b>	<b>1.4</b>

18 Source: BEA 2014e

1 **19.3.3.2.4 Local Government Finances**

2 As of April 1, 2014, the county sales tax rates in the counties within the San  
 3 Joaquin Valley portion of the Central Valley ranged from 7.5 percent in Merced,  
 4 Kern, and Kings counties to 8.225 percent in Fresno County (BOE 2014).

5 The total annual taxable sales for the counties in the San Joaquin Valley portion  
 6 of the Central Valley Region in 2000, 2008, and 2012 are presented in  
 7 Table 19.19. The contribution of the area to California total annual taxable sales  
 8 increased between 2000 and 2012. The lower rates of growth for the period 2008  
 9 to 2012 may be attributable to the effects of the recession that started in 2007 and  
 10 a decline in employment, as discussed above.

11 **Table 19.19 Total Taxable Sales in Central Valley Region – San Joaquin Valley**

Area	Total Taxable Sales (millions)			Average Annual Growth Rate (percent)	
	2000	2008	2012	2000-2008	2008-2012
Stanislaus County	\$5,195	\$6,729	\$7,178	3.3	1.6
Madera County	\$881	\$1,327	\$1,356	5.2	0.5
Merced County	\$1,740	\$2,388	\$2,512	4.0	1.3
Fresno County	\$8,472	\$11,729	\$12,021	4.2	0.6
Tulare County	\$3,222	\$4,755	\$5,499	5.0	3.7
Kings County	\$888	\$1,389	\$1,386	5.8	-0.1
Kern County	\$6,938	\$12,086	\$14,666	7.2	5.0
Total San Joaquin Valley	\$27,337	\$40,403	\$44,619	5.0	2.5
Central Valley Region	\$81,975	\$107,699	\$113,368	3.5	1.3
<b>STATE OF CALIFORNIA</b>	<b>\$441,854</b>	<b>\$531,654</b>	<b>\$407,714</b>	<b>2.3</b>	<b>-6.4</b>

12 Sources: BOE 2000, 2008, 2012

13 The combined (secured and unsecured) property tax revenues in each of the  
 14 counties in the San Joaquin Valley portion of the Central Valley Region for Fiscal  
 15 Year 2011-2012 are presented in Table 19.20. Total property tax revenues from  
 16 these counties accounted for about 6 percent of the total state property tax  
 17 revenues.

1 **Table 19.20 Property Tax Revenues, Fiscal Year 2011-2012,**  
 2 **in Central Valley Region – San Joaquin Valley**

Area	Property Tax Revenues (millions)
Stanislaus County	\$426
Madera County	\$128
Merced County	\$197
Fresno County	\$755
Tulare County	\$327
Kings County	\$104
Kern County	\$1,102
San Joaquin Valley Subtotal	\$3,039
Central Valley Region	\$9,874
<b>STATE OF CALIFORNIA</b>	<b>\$55,459</b>

3 Source: California State Controller 2012

4 **19.3.3.3 Delta and Suisun Marsh**

5 The Delta and Suisun Marsh portion of the Central Valley Region includes  
 6 Sacramento, Yolo, Solano, San Joaquin, and Contra Costa counties. These  
 7 counties include some of the leading agricultural areas in the state. In addition to  
 8 agriculture, this area includes important transportation infrastructures including  
 9 inland shipping ports (Port of West Sacramento and Port of Stockton); major  
 10 employment centers (cities of Sacramento, West Sacramento, Fairfield, Stockton,  
 11 and Concord); and water-based recreation activities (e.g., boating, fishing, and  
 12 water skiing).

13 **19.3.3.3.1 Population**

14 Population characteristics in the counties of the Delta and Suisun Marsh portion  
 15 of the Central Valley Region are presented in Table 19.21. San Joaquin County  
 16 had the highest average annual population growth rate between 2000 and 2012,  
 17 and Solano County had the lowest growth rate.

1 **Table 19.21 Population Characteristics in Central Valley Region – Delta and**  
 2 **Suisun Marsh**

Area	Population		Average Annual Growth Rate (percent)
	2000	2012	2000-2012
Sacramento County	1,223,499	1,433,525	1.3
Yolo County	168,660	204,349	1.6
Solano County	394,930	415,787	0.4
San Joaquin County	563,598	692,997	1.7
Contra Costa County	948,816	1,066,602	1.0
Delta and Suisun Marsh Subtotal	3,299,503	3,813,260	1.2
Total Central Valley Region	6,062,064	7,238,742	1.5
<b>STATE OF CALIFORNIA</b>	<b>33,873,086</b>	<b>37,668,804</b>	<b>0.9</b>

3 Sources: DOF 2013a, 2013b, 2014

4 **19.3.3.3.2 Employment**

5 Civilian labor force characteristics for the Sacramento, Yolo, Solano, San  
 6 Joaquin, and Contra Costa counties are presented in Table 19.22. The civilian  
 7 labor force in these counties increased between 2001 and 2012. The data for 2008  
 8 represents the employment situation immediately following the recession in 2007.

9 **Table 19.22 Civilian Labor Force and Unemployment Rates in Central Valley**  
 10 **Region – Delta and Suisun Marsh**

Area	Civilian Labor Force (subject to unemployment insurance)			Unemployment Rate (percent)		
	2001	2008	2012	2001	2008	2012
Sacramento County	624,693	680,373	680,349	4.5	7.2	10.6
Yolo County	88,331	98,438	98,475	5.1	7.4	11.5
Solano County	197,178	211,369	217,024	4.6	6.8	10.1
San Joaquin County	266,288	293,190	298,468	7.5	10.4	15.2
Contra Costa County	508,730	524,519	535,782	4.1	6.2	9.0
Delta and Suisun Marsh Subtotal	1,685,220	1,807,889	1,830,098	4.9	7.4	10.8
Total Central Valley Region	3,448,061	3,807,278	3,911,569	6.8	8.7	12.6
<b>STATE OF CALIFORNIA</b>	<b>17,152,106</b>	<b>18,392,000</b>	<b>18,494,881</b>	<b>4.9</b>	<b>7.2</b>	<b>10.5</b>

11 Source: BLS 2014

12 Total employment and farm employment in 2001, 2008, and 2012 in the  
 13 Sacramento, Yolo, Solano, San Joaquin, and Contra Costa counties are presented  
 14 in Table 19.23. The contribution of farm employment to the total employment  
 15 declined slightly between 2001 and 2008, and then increased slightly between  
 16 2008 and 2012.

1 **Table 19.23 Employment in Central Valley Region – Delta and Suisun Marsh**

Area	Total Employment			Farm Employment		
	2001	2008	2012	2001	2008	2012
Sacramento County	739,256	806,976	784,386	5,176	4,019	3,924
Yolo County	110,902	122,054	117,609	5,244	5,364	5,745
Solano County	162,874	174,565	169,096	3,321	2,144	2,116
San Joaquin County	260,809	286,171	277,260	21,088	16,939	17,496
Contra Costa County	475,493	497,887	492,144	3,130	910	1,599
Delta and Suisun Marsh Subtotal	1,749,334	1,887,653	1,840,495	37,959	29,376	30,880
Total Central Valley Region	3,616,241	3,997,557	3,923,230	256,672	226,321	230,832
<b>STATE OF CALIFORNIA</b>	<b>19,411,367</b>	<b>20,820,306</b>	<b>20,653,860</b>	<b>479,283</b>	<b>438,013</b>	<b>443,764</b>

2 Source: BEA 2014a

3 Note:

4 Farm employment includes employment numbers in forestry, fishing, and related activities.

5 Annual farm employment for the Sacramento, Yolo, Solano, San Joaquin, and  
6 Contra Costa counties declined in 2004, slightly increased in 2006, and continued  
7 to fluctuate through 2012, as shown in Figure 19.5. Within these counties, farm  
8 employment started to decline in 2004 and began to increase slightly in 2006, as  
9 shown in Figure 19.5. The overall trend in farm employment in the Delta and  
10 Suisun Marsh portion of the Central Valley Region is influenced by the farm  
11 employment trends in San Joaquin County. The decrease in farm employment is  
12 related to the reduction in cultivated acreage during this period, as described in  
13 Chapter 12, Agricultural Resources.

14 The farm employment numbers presented in Table 19.23 include only workers  
15 directly involved in farming, forestry, and fishing activities. However, farming is  
16 one of the most important basic industries in many counties in the Central Valley  
17 Region; and supports many other businesses including farm inputs (e.g., fertilizer,  
18 seed, machinery, and fuel) and processing of food and fiber grown on farms. As a  
19 result, employment both directly on farm and indirectly dependent on farming is  
20 higher than the values displayed in Table 19.23.

### 21 **19.3.3.3 Income**

22 The average per capita personal income in the Sacramento, Yolo, Solano, San  
23 Joaquin, and Contra Costa counties was about 15 percent higher than the average  
24 per capita personal income in the entire Central Valley Region, as presented in  
25 Table 19.24. San Joaquin and Contra Costa counties experienced the lowest  
26 average annual growth rates in per capita personal income between 2000 and  
27 2008. Between 2008 and 2012, Yolo County was the only county with a slightly  
28 higher average annual growth rate as compared to the entire Central Valley  
29 Region.

1 **Table 19.24 Per Capita Personal Income in Central Valley Region – Delta and**  
 2 **Suisun Marsh**

Area	Per Capita Personal Income			Average Annual Growth Rate (percent)	
	2000	2008	2012	2000-2008	2008-2012
Sacramento County	\$29,406	\$38,782	\$41,837	3.5	1.9
Yolo County	\$27,093	\$37,488	\$41,811	4.1	2.8
Solano County	\$28,373	\$39,178	\$42,354	4.1	2.0
San Joaquin County	\$25,147	\$31,250	\$33,024	2.8	1.4
Contra Costa County	\$45,576	\$58,547	\$61,638	3.2	1.3
Average in Delta and Suisun Marsh Counties	\$33,079	\$42,861	\$45,829	3.3	1.7
Central Valley Region	\$28,183	\$37,198	\$40,601	3.5	2.2
<b>STATE OF CALIFORNIA</b>	<b>\$33,404</b>	<b>\$44,003</b>	<b>\$46,477</b>	<b>3.5</b>	<b>1.4</b>

3 Source: BEA 2014e

4 **19.3.3.3.4 Local Government Finances**

5 As of April 1, 2014, the county sales tax rates in the Sacramento, Yolo, Solano,  
 6 San Joaquin, and Contra Costa counties ranged between 7.5 percent in Yolo to  
 7 8 percent in San Joaquin (BOE 2014).

8 Total annual taxable sales for Sacramento, Yolo, Solano, San Joaquin, and Contra  
 9 Costa counties in 2000, 2008, and 2012 are presented in Table 19.25. Between  
 10 2000 and 2008 Yolo, Solano, and San Joaquin counties experienced average  
 11 annual growth in total taxable sales that were higher than the entire Central Valley  
 12 Region and the state. Between 2008 and 2012, Sacramento County experienced  
 13 negative average annual growth in total taxable sales.

14 **Table 19.25 Total Taxable Sales in Central Valley Region – Delta and Suisun Marsh**

Area	Total Taxable Sales (millions)			Average Annual Growth Rate (percent)	
	2000	2008	2012	2000-2008	2008-2012
Sacramento County	\$16,594	\$19,332	\$19,090	1.9	-0.3
Yolo County	\$2,416	\$3,347	\$3,475	4.2	0.9
Solano County	\$4,424	\$6,033	\$6,038	4.0	0.0
San Joaquin County	\$6,582	\$8,696	\$9,011	3.5	0.9
Contra Costa County	\$12,331	\$13,308	\$13,997	1.0	1.3
Delta and Suisun Marsh Counties	\$42,347	\$50,715	\$51,611	2.3	0.4
Central Valley Region	\$81,975	\$107,699	\$113,368	3.5	1.3
<b>STATE OF CALIFORNIA</b>	<b>\$441,854</b>	<b>\$531,654</b>	<b>\$407,714</b>	<b>2.3</b>	<b>-6.4</b>

15 Sources: BOE 2000, 2008, 2012

1 The combined (secured and unsecured) property tax revenues in Sacramento,  
 2 Yolo, Solano, San Joaquin, and Contra Costa counties for Fiscal Year 2011-2012  
 3 are presented in Table 19.26. Total property tax revenues from these counties  
 4 accounted for about 9 percent of the total state property tax revenues.

5 **Table 19.26 Property Tax Revenues, Fiscal Year 2011-2012,**  
 6 **in Central Valley Region – Delta and Suisun Marsh**

Area	Property Tax Revenues (millions)
Sacramento County	\$1,539
Yolo County	\$270
Solano County	\$497
San Joaquin County	\$684
Contra Costa County	\$1,979
Delta and Suisun Marsh Counties	\$4,969
Central Valley Region	\$9,874
<b>STATE OF CALIFORNIA</b>	<b>\$55,459</b>

7 Source: California State Controller 2012

### 8 **19.3.4 San Francisco Bay Area Region**

9 The San Francisco Bay Area Region includes portions of Napa, Alameda, Santa  
 10 Clara, and San Benito counties that are within the CVP and SWP service areas.  
 11 Contra Costa County also is part of the San Francisco Bay Area Region.  
 12 However, for this chapter, Contra Costa County is discussed under  
 13 Section 19.3.4.3, Delta and Suisun Marsh.

#### 14 **19.3.4.1 Population**

15 Population characteristics in the San Francisco Bay Area Region are presented in  
 16 Table 19.27. The population of the San Francisco Bay Area Region grew slightly  
 17 less than a quarter million, or at an average annual growth rate of less than one  
 18 half of one percent between 2000 and 2012.

19 **Table 19.27 Population Characteristics in San Francisco Bay Area Region**

Area	Population		Average Annual Growth Rate (percent)
	2000	2012	2000-2012
Alameda County	1,443,939	1,530,176	0.5
Santa Clara County	1,682,585	1,813,696	0.6
San Benito County	53,234	56,137	0.4
Napa County	124,279	137,731	0.9
Total San Francisco Bay Area Region	3,304,037	3,537,740	0.6
<b>STATE OF CALIFORNIA</b>	<b>33,873,086</b>	<b>37,668,804</b>	<b>0.9</b>

20 Sources: DOF 2013a, 2013b, 2014



1 **19.3.4.2 Employment**

2 Civilian labor force characteristics for the counties in the San Francisco Bay Area  
 3 Region are presented in Table 19.28. The civilian labor force in the counties  
 4 within the San Francisco Bay Area Region declined between 2001 and 2008, and  
 5 then increased between 2008 and 2012. The data for 2008 represents the  
 6 employment situation immediately following the onset of the recession in 2007.

7 **Table 19.28 Civilian Labor Force and Unemployment Rates in San Francisco Bay**  
 8 **Area Region**

Area	Civilian Labor Force (subject to unemployment insurance)			Unemployment Rate (percent)		
	2001	2008	2012	2001	2008	2012
Alameda County	778,472	757,566	775,855	4.8	6.2	9.0
Santa Clara County	939,501	870,251	910,983	5.1	6.0	8.4
San Benito County	27,461	24,870	26,611	6.3	9.6	13.9
Napa County	70,447	75,670	77,843	3.6	5.1	7.8
Total San Francisco Bay Area Region	1,815,881	1,728,357	1,791,292	4.9	6.1	8.7
<b>STATE OF CALIFORNIA</b>	<b>17,152,106</b>	<b>18,392,000</b>	<b>18,494,881</b>	<b>4.9</b>	<b>7.2</b>	<b>10.5</b>

9 Source: BLS 2014

10 Total employment and farm employment in 2001, 2008 and 2012 in the San  
 11 Francisco Bay Area Region are presented in Table 19.29. The contribution of  
 12 farm employment to total employment in the San Francisco Bay Area Region  
 13 declined slightly between 2001 and 2008, and remained relatively stable between  
 14 2008 and 2012.

15 **Table 19.29 Employment in San Francisco Bay Area Region**

Area	Total Employment			Farm Employment		
	2001	2008	2012	2001	2008	2012
Alameda County	886,316	906,403	894,625	1,704	1,475	1,291
Santa Clara County	1,226,987	1,176,129	1,187,799	5,969	4,436	2,643
San Benito County	21,722	21,827	21,116	1,969	1,244	1,073
Napa County	84,369	91,837	93,050	4,835	5,730	3,148
Total San Francisco Bay Area Region	2,219,394	2,196,196	2,196,590	14,477	12,885	8,155
<b>STATE OF CALIFORNIA</b>	<b>19,411,367</b>	<b>20,820,306</b>	<b>20,653,860</b>	<b>479,283</b>	<b>438,013</b>	<b>443,764</b>

16 Source: BEA 2014a

17 Note:

18 Farm employment includes employment numbers in forestry, fishing, and related activities.

1 As shown in Table 19.29, overall farm employment has declined by 45 percent  
 2 between 2001 and 2012, as presented in Figure 19.1. The decrease in farm  
 3 employment is related to the reduction in cultivated acreage during this period, as  
 4 described in Chapter 12, Agricultural Resources.

#### 5 **19.3.4.3 Income**

6 The average per capita personal incomes for the counties in the San Francisco  
 7 Bay Area Region are presented in Table 19.30. Among the four counties in this  
 8 region, San Benito County had the lowest per capita personal income. Santa  
 9 Clara County had the lowest average annual per capita growth rate between 2000  
 10 and 2008. All counties experienced smaller average annual per capita growth  
 11 rates between 2008 and 2012 compared to the 2000 to 2008 period.

12 **Table 19.30 Per Capita Personal Income in San Francisco Bay Area Region**

Area	Per Capita Personal Income			Average Annual Growth Rate (percent)	
	2000	2008	2012	2000-2008	2008-2012
Alameda County	\$39,613	\$50,302	\$54,683	3.0	2.1
Santa Clara County	\$55,588	\$59,927	\$66,535	0.9	2.6
San Benito County	\$29,608	\$36,100	\$38,030	2.5	1.3
Napa County	\$38,854	\$51,712	\$54,807	3.6	1.5
Total San Francisco Bay Area Region	\$47,546	\$55,050	\$60,493	1.8	2.4
<b>STATE OF CALIFORNIA</b>	<b>\$33,404</b>	<b>\$44,003</b>	<b>\$46,477</b>	<b>3.5</b>	<b>1.4</b>

13 Source: BEA 2014e

#### 14 **19.3.4.4 Local Government Finances**

15 As of April 1, 2014, the county sales tax rates in the San Francisco Bay Area  
 16 region ranged between 7.5 percent in San Benito and 9.0 percent in Alameda  
 17 (BOE 2014).

18 Total annual taxable sales for the counties in the San Francisco Bay Area Region  
 19 in 2000, 2008, and 2012 are presented in Table 19.31. Between 2000 and 2008  
 20 all counties in the region, except Santa Clara County, experienced small increases  
 21 in average annual growth in total taxable sales. All counties experienced  
 22 increasing growth rates between 2008 and 2012. Santa Clara County had the  
 23 highest annual average growth rate in total taxable sales among all the counties in  
 24 the region during this period.

1 **Table 19.31 Total Taxable Sales in San Francisco Bay Area Region**

Area	Total Taxable Sales (Millions)			Average Annual Growth Rate (percent)	
	2000	2008	2012	2000-2008	2008-2012
Alameda County	\$23,764	\$23,863	\$25,182	0.1	1.4
Santa Clara County	\$37,304	\$32,274	\$36,220	-1.8	2.9
San Benito County	\$476	\$505	\$530	0.7	1.2
Napa County	\$1,908	\$2,549	\$2,719	3.7	1.6
Total San Francisco Bay Area Region	\$63,451	\$59,191	\$64,651	-0.9	2.2
<b>STATE OF CALIFORNIA</b>	<b>\$441,854</b>	<b>\$531,654</b>	<b>\$407,714</b>	<b>2.3</b>	<b>-6.4</b>

2 Sources: BOE 2000, 2008, 2012

3 The combined (secured and unsecured) property tax revenues in each of the  
 4 counties in the San Francisco Bay Area Region for Fiscal Year 2011-2012 are  
 5 presented in Table 19.32. Total property tax revenues in the four counties  
 6 accounted for about 13 percent of the total state property tax revenues.

7 **Table 19.32 Property Tax Revenues, Fiscal Year 2011-2012,**  
 8 **in San Francisco Bay Area Region**

Area	Property Tax Revenues (millions)
Alameda County	\$2,830
Santa Clara County	\$3,973
San Benito County	\$68
Napa County	\$327
Total San Francisco Bay Area Region	\$7,198
<b>STATE OF CALIFORNIA</b>	<b>\$55,459</b>

9 Source: California State Controller 2014

10 **19.3.5 Central Coast Region**

11 The Central Coast Region includes portions of San Luis Obispo and Santa  
 12 Barbara counties served by the SWP. San Luis Obispo and Santa Barbara  
 13 counties are among the top 15 counties in total agricultural production in the state.

14 **19.3.5.1 Population**

15 Population characteristics in the Central Coast Region are presented in Table  
 16 19.33. The population of the Central Coast Region grew by an average annual  
 17 growth rate of about one half of one percent between 2000 and 2012.

1 **Table 19.33 Population Characteristics in Central Coast Region**

Area	Population		Average Annual Growth Rate (percent)
	2000	2012	2000-2012
San Luis Obispo County	246,681	271,502	0.8
Santa Barbara County	399,347	426,351	0.5
Total Central Coast Region	646,028	697,853	0.6
<b>STATE OF CALIFORNIA</b>	<b>33,873,086</b>	<b>37,668,804</b>	<b>0.9</b>

2 Sources: DOF 2013a, 2013b, 2014

3 **19.3.5.2 Employment**

4 Civilian labor force characteristics for the counties in the Central Coast Region  
5 are presented in Table 19.34. The civilian labor force in the Central Coast Region  
6 increased between 2000 and 2012.

7 **Table 19.34 Civilian Labor Force and Unemployment Rates in Central Coast Region**

Area	Civilian Labor Force (subject to unemployment insurance)			Unemployment Rate (percent)		
	2001	2008	2012	2001	2008	2012
San Luis Obispo County	126,176	136,615	138,650	4.0	5.7	9.3
Santa Barbara County	203,039	218,429	225,635	4.4	5.4	8.8
Total Central Coast Region	329,215	355,044	364,285	4.3	5.6	5.9
<b>STATE OF CALIFORNIA</b>	<b>17,152,106</b>	<b>18,392,000</b>	<b>18,494,881</b>	<b>4.9</b>	<b>7.2</b>	<b>10.5</b>

8 Source: BLS 2014

9 Total employment and farm employment in 2001, 2008, and 2012 in the Central  
10 Coast Region are presented in Table 19.35. Farm employment accounted for less  
11 than ten percent of total employment during this period.

12 **Table 19.35 Employment in Central Coast Region**

Area	Total Employment			Farm Employment		
	2001	2008	2012	2001	2008	2012
San Luis Obispo County	140,320	155,093	156,757	7,775	6,866	7,374
Santa Barbara County	243,955	260,056	257,841	15,228	16,483	18,075
Total Central Coast Region	384,275	415,149	414,598	23,003	23,349	25,449
<b>STATE OF CALIFORNIA</b>	<b>19,411,367</b>	<b>20,820,306</b>	<b>20,653,860</b>	<b>479,283</b>	<b>438,013</b>	<b>443,764</b>

13 Source: BEA 2014a

14 Note: Farm employment includes employment numbers in forestry, fishing, and related activities.

15 The farm employment numbers presented in Table 19.35 include only workers  
16 directly involved in farming, forestry, and fishing activities. However, farming is  
17 one of the most important basic industries in many counties in the Central Coast  
18 Region; and supports many other businesses including farm inputs (e.g., fertilizer,  
19 seed, machinery, and fuel) and processing of food and fiber grown on farms. As a

1 result, employment both directly on farm and indirectly dependent on farming is  
 2 higher than the values displayed in Table 19.35.

3 **19.3.5.3 Income**

4 Per capita personal incomes for the counties in the Central Coast Region are  
 5 lower than those for the state. Both San Luis Obispo and Santa Barbara had  
 6 average annual per capita personal income growth rates between 2000 and 2008  
 7 that were among the highest in the state. Per capita personal income for each of  
 8 the two counties in the Central Coast Region in 2000, 2008 and 2012 are  
 9 presented in Table 19.36.

10 **Table 19.36 Per Capita Personal Income in Central Coast Region**

Area	Per Capita Personal Income			Average Annual Growth Rate (percent)	
	2000	2008	2012	2000-2008	2008-2012
San Luis Obispo County	\$28,671	\$40,204	\$43,698	4.3	2.1
Santa Barbara County	\$33,317	\$45,997	\$47,862	4.1	1.0
Central Coast Region	\$31,540	\$43,735	\$46,241	4.2	1.4
<b>STATE OF CALIFORNIA</b>	<b>\$33,404</b>	<b>\$44,003</b>	<b>\$46,477</b>	<b>3.5</b>	<b>1.4</b>

11 Source: BEA 2014e

12 **19.3.5.4 Local Government Finances**

13 As of April 1, 2014, the county sales tax rates in the San Luis Obispo and Santa  
 14 Barbara counties were 7.5 percent and 8.0 percent, respectively (BOE 2014).

15 Total annual taxable sales for San Luis Obispo and Santa Barbara counties in the  
 16 Central Coast Region in 2000, 2008, and 2012 are presented in Table 19.37. The  
 17 Central Coast Region’s average annual growth in total taxable sales were higher  
 18 than for the state.

19 **Table 19.37 Total Taxable Sales in Central Coast Region**

Area	Total Taxable Sales (Millions)			Average Annual Growth Rate (percent)	
	2000	2008	2012	2000-2008	2008-2012
San Luis Obispo County	\$2,925	\$3,974	\$5,026	3.9	6.0
Santa Barbara County	\$4,823	\$5,884	\$6,051	2.5	0.7
Central Coast Region	\$7,748	\$9,858	\$11,077	3.1	3.0
<b>STATE OF CALIFORNIA</b>	<b>\$441,854</b>	<b>\$531,654</b>	<b>\$407,714</b>	<b>2.3</b>	<b>-6.4</b>

20 Sources: BOE 2000, 2008, 2012

21 The combined (secured and unsecured) property tax revenues in the Central Coast  
 22 Region for Fiscal Year 2011-2012 are presented in Table 19.38. Total property  
 23 tax revenues in the two counties accounted for about 2 percent of the total state  
 24 property tax revenues.

1 **Table 19.38 Property Tax Revenues, Fiscal Year 2011-2012,**  
 2 **in Central Coast Region**

Area	Property Tax Revenues (millions)
San Luis Obispo County	\$443
Santa Barbara County	\$695
Central Coast Region	\$1,138
<b>STATE OF CALIFORNIA</b>	<b>\$55,459</b>

3 Source: California State Controller 2014

#### 4 **19.3.6 Southern California Region**

5 The Southern California Region includes portions of Ventura, Los Angeles,  
 6 Orange, San Diego, Riverside, and San Bernardino counties served by the SWP.

##### 7 **19.3.6.1 Population**

8 Population characteristics in Southern California Region are presented in  
 9 Table 19.39. Among the counties in the Southern California Region, Riverside  
 10 County had the highest average annual population growth rate, and Los Angeles  
 11 County had the lowest average annual population growth rate between 2000  
 12 and 2012.

13 **Table 19.39 Population Characteristics in Southern California Region**

Area	Population		Average Annual Growth Rate (percent)
	2000	2012	2000-2012
Ventura County	753,197	829,065	0.8
Los Angeles County	9,519,330	9,889,520	0.3
Orange County	2,846,289	3,057,879	0.6
San Diego County	2,813,833	3,128,734	0.9
Riverside County	1,545,387	2,234,193	3.1
San Bernardino County	1,710,139	2,059,699	1.6
Total Southern California Region	19,188,175	21,199,090	0.8
<b>STATE OF CALIFORNIA</b>	<b>33,873,086</b>	<b>37,668,804</b>	<b>0.9</b>

14 Sources: DOF 2013a, 2013b, 2014

##### 15 **19.3.6.2 Employment**

16 Civilian labor force characteristics for the counties in the Southern California  
 17 Region are presented in Table 19.40. The civilian labor force in the Southern  
 18 California Region increased between 2001 and 2012. The average unemployment  
 19 rates for the Southern California Region have been lower than for the state.

1 **Table 19.40 Civilian Labor Force and Unemployment Rates in Southern**  
 2 **California Region**

Area	Civilian Labor Force (subject to unemployment insurance)			Unemployment Rate (percent)		
	2001	2008	2012	2001	2008	2012
Ventura County	399,325	429,444	440,649	4.8	6.3	9.0
Los Angeles County	4,752,839	4,934,756	4,879,674	5.7	7.5	10.9
Orange County	1,513,234	1,618,079	1,618,677	4.0	5.3	7.6
San Diego County	1,409,726	1,548,233	1,599,133	4.2	6.0	8.9
Riverside County	711,134	912,717	944,458	5.5	8.5	12.2
San Bernardino County	763,221	863,293	860,895	5.1	8.0	12.0
Total Southern California Region	9,549,479	10,306,522	10,343,486	5.1	7.0	10.2
<b>STATE OF CALIFORNIA</b>	<b>17,152,106</b>	<b>18,392,000</b>	<b>18,494,881</b>	<b>4.9</b>	<b>7.2</b>	<b>10.5</b>

3 Source: BLS 2014

4 Total employment and farm employment in 2001, 2008, and 2012 in the Southern  
 5 California Region are presented in Table 19.41. Farm employment accounted for  
 6 less than one percent of total employment.

7 **Table 19.41 Employment in Southern California Region**

Area	Total Employment			Farm Employment <sup>1</sup>		
	2001	2008	2012	2001	2008	2012
Ventura County	399,928	436,031	431,196	21,329	23,430	24,826
Los Angeles County	5,440,785	5,695,501	5,669,105	11,082	8,709	7,589
Orange County	1,845,392	1,999,036	1,963,080	7,888	4,713	3,183
San Diego County	1,723,801	1,901,598	1,887,077	17,871	15,718	14,778
Riverside County	677,214	866,247	864,308	20,892	15,669	15,024
San Bernardino County	730,150	881,700	864,432	6,050	3,931	3,688
Total Southern California Region	10,817,270	11,780,113	11,679,198	85,112	72,170	69,088
<b>STATE OF CALIFORNIA</b>	<b>19,411,367</b>	<b>20,820,306</b>	<b>20,653,860</b>	<b>479,283</b>	<b>438,013</b>	<b>443,764</b>

8 Source: BEA 2014a

9 Note:

10 Farm employment includes employment numbers in forestry, fishing, and related activities.

### 11 **19.3.6.3 Income**

12 Among the six counties in this region, San Bernardino County had the lowest per  
 13 capita personal income in 2000 and 2008, as presented in Table 19.42. In 2012,  
 14 Riverside County had the lowest per capita personal income.

1 **Table 19.42 Per Capita Personal Income in Southern California Region**

Area	Per Capita Personal Income			Average Annual Growth Rate (percent)	
	2000	2008	2012	2000-2008	2008-2012
Ventura County	\$34,296	\$46,634	\$48,837	3.9	1.2
Los Angeles County	\$29,878	\$42,881	\$44,474	4.6	0.9
Orange County	\$38,357	\$49,436	\$52,342	3.2	1.4
San Diego County	\$33,779	\$47,197	\$49,719	4.3	1.3
Riverside County	\$24,528	\$30,842	\$31,742	2.9	0.7
San Bernardino County	\$22,624	\$30,220	\$32,072	3.7	1.5
Total Southern California Region	\$30,801	\$41,078	\$44,004	3.7	1.7
<b>STATE OF CALIFORNIA</b>	<b>\$33,404</b>	<b>\$44,003</b>	<b>\$46,477</b>	<b>3.5</b>	<b>1.4</b>

2 Source: BEA 2014e

3 **19.3.6.4 Local Government Finances**

4 As of April 1, 2014, the county sales tax rates in the Southern California Region  
5 ranged from 7.5 percent in Ventura County to 9.0 percent in Los Angeles County  
6 (BOE 2014).

7 Total annual taxable sales for the counties in the Southern California Region in  
8 2000, 2008, and 2012 are presented in Table 19.43. The counties in this region  
9 have had higher average annual growth rates in total taxable retail sales compared  
10 to the state. Between 2000 and 2008, Riverside and San Bernardino led the  
11 region with higher average annual growth rates. However, between 2008 and  
12 2012, the two counties experienced declining growth rates.

13 **Table 19.43 Total Taxable Sales in Southern California Region**

Area	Total Taxable Sales (millions)			Average Annual Growth Rate (percent)	
	2000	2008	2012	2000-2008	2008-2012
Ventura County	\$9,096	\$11,322	\$11,958	2.8	1.4
Los Angeles County	\$106,674	\$131,882	\$135,296	2.7	0.6
Orange County	\$44,462	\$53,607	\$55,231	2.4	0.7
San Diego County	\$36,245	\$45,329	\$47,947	2.8	1.4
Riverside County	\$16,979	\$26,004	\$28,096	5.5	2.0
San Bernardino County	\$18,885	\$27,778	\$29,532	4.9	1.5
Total Southern California Region	\$232,342	\$295,921	\$308,059	3.1	1.0
<b>STATE OF CALIFORNIA</b>	<b>\$441,854</b>	<b>\$531,654</b>	<b>\$407,714</b>	<b>2.3</b>	<b>-6.4</b>

14 Sources: BOE 2000, 2008, 2012

15 The combined (secured and unsecured) property tax revenues in the Southern  
16 California Region for Fiscal Year 2011-2012 are presented in Table 19.44. Total



1 property tax revenues accounted for about 55 percent of the total state property  
 2 tax revenues.

3 **Table 19.44 Property Tax Revenues, Fiscal Year 2011-2012,**  
 4 **in Southern California Region**

Area	Property Tax Revenues (millions)
Ventura County	\$1,230
Los Angeles County	\$14,191
Orange County	\$5,046
San Diego County	\$4,646
Riverside County	\$2,812
San Bernardino County	\$2,132
Southern California Region	\$30,057
<b>STATE OF CALIFORNIA</b>	<b>\$55,459</b>

5 Source: California State Controller 2012

6 **19.3.7 Ocean Salmon Fishery**

7 The ocean salmon fishery along the southern Oregon and northern California  
 8 coast are affected by the population of salmon that rely upon the northern  
 9 California rivers, including the Sacramento and San Joaquin rivers. Changes in  
 10 CVP and SWP water operations would affect the flow patterns and water quality  
 11 of the Sacramento and San Joaquin rivers; and the survivability of the salmon that  
 12 use those rivers for habitat, as described in Chapter 9, Fish and Aquatic  
 13 Resources. This section discusses the economic contributions of the Pacific Coast  
 14 salmon fishery.

15 Management of the California ocean salmon fishery is a combined effort of the  
 16 California Department of Fish and Wildlife (CDFW) and the Pacific Fishery  
 17 Management Council (PFMC), a regional council of the National Oceanic and  
 18 Atmospheric Administration. The California Department of Fish and Wildlife  
 19 manages salmon harvest from the shoreline to three nautical miles off the  
 20 California coast. From three nautical miles to two hundred nautical miles  
 21 offshore is managed by the PFMC. The PFMC is responsible for developing the  
 22 Pacific Coast Salmon Fishery Management Plan (FMP) that guides management  
 23 of the ocean commercial and recreational fishery in California, Oregon, and  
 24 Washington (PFMC 2014a). The annual ocean salmon fishery regulations  
 25 promote the maximum amount of harvest while ensuring that suitable population  
 26 levels are maintained (NOAA 2014).

27 **19.3.7.1 Commercial Ocean Fisheries for Salmon along the Southern**  
 28 **Oregon and Northern California Coasts**

29 The commercial ocean salmon fishery plays a large role in the overall California  
 30 commercial ocean industry, as shown in Table 19.45. The total harvest value for  
 31 Chinook salmon ranked fourth among all commercially harvested ocean species  
 32 in 2012. The harvest value rank of Chinook salmon in California between 2001

1 and 2012 as compared to the other commercially harvested ocean species are  
 2 presented in Table 19.46.

3 **Table 19.45 Top Ten Species by Total Value for Commercially Harvested Ocean**  
 4 **Species in California in 2012**

Rank	Species	Total Value
1	Dungeness Crab	\$85,643,530
2	California Market Squid	\$63,883,456
3	California Spiny Lobster	\$13,706,721
<b>4</b>	<b>Chinook Salmon</b>	<b>\$12,841,853</b>
5	Sablefish	\$8,987,599
6	Pacific Oyster	\$8,736,923
7	Sea Urchins	\$8,320,111
8	Spot Shrimp	\$4,462,204
9	Pacific Sardine	\$4,248,504
10	Kumamoto Oyster	\$3,170,760

5 Sources: NMFS 2014a, 2014b, 2014c, 2014d, 2014e, 2014f, 2014g, 2014h, 2014i, 2014j

6 **Table 19.46 Chinook Salmon Total Harvest Value Ranking as compared to Other**  
 7 **Commercially Harvested Ocean Species in California**

Year	Total Value of Chinook Salmon Landings	Rank
2001	\$4,760,786	7
2002	\$7,610,882	4
2003	\$12,153,111	3
2004	\$17,770,036	3
2005	\$12,804,188	3
2006	\$5,260,526	4
2007	\$7,835,240	4
2008	Season Closed	
2009	Season Closed	
2010	\$1,214,959	19
2011	\$5,096,433	7
2012	\$12,841,853	4

8 Source: NMFS 2014k

9 Annual revenues from commercial ocean salmon fishery in California have  
 10 fluctuated with changes in salmon prices and total landings. The dollar per  
 11 dressed pound for Chinook salmon paid to the commercial operator can change  
 12 within a season, across seasons, and at different ports, as presented in  
 13 Table 19.47. Prices for Chinook salmon have increased over the past years;  
 14 however, the costs for fuel, labor, and equipment maintenance also have  
 15 increased.

1 **Table 19.47 Average Annual Commercial Chinook Salmon Prices**

Year	Average Annual California Price (dollar per dressed pound)	Average Annual Oregon Price (dollar per dressed pound)
2001	\$1.98	\$1.61
2002	\$1.55	\$1.54
2003	\$1.91	\$1.97
2004	\$2.87	\$3.45
2005	\$2.97	\$3.17
2006	\$5.13	\$5.48
2007	\$5.18	\$5.66
2008	Season Closed	\$7.31
2009	Season Closed	Season Closed
2010	\$5.46	\$5.49
2011	\$5.17	\$5.96
2012	\$5.34	\$5.75

2 Source: PFMC 2014b (Tables D-4, D-5)

3 The total value of landings for the commercial ocean fishery in southern Oregon  
4 and California are presented in Table 19.48.

5 **Table 19.48 Value of Landings for Salmon for the Commercial Ocean**  
6 **Salmon Fishery**

Year	Total Value, California	Total Value, Oregon
2001	\$4,773	\$4,721
2002	\$7,776	\$5,391
2003	\$12,181	\$7,222
2004	\$17,895	\$9,919
2005	\$12,913	\$8,503
2006	\$5,350	\$2,701
2007	\$7,902	\$2,822
2008	Season Closed	\$51,118
2009	Season Closed	\$51,118
2010	\$1,246	\$2,791
2011	\$5,133	\$2,401
2012	\$13,521	\$4,271

7 Sources: PFMC 2014b (Tables D-4, D-5); PacFIN 2014

8 The economic contribution of the California commercial ocean salmon fishery  
9 extends beyond the revenues received by fishermen. Supporting industries  
10 include fish processors, boat manufacturers, repair and maintenance. The  
11 economic contribution of the commercial ocean salmon fishery can be estimated  
12 through the use of Input-Output models. Economic contributions are estimated by  
13 PFMC using an Input-Output model, the Fishery Economic Assessment Model  
14 (FEAM), as summarized in Table 19.49 for the commercial ocean salmon fishery  
15 by management area.

1 **Table 19.49 Estimated Total Economic Impact for the Commercial Fishery by PFMC**

Year	Economic Values by Management Areas (\$1,000)					
	KMZ – Oregon	KMZ – California	Fort Bragg	San Francisco	Monterey	Total
2001	\$635	\$328	\$1,033	\$10,857	\$2,297	\$15,150
2002	\$806	\$797	\$3,730	\$15,516	\$4,179	\$25,028
2003	\$699	\$259	\$15,160	\$15,795	\$2,491	\$34,404
2004	\$1,502	\$2,373	\$7,434	\$23,356	\$5,257	\$39,922
2005	\$1,259	\$582	\$5,420	\$13,496	\$7,083	\$27,840
2006	\$378	\$0	\$2,471	\$6,389	\$985	\$10,223
2007	\$780	\$1,156	\$3,407	\$8,131	\$1,658	\$15,132
2008	\$72	\$0	\$0	\$0	\$0	\$72
2009	\$42	\$0	\$0	\$0	\$0	\$42
2010	\$367	\$35	\$1,780	\$140	\$161	\$2,483
2011	\$504	\$505	\$4,952	\$2,225	\$979	\$9,165
2012	\$698	\$725	\$4,706	\$10,653	\$5,759	\$22,541
2013	\$1,252	\$2,146	\$12,909	\$19,181	\$4,010	\$39,498

2 Source: PFMC 2014b (Tables IV-16, IV-17)

## 3 Notes:

4 All values estimated using the Fishery Economic Assessment Model, and presented as 2013 dollars.

5 Southern Oregon values include data for Brookings, Oregon which may include values from landings outside of the KMZ.

6 a. KMZ –Oregon represents the area from Humbug Mountain to the Oregon-California Border, and includes landings at the Brookings port and season length and quota values for the entire area including Chetco River Ocean Terminal Area between Twin Rocks and the Oregon-California border.

7 b. KMZ –California represents the area from Oregon-California Border to Humboldt South Jetty, and includes landings at the Crescent City and Eureka ports.

12 Fisherman and industries that rely on the commercial ocean salmon fishery have  
13 access to financial assistance from the federal government in years of low revenue  
14 or closure. The fishery can be declared a failure by the Department of Commerce  
15 after requests are sent by state or local officials and certain criteria have been met.  
16 After a fishery failure is declared, disaster relief can be provided in the form of  
17 monetary compensation, community grants, low-interest loans, habitat restoration,  
18 or fishery capacity reduction. Disaster relief related to the California commercial  
19 ocean salmon fishery has occurred six times between 1994 and 2009, as  
20 summarized in Table 19.50 (CRS 2013). Direct payments may involve a  
21 minimum amount to any permit holder and additional amounts based upon past  
22 landing values (Hackett and Hansen 2008). Disaster relief funds distribution is  
23 conducted by the PFMC and the California Salmon Council.

1 **Table 19.50 Disaster Relief Monies and Programs for the Commercial Ocean**  
 2 **Salmon Fishery in California**

Year	Programs	Dollar Value
1994	Fishery capacity reduction, habitat restoration jobs, and data collection jobs	\$12 Million
1995	Similar programs as in 1994	\$13 Million
1998	Fishery capacity reduction	\$3.5 Million
2007	Direct payments to fisherman and businesses dependent on the Klamath River salmon	\$60.4 Million
2008	Direct payments to fisherman and businesses dependent on the Sacramento River salmon	\$170 Million
2009-2010	Continuation of 2008 programs	Remainder of the 2008 \$170 Million

3 Source: CRS 2013

4 **19.3.7.2 Ocean Sport Fisheries for Salmon along the Southern Oregon**  
 5 **and Northern California Coasts**

6 The PFMC and CDFW also manages the ocean sport fishery. The economic  
 7 contribution of the ocean sport salmon fishery can be estimated through the use of  
 8 Input-Output models. Economic contributions are estimated by PFMC using an  
 9 Input-Output model, the Fishery Economic Assessment Model (FEAM), as  
 10 summarized in Table 19.51.

11 **Table 19.51 Estimated Total Economic Impact for the Recreational Fishery**  
 12 **by PFMC**

Year	Economic Values by Management Areas (\$1,000)					
	KMZ – Oregon	KMZ- California	Fort Bragg	San Francisco	Monterey	Total
2001	\$1,052	\$1,136	\$2,101	\$7,683	\$3,079	\$15,051
2002	\$775	\$1,026	\$2,221	\$9,646	\$4,752	\$18,420
2003	\$608	\$743	\$1,677	\$6,990	\$2,288	\$12,306
2004	\$751	\$1,229	\$2,175	\$11,310	\$4,439	\$19,904
2005	\$501	\$794	\$1,759	\$8,554	\$3,234	\$14,842
2006	\$426	\$743	\$1,450	\$5,812	\$1,947	\$10,378
2007	\$437	\$977	\$1,170	\$4,119	\$1,427	\$8,130
2008	\$189	\$0	\$26	\$0	\$0	\$215
2009	\$241	\$276	\$0	\$0	\$0	\$517
2010	\$229	\$201	\$421	\$1,712	\$1,140	\$3,703
2011	\$241	\$744	\$972	\$3,367	\$1,778	\$7,102
2012	\$732	\$1,614	\$970	\$6,069	\$2,947	\$12,332

13 Source: PFMC 2014b (Tables IV-16, IV-17)

14 Notes:  
 15 All values estimated using the Fishery Economic Assessment Model, and presented as 2013 dollars.  
 16 Southern Oregon values include data for Brookings, Oregon which may include values from landings outside of  
 17 the KMZ.

- 1 a. KMZ –Oregon represents the area from Humbug Mountain to the Oregon-California Border, and includes
- 2 landings at the Brookings port and season length and quota values for the entire area including Chetco River
- 3 Ocean Terminal Area between Twin Rocks and the Oregon-California border.
- 4 b. KMZ –California represents the area from Oregon-California Border to Humboldt South Jetty, and includes
- 5 landings at the Crescent City and Eureka ports.

6 **19.3.8 Ocean Salmon Fisheries for the Yurok and Hoopa Valley**  
 7 **Tribes**

8 The salmon populations are extremely important to the Yurok Tribe and Hoopa  
 9 Valley Tribe as part of their lives, cultural traditions, ceremonies, and community  
 10 health (Reclamation 2012). Fifty percent of the total available salmon in the  
 11 Trinity River is the federally protected harvest for the Yurok and Hoopa Valley  
 12 tribes (DOI 1993). Each tribe determines the use of the harvest. Historical  
 13 landing data for the Yurok and Hoopa Valley tribes are presented in Table 19.52  
 14 (Reclamation 2012).

15 **Table 19.52 Salmon Landings by the Yurok Tribe and Hoopa Valley Tribe**

Year	Spring Run Chinook Salmon	Fall Run Chinook Salmon	Total
2001	19,640	39,044	58,684
2002	15,136	24,700	39,836
2003	9,065	30,078	39,143
2004	8,682	25,971	34,653
2005	7,302	8,087	15,389
2006	4,409	10,698	15,107
2007	5,849	27,594	33,443
2008	3,439	22,901	26,340
2009	3,562	28,565	32,127
2010	5,023	30,315	35,338
2011	5,005	28,084	33,089
2012	6,477	101,662	108,139
2013 <sup>a</sup>	4,972	63,030	68,002

- 16 Source: PFMC 2014b (Table B-5)
- 17 Note:
- 18 a. 2013 data are preliminary.
- 19 Includes landings at the Klamath River estuary, along the Klamath River from the estuary to Weitchpec (at the
- 20 confluence of the Klamath and Trinity rivers), and along the Trinity River.

21 **19.4 Impact Analysis**

22 This section describes the potential mechanisms and analytical methods for  
 23 change in socioeconomic factors; results of the impact analysis; potential  
 24 mitigation measures; and cumulative effects.

25 This Chapter includes the analysis of overall regional economic changes and  
 26 economic changes related to changes in CVP and SWP water supplies for M&I  
 27 water users. More detailed discussions of changes in agricultural production are  
 28 presented in Chapter 12, Agricultural Resources.

1 **19.4.1 Potential Mechanisms and Analytical Methods**

2 As described in Chapter 4, Approach to Environmental Analysis, the impact  
3 assessment considers changes in socioeconomic factors related to changes in CVP  
4 and SWP operations under the alternatives as compared to the No Action  
5 Alternative and Second Basis of Comparison.

6 Changes in CVP and SWP operations under the alternatives as compared to the  
7 No Action Alternative and Second Basis of Comparison could change water  
8 supply availability for CVP and SWP water users, recreational opportunities at  
9 reservoirs that store CVP and SWP water, and salmon from the Delta watershed  
10 that are relied upon by commercial, sport, and tribal fisherman.

11 **19.4.1.1 Regional Changes in Irrigated Agricultural Production Value**

12 Changes in CVP and SWP operations could change the extent of total agricultural  
13 production value as compared to the No Action Alternative and the Second Basis  
14 of Comparison. As described in Chapter 12, Agricultural Resources, there was no  
15 changes in agricultural production in the Central Valley under long-term  
16 conditions (over the 81-year model simulation period). Therefore, this analysis  
17 only addresses regional economic changes during dry and critical dry years.

18 This analysis uses model output from the Statewide Agricultural Production  
19 (SWAP) model and the IMPLAN model. The SWAP model, as described in  
20 Chapter 12, is a regional model of irrigated agricultural production and economics  
21 that simulates the decisions of producers (farmers) in the Central Valley Region.  
22 The model selects the crops, water supplies, and other inputs that maximize profit  
23 subject to constraints on water and land, and subject to economic conditions  
24 regarding prices, yields, and costs. The SWAP model incorporates CVP and  
25 SWP water supplies, other local water supplies represented in the CalSim II  
26 model, and groundwater. As conditions change within a SWAP subregion  
27 (e.g., the quantity of available project water supply declines), the model optimizes  
28 production by adjusting the crop mix, water sources and quantities used, and other  
29 inputs. The model also fallows land when that appears to be the most cost-  
30 effective response to resource conditions. The analysis only reduces groundwater  
31 withdrawals based upon an optimization of agricultural production costs. The  
32 analysis does not restrict groundwater withdrawals based upon groundwater  
33 overdraft or groundwater quality conditions.

34 As described in Chapter 7, Groundwater Resources and Groundwater Quality,  
35 The Sustainable Groundwater Management Act (SGMA) requires preparation of  
36 Groundwater Sustainability Plans (GSPs) by 2020 or 2022 for most of the  
37 groundwater basins. The GSPs will identify methods to implement measures that  
38 will achieve sustainable groundwater operations by 2040 or 2042. The analysis in  
39 this Chapter is focused on conditions that would occur in 2030. If local agencies  
40 fully implement GSPs prior to the regulatory deadline, increasing groundwater  
41 use would be less of an option for agricultural water users. However, to achieve  
42 sustainable conditions, some measures could require several years to design and  
43 construct new water supply facilities, and sustainable groundwater conditions are  
44 not required until the 2040s. Therefore, it was assumed that Central Valley

1 agriculture water users would not reduce groundwater use by 2030, and that  
2 groundwater use would increase in response to reduced CVP and SWP  
3 water supplies.

4 As described in Chapter 12, the impact to irrigated acreage and agricultural  
5 production is relatively small. Most of the change in CVP or SWP irrigation  
6 supplies would be offset by changes in groundwater pumping, with only small  
7 changes in crop acreage in production. However, this is an aggregate result for  
8 the Central Valley. Individual growers that rely on CVP or SWP supply and have  
9 no access to groundwater would have their irrigated acreage affected by larger  
10 amounts. Some of their change in production can and would be offset by changes  
11 on other farms that have access to groundwater or other surface supplies. Over  
12 time, growers without the buffer of access to groundwater could be driven to sell  
13 to or merge with other farming operations. From the larger, regional perspective,  
14 total value of production is estimated to change relatively little.

15 The regional economic analysis was conducted using the results of the impact  
16 analysis on agricultural production and M&I water use. The incremental impact  
17 results, estimated by the SWAP and CWEST economic models, were input into  
18 the regional IMPLAN models as the direct change caused by each of  
19 Alternative as compared to the No Action Alternative and the Second Basis of  
20 Comparison. Changes in economic effects depend upon loss of production or  
21 expenditures for water supplies, interactions within the regional economy, and  
22 “leakage” of economic activity between regions. Economic linkages create  
23 multiplier effects in a regional economy in the IMPLAN input-output model  
24 based upon estimates of county-level final demands and final payments developed  
25 from published data, national average matrix of technical coefficients, and  
26 mathematical relationships. IMPLAN uses information from the U.S. Department  
27 of Commerce’s Bureau of Economic Analysis, U.S. Department of Labor’s  
28 Bureau of Labor Statistics, and other federal and state government agencies. Data  
29 is collected for 440 different industrial sectors of the national economy per the  
30 North American Industry Classification System based on the primary commodity  
31 or service produced. Data sets are provided for the IMPLAN model for each  
32 county in the United States. In this analysis counties were grouped into the  
33 Central Valley Region (does not include Contra Costa County), San Francisco  
34 Bay Area Region (does include Contra Costa County), Central Coast Region, and  
35 Southern California Region.

36 IMPLAN is a static model that estimates impacts for a snapshot in time when the  
37 impacts are expected to occur, based on the makeup of the economy at the time of  
38 the underlying IMPLAN data. IMPLAN measures the initial impact to the  
39 economy based on average expenditure patterns, but does not consider long-term  
40 adjustments if labor and capital move into alternative uses.

41 Irrigated acreage occurs in the San Francisco Bay Area, Central Coast, and  
42 Southern California regions that use CVP and SWP water. This irrigated acreage  
43 is not included in the SWAP model simulation; and therefore, is not evaluated  
44 quantitatively in this EIS. However, changes in irrigated acreage in response to



1 reductions in CVP and SWP water deliveries are assumed to occur in a similar  
2 manner as projected for the Central Valley Region.

3 As described in this chapter, the SWAP and IMPLAN models are annual-time  
4 step models that use information from the monthly-time step model. The model  
5 results represent long-term responses and must be used in a comparative manner  
6 to reduce the effects of use of monthly assumptions and other assumptions that  
7 are indicative of real-time operations, but do not specific match real-time  
8 observations. The CalSim II model output includes minor fluctuations of up to  
9 5 percent due to model assumptions and approaches. Therefore, if the  
10 quantitative changes between a specific alternative and the No Action  
11 Alternative and/or Second Basis of Comparison are 5 percent or less, the  
12 conditions under the specific alternative would be considered to be “similar” to  
13 conditions under the No Action Alternative and/or Second Basis of Comparison.

14 **19.4.1.2 Regional Changes in Municipal and Industrial Water Supplies and**  
15 **Water Supply Costs**

16 Changes in CVP and SWP operations could change availability of water supplies  
17 for M&I water in the study area, related costs of additional supplies or shortages,  
18 and changes in regional economics as compared to the No Action Alternative and  
19 the Second Basis of Comparison. The quantitative analyses of regional changes  
20 related to changes in M&I water supplies and associated costs, employment, and  
21 economic output are analyzed using the California Water Economics Spreadsheet  
22 Tool (CWEST) model and the IMPLAN model.

23 Changes in M&I water supplies were evaluated using a regional economic model  
24 that was specifically modified to address water supply and cost changes to CVP  
25 and SWP M&I water users. The CWEST is a regional model that considers the  
26 economic costs to M&I water users including the cost of CVP and SWP water  
27 supplies, regional surface water supplies (including recycled water), conveyance  
28 costs, shortage costs, and changes in groundwater pumping costs. The model  
29 operations on an annual time step. Annual supplies are calculated for each water  
30 user based upon annual CVP and/or SWP water supplies, local surface water and  
31 groundwater supplies, surface water and groundwater storage, wastewater effluent  
32 and stormwater recycling water treatment, and desalination water treatment.

33 CVP and SWP water supply inputs are provided for the 81-year hydrologic period  
34 from the CalSim II model. The CWEST model analyzes the changes in annual  
35 conditions over the 81-long-term condition, and averages the overall costs for  
36 each Alternative over the 81-long-term condition. The CWEST model evaluates  
37 responses to changes in CVP and SWP water supplies differently for wet, above  
38 normal, and below normal water year types as compared to dry and critical dry  
39 water year types.

40 The goal of the CWEST model is to minimize the cost for the water providers and  
41 end-users to meet 2030 water demand. In years when the combination of average  
42 existing water supplies (either for the wetter or drier conditions) are greater than  
43 the 2030 water demand, the CWEST model assumes any overage water amount  
44 would be placed into surface water or groundwater storage, if available. If

1 storage is not available, groundwater pumping would be reduced so that the other  
 2 available supplies can be utilized. The CWEST model assumes that local surface  
 3 water, other imported water supplies, recycled water use, and desalinated water  
 4 use would not be reduced. However, during wet years, total CVP and SWP water  
 5 deliveries may not be delivered if groundwater pumping is reduced to zero and  
 6 local storage facilities are full.

7 In years when annual supplies are less than the 2030 water demand, the model  
 8 assumes that water users with local surface water and groundwater storage would  
 9 first fully utilize those supplies, and participate in temporary water transfers or a  
 10 similar annual option if necessary. If shortage and transfer costs occur frequently,  
 11 the model can select to purchase additional fixed-yield supplies, such as  
 12 additional recycled water, desalination water treatment, or groundwater capacity.  
 13 The model optimizes these long-term supply decisions to provide the lowest-cost  
 14 water supply portfolio to meet 2030 demands throughout the 81-year hydrologic  
 15 period.

16 The CWEST model local supply amounts and costs for this EIS are primarily  
 17 based upon information presented in 2010 Urban Water Management Plans  
 18 (UWMPs) developed by the CVP and SWP contractors (see Appendix 5D,  
 19 Municipal and Industrial Water Demands and Supplies). The assumptions related  
 20 to future water supplies presented in the UWMPs were evaluated to determine if  
 21 the projects were reasonable and certain to occur by 2030. Projects that had  
 22 undergone environmental review, were under design, or under construction were  
 23 considered to exist in 2030 water supply assumptions in the CWEST model.  
 24 Projects described in the UWMPs were considered as options to increase fixed-  
 25 yield supplies. Existing and future water supplies considered for municipalities  
 26 by 2030 are presented in Appendix 5B, Future Municipal Water Supplies for CVP  
 27 and SWP Water Users. For smaller water users that are not addressed in an  
 28 UWMP, information was obtained from water master plans and integrated  
 29 regional water management plans.

30 CWEST calculates the change in the cost of water supplies plus end-user shortage  
 31 costs. It does not calculate the total cost of water supplies. To provide a basis for  
 32 understanding the relative importance of a change in costs, annual operating  
 33 expenses were obtained from the fiscal year 2011-12 reports for special districts,  
 34 counties, and cities published by the State Controllers' office (2013, 2014,  
 35 2014a). These operating expenses were updated to 2014 dollars using the  
 36 California urban consumer price index. The cost change from CWEST, divided  
 37 by the operating expense, provides a reasonable indication of the relative  
 38 importance of cost changes for urban water providers.

39 The level of 2014 operating expense for each region includes:

- 40 • Central Valley Region
  - 41 – Sacramento Valley - \$257 million
  - 42 – San Joaquin Valley - \$297 million
- 43 • San Francisco Bay Area Region - \$415 million
- 44 • Central Coast Region - \$38 million

1 • Southern California Region (also known as “South Coast”) - \$1,613 million  
2 The CWEST model assumes that groundwater pumping would occur up to the  
3 amounts included in the UWMPs for wetter and drier conditions. As described  
4 above for agricultural production, it is assumed that full implementation of  
5 SGMA would not occur by 2030. Therefore, it was assumed that water users that  
6 are not currently operating groundwater resources in accordance with adjudication  
7 or other types of agreements, would not reduce groundwater use by 2030.

8 The IMPLAN model, described above, also is used to analyze changes in regional  
9 economics related to M&I water supplies. Increased costs of water supply are  
10 estimated from CWEST results. It is assumed that these costs must be passed on  
11 to regional water users. Regional water users are assumed to reduce their  
12 spending by an amount equal to the water supply cost increase. This reduced  
13 spending is distributed over regional industries according to coefficients provided  
14 by IMPLAN.

15 As described in this chapter, the CWEST and IMPLAN models are annual-time  
16 step models that use information from the monthly-time step model. The model  
17 results represent long-term responses and must be used in a comparative manner  
18 to reduce the effects of use of monthly assumptions and other assumptions that  
19 are indicative of real-time operations, but do not specific match real-time  
20 observations. The CalSim II model output includes minor fluctuations of up to  
21 5 percent due to model assumptions and approaches. Therefore, if the  
22 quantitative changes between a specific alternative and the No Action  
23 Alternative and/or Second Basis of Comparison are 5 percent or less, the  
24 conditions under the specific alternative would be considered to be “similar” to  
25 conditions under the No Action Alternative and/or Second Basis of Comparison.

26 **19.4.1.3 Changes in Local Government Finances**

27 Changes in CVP and SWP operations would not result in major changes in land  
28 use, as described in Chapter 13, Land Use. Therefore, changes to collection of  
29 local taxes and fees are not anticipated under the alternatives as compared to the  
30 No Action Alternative and the Second Basis of Comparison. Therefore, changes  
31 in local government finances are not evaluated in this EIS.

32 **19.4.1.4 Changes in Recreational Economics**

33 Reservoirs that store CVP and SWP water provide a wide diversity of recreational  
34 experiences on the water surface, as described in Chapter 15, Recreational  
35 Resources. However, changes to recreational economic opportunities under the  
36 alternatives primarily would occur due to changes in surface water elevations at  
37 San Luis Reservoir and reduced Striped Bass fishing opportunities under  
38 Alternatives 3 and 4.

39 This EIS does not quantitatively analyze potential changes in recreation user days  
40 or recreation spending because specific projects or responses to the changes in  
41 reservoir elevations are not considered under the purpose and need of this EIS.  
42 The qualitative analysis presented in this Chapter is based upon potential changes  
43 in recreational use related to changes under the alternatives as compared to the No

1 Action Alternative and the Second Basis of Comparison, as described in  
2 Chapter 15, Recreational Resources.

3 **19.4.1.5 Changes in Commercial, Sport, and Tribal Salmon Fishing**  
4 **Opportunities**

5 Changes in CVP and SWP operations under the alternatives could change the  
6 salmon population as compared to the No Action Alternative and the Second  
7 Basis of Comparison. Commercial, sport, and tribal fishing primarily relies upon  
8 Fall-run Chinook Salmon because the populations of other runs of salmon are  
9 substantially lower. Specific population changes for Fall-run Chinook Salmon are  
10 not projected in this EIS. Therefore, this Chapter presents a qualitative analysis  
11 of potential changes in socioeconomic factors under the alternatives as compared  
12 to the No Action Alternative and the Second Basis of Comparison.

13 **19.4.1.6 Effects of Cross Delta Water Transfers**

14 Historically water transfer programs have been developed on an annual basis.  
15 The demand for water transfers is dependent upon the availability of water  
16 supplies to meet water demands. Water transfer transactions have increased over  
17 time as CVP and SWP water supply availability has decreased, especially during  
18 drier water years.

19 Parties seeking water transfers generally acquire water from sellers who have  
20 available surface water who can make the water available through releasing  
21 previously stored water, pump groundwater instead of using surface water  
22 (groundwater substitution); idle crops; or substitute crops that uses less water in  
23 order to reduce normal consumptive use of surface water.

24 Water transfers using CVP and SWP Delta pumping plants and south of Delta  
25 canals generally occur when there is unused capacity in these facilities. These  
26 conditions generally occur drier water year types when the flows from upstream  
27 reservoirs plus unregulated flows are adequate to meet the Sacramento Valley  
28 water demands and the CVP and SWP export allocations. In non-wet years, the  
29 CVP and SWP water allocations would be less than full contract amounts;  
30 therefore, capacity may be available in the CVP and SWP conveyance facilities to  
31 move water from other sources.

32 Projecting future socioeconomic conditions related to water transfer activities is  
33 difficult because specific water transfer actions required to make the water  
34 available, convey the water, and/or use the water would change each year due to  
35 changing hydrological conditions, CVP and SWP water availability, specific local  
36 agency operations, and local cropping patterns. Reclamation recently prepared a  
37 long-term regional water transfer environmental document which evaluated  
38 potential changes in conditions related to water transfer actions (Reclamation  
39 2014c). Results from this analysis were used to inform the impact assessment of  
40 potential effects of water transfers under the alternatives as compared to the No  
41 Action Alternative and the Second Basis of Comparison.

1 **19.4.2 Conditions in Year 2030 without Implementation of**  
2 **Alternatives 1 through 5**

3 This EIS includes two bases of comparison, as described in Chapter 3,  
4 Description of Alternatives: the No Action Alternative and the Second Basis of  
5 Comparison. Both of these bases are evaluated at 2030 conditions. Changes that  
6 would occur over the next 15 years without implementation of the alternatives are  
7 not analyzed in this EIS. However, the changes to socioeconomics that are  
8 assumed to occur by 2030 under the No Action Alternative and the Second Basis  
9 of Comparison are summarized in this section. Many of the changed conditions  
10 would occur in the same manner under both the No Action Alternative and the  
11 Second Basis of Comparison.

12 **19.4.2.1 Common Changes in Conditions under the No Action**  
13 **Alternative and Second Basis of Comparison**

14 Conditions in 2030 would be different than existing conditions due to:

- 15 • Climate change and sea level rise  
16 • General plan development throughout California, including increased water  
17 demands in portions of Sacramento Valley  
18 • Implementation of reasonable and foreseeable water resources management  
19 projects to provide water supplies

20 It is anticipated that climate change would result in more short-duration high-  
21 rainfall events and less snowpack in the winter and early spring months. The  
22 reservoirs would be full more frequently by the end of April or May by 2030 than  
23 in recent historical conditions. However, as the water is released in the spring,  
24 there would be less snowpack to refill the reservoirs. This condition would  
25 reduce reservoir storage and available water supplies to downstream uses in the  
26 summer. The reduced end of September storage also would reduce the ability to  
27 release stored water to downstream regional reservoirs. These conditions would  
28 occur for all reservoirs in the California foothills and mountains, including  
29 non-CVP and SWP reservoirs.

30 These changes would result in a decline of the long-term average CVP and SWP  
31 water supply deliveries by 2030 as compared to recent historical long-term  
32 average deliveries under the No Action Alternative and the Second Basis of  
33 Comparison. However, the CVP and SWP water deliveries would be less under  
34 the No Action Alternative as compared to the Second Basis of Comparison, as  
35 described in Chapter 5, Surface Water Resources and Water Supplies, which  
36 could result in more crop idling.

37 Under the No Action Alternative and the Second Basis of Comparison, land uses  
38 in 2030 would occur in accordance with adopted general plans.

39 The No Action Alternative and the Second Basis of Comparison assumes  
40 completion of water resources management and environmental restoration  
41 projects that would have occurred without implementation of Alternatives 1  
42 through 5, including regional and local recycling projects, surface water and

1 groundwater storage projects, conveyance improvement projects, and desalination  
 2 projects, as described in Chapter 3, Description of Alternatives. The No Action  
 3 Alternative and the Second Basis of Comparison also assumes implementation of  
 4 actions included in the 2008 U.S. Fish and Wildlife Service (USFWS) Biological  
 5 Opinion (BO) and 2009 National Marine Fisheries Service (NMFS) BO that  
 6 would have been implemented without the BOs by 2030, as described in  
 7 Chapter 3, Description of Alternatives.

#### 8 **19.4.2.2 Population Projections under the No Action Alternative and** 9 **Second Basis of Comparison**

10 The 2030 population projections for each region addressed in this EIS are  
 11 presented in Tables 19.53 through 19.59.

12 **Table 19.53 Population Projections in Trinity River Region**

Area	Population		Average Annual Growth Rate (percent)
	2012	2030	2012-2030
Trinity County	13,471	15,309	0.7
Humboldt County	134,728	143,811	0.4
Del Norte County	28,527	31,252	0.5
Total Trinity River Region	176,726	190,373	0.4
<b>STATE OF CALIFORNIA</b>	<b>37,427,946</b>	<b>44,574,756</b>	<b>0.9</b>

13 Sources: DOF 2013a, 2013b, 2014

14 **Table 19.54 Population Projections in Central Valley Region – Sacramento Valley**

Area	Population		Average Annual Growth Rate (percent)
	2012	2030	2012-2030
Shasta County	177,516	210,997	0.9
Plumas County	19,901	20,390	0.1
Tehama County	62,985	75,522	1.0
Glenn County	28,105	33,318	0.9
Colusa County	21,552	28,112	1.4
Butte County	220,465	276,009	1.2
Yuba County	72,642	97,037	1.6
Nevada County	97,366	111,836	0.8
Sutter County	94,620	131,390	1.7
Placer County	351,463	454,124	1.4
El Dorado County	180,483	230,503	1.3
Sacramento Valley Subtotal	1,333,615	1,669,238	1.3
Total Central Valley Region	7,408,750	9,677,315	1.5
<b>STATE OF CALIFORNIA</b>	<b>37,668,804</b>	<b>44,574,756</b>	<b>0.9</b>

15 Sources: DOF 2013a, 2013b, 2014

1 **Table 19.55 Population Projections in Central Valley – San Joaquin Valley**

Area	Population		Average Annual Growth Rate (percent)
	2012	2030	2012-2030
Stanislaus County	519,339	666,446	1.4
Madera County	152,325	219,908	2.1
Merced County	260,029	359,798	1.8
Fresno County	943,493	1,232,151	1.5
Tulare County	451,540	636,606	1.9
Kings County	151,774	209,440	1.8
Kern County	849,977	1,276,155	2.3
San Joaquin Valley Subtotal	3,328,477	4,600,505	1.8
Total Central Valley Region	7,238,742	9,468,443	1.5
<b>STATE OF CALIFORNIA</b>	<b>37,668,804</b>	<b>44,574,756</b>	<b>0.9</b>

2 Sources: DOF 2013a, 2013b, 2014

3 **Table 19.56 Population Projections in Central Valley Region – Delta and Suisun Marsh**

Area	Population		Average Annual Growth Rate (percent)
	2012	2030	2012-2030
Sacramento County	1,433,525	1,731,061	1.1
Yolo County	204,349	250,420	1.1
Solano County	415,787	490,381	0.9
San Joaquin County	692,997	935,709	1.7
Contra Costa County	1,066,602	1,263,049	0.9
Delta and Suisun Marsh Subtotal	3,813,260	4,670,621	1.1
Total Central Valley Region	7,238,742	9,468,443	1.5
<b>STATE OF CALIFORNIA</b>	<b>37,668,804</b>	<b>44,574,756</b>	<b>0.9</b>

5 Sources: DOF 2013a, 2013b, 2014

1 **Table 19.57 Population Projections in San Francisco Bay Area Region**

Area	Population		Average Annual Growth Rate (percent)
	2012	2030	2012-2030
Alameda County	1,530,176	1,650,596	0.4
Santa Clara County	1,813,696	2,048,021	0.7
San Benito County	56,137	59,259	0.3
Napa County	137,731	158,538	0.8
Total San Francisco Bay Area Region	3,537,740	3,916,413	0.6
<b>STATE OF CALIFORNIA</b>	<b>37,668,804</b>	<b>44,574,756</b>	<b>0.9</b>

2 Sources: DOF 2013a, 2013b, 2014

3 **Table 19.58 Population Projections in Central Coast Region**

Area	Population		Average Annual Growth Rate (percent)
	2000	2030	2012-2030
San Luis Obispo County	271,502	311,388	0.8
Santa Barbara County	426,351	469,070	0.5
Total Central Coast Region	697,853	780,457	0.6
<b>STATE OF CALIFORNIA</b>	<b>37,668,804</b>	<b>44,574,756</b>	<b>0.9</b>

4 Sources: DOF 2013a, 2013b, 2014

5 **Table 19.59 Population Projections in Southern California Region**

Area	Population		Average Annual Growth Rate (percent)
	2012	2030	2012-2030
Ventura County	829,065	956,324	0.8
Los Angeles County	9,889,520	11,138,280	0.7
Orange County	3,057,879	3,385,762	0.6
San Diego County	3,128,734	3,665,358	0.9
Riverside County	2,234,193	3,145,948	1.9
San Bernardino County	2,059,699	2,588,990	1.3
Total Southern California Region	21,199,090	24,880,663	0.9
<b>STATE OF CALIFORNIA</b>	<b>37,668,804</b>	<b>44,574,756</b>	<b>0.9</b>

6 Sources: DOF 2013a, 2013b, 2014



1 **19.4.3 Evaluation of Alternatives**

2 Alternatives 1 through 5 have been compared to the No Action Alternative; and  
3 the No Action Alternative and Alternatives 1 through 5 have been compared to  
4 the Second Basis of Comparison.

5 During review of the numerical modeling analyses used in this EIS, an error was  
6 determined in the CalSim II model assumptions related to the Stanislaus River  
7 operations for the Second Basis of Comparison, Alternative 1, and Alternative 4  
8 model runs. Appendix 5C includes a comparison of the CalSim II model run  
9 results presented in this Chapter and CalSim II model run results with the error  
10 corrected. Appendix 5C also includes a discussion of changes in the comparison  
11 of groundwater conditions for the following Alternative analyses.

- 12 • No Action Alternative compared to the Second Basis of Comparison
- 13 • Alternative 1 compared to the No Action Alternative
- 14 • Alternative 3 compared to the Second Basis of Comparison
- 15 • Alternative 5 compared to the Second Basis of Comparison.

16 **19.4.3.1 No Action Alternative**

17 The No Action Alternative is compared to the Second Basis of Comparison.

18 **19.4.3.1.1 Trinity River Region**

19 *Regional Changes to Irrigated Agriculture*

20 There are no agricultural lands irrigated with CVP and SWP water supplies in the  
21 Trinity River Region. Therefore, there would be no changes in irrigated lands  
22 under the No Action Alternative as compared to the Second Basis of Comparison.

23 *Regional Changes to Municipal and Industrial Water Supplies*

24 The CVP would continue to release water in Trinity River for downstream  
25 beneficial uses, including water supplies under the No Action Alternative and the  
26 Second Basis of Comparison. There are no municipal and industrial CVP or SWP  
27 water service contractors in the Trinity River Region.

28 *Regional Changes to Recreational Opportunities*

29 Recreational opportunities would be similar in the Trinity River Region under the  
30 No Action Alternative as compared to the Second Basis of Comparison as  
31 described in Chapter 15, Recreational Resources.

32 *Regional Changes related to Changes in Salmon Fishing*

33 Trinity River flows would be similar under the No Action Alternative as  
34 compared to the Second Basis of Comparison. This could result in similar salmon  
35 harvest conditions by the Yurok and Hoopa Valley tribes.

36 **19.4.3.1.2 Central Valley Region**

37 *Regional Changes to Irrigated Agriculture*

38 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
39 and SWP water supplies would be less under the No Action Alternative than  
40 under the Second Basis of Comparison. It is anticipated that groundwater use

1 would increase in response to reduced CVP and SWP water supplies in 2030  
 2 because sustainable groundwater management plans would not be fully  
 3 implemented until the 2040s, as discussed in Chapter 12, Agricultural Resources.

4 The agricultural production value under long-term average conditions would be  
 5 reduced by less than 1 percent (\$1.6 million/year in the Sacramento Valley and  
 6 \$0.5 million/year in the San Joaquin Valley) primarily due to an increase in  
 7 groundwater pumping of approximately 6 percent. The agricultural production  
 8 value under dry and critical dry conditions also would be reduced by less than  
 9 1 percent (\$11.3 million/year in the Sacramento Valley and \$20.3 million/year in  
 10 the San Joaquin Valley) primarily due to an increase in groundwater pumping.

11 The overall reduction in agricultural production values are less than 0.05 percent  
 12 under long-term conditions; and, changes in employment and regional economic  
 13 output would be minimal. Therefore, the analysis of employment and regional  
 14 economic output is focused on dry and critical dry years.

15 The direct changes in agricultural production would result in changes to  
 16 employment and regional economic output in the Sacramento and San Joaquin  
 17 valleys, as summarized in Tables 19.60 and 19.61, respectively.

18 **Table 19.60 Changes in Agricultural-Related Employment and Regional Economic**  
 19 **Output for the Sacramento Valley under the No Action Alternative as Compared to**  
 20 **the Second Basis of Comparison in Dry and Critical Dry Years**

Economic Sectors	Employment				Economic Output (\$ millions)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	-87	-21	0	-108	-11.3	-1.3	0.0	-12.7
Mining & Logging	0	0	0	0	0.0	0.0	0.0	0.0
Construction	0	-1	0	-1	0.0	-0.1	0.0	-0.2
Manufacturing	0	0	0	0	0.0	-0.1	0.0	-0.1
Transportation, Warehousing & Utilities	0	-1	0	-2	0.0	-0.4	-0.1	-0.5
Wholesale Trade	0	-1	-1	-2	0.0	-0.2	-0.1	-0.3
Retail Trade	0	0	-4	-4	0.0	0.0	-0.3	-0.3
Information	0	0	0	0	0.0	0.0	-0.1	-0.1
Financial Activities	0	-7	-2	-9	0.0	-1.6	-0.8	-2.5
Services	0	-3	-12	-15	0.0	-0.3	-1.0	-1.3
Government	0	0	0	0	0.0	-0.1	0.0	-0.1
<b>Total</b>	<b>-87</b>	<b>-36</b>	<b>-19</b>	<b>-142</b>	<b>-11.3</b>	<b>-4.2</b>	<b>-2.5</b>	<b>-18.1</b>

1 **Table 19.61 Changes in Agricultural-Related Employment and Regional Economic**  
 2 **Output for the San Joaquin Valley under the No Action Alternative as Compared to**  
 3 **the Second Basis of Comparison in Dry and Critical Dry Years**

Economic Sectors	Employment				Economic Output (\$ millions)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	-139	-53	0	-192	-20.3	-2.3	-0.1	-22.7
Mining & Logging	0	-1	0	-1	0.0	-0.3	0.0	-0.3
Construction	0	-2	0	-2	0.0	-0.2	0.0	-0.2
Manufacturing	0	-1	0	-2	0.0	-1.8	-0.3	-2.1
Transportation, Warehousing & Utilities	0	-3	-1	-4	0.0	-0.8	-0.2	-1.0
Wholesale Trade	0	-2	-1	-3	0.0	-0.4	-0.2	-0.5
Retail Trade	0	0	-7	-8	0.0	0.0	-0.6	-0.6
Information	0	0	0	-1	0.0	-0.1	-0.1	-0.2
Financial Activities	0	-12	-3	-15	0.0	-2.7	-1.5	-4.1
Services	0	-5	-21	-26	0.0	-0.5	-1.7	-2.2
Government	0	-1	0	-1	0.0	-0.2	-0.1	-0.3
<b>Total</b>	<b>-139</b>	<b>-79</b>	<b>-35</b>	<b>-254</b>	<b>-20.3</b>	<b>-9.2</b>	<b>-4.9</b>	<b>-34.4</b>

4 As described in Chapter 11, Geology and Soils Resources, increased groundwater  
 5 pumping under the long-term average conditions may result in an additional  
 6 increment of subsidence in those areas within the Central Valley. The additional  
 7 amount of subsidence and the economic costs associated with it have not been  
 8 quantified in this EIS. However, total subsidence-related costs have been shown  
 9 to be substantial, as reported by Borchers et al. (2014) who estimated that the cost  
 10 of subsidence in San Joaquin Valley between 1955 and 1972 was more than  
 11 \$1.3 billion (in 2013 dollars). These estimates are based on the impacts to major  
 12 infrastructure in the region including the San Joaquin River, Delta Mendota  
 13 Canal, Friant-Kern Canal and San Luis Canal in addition to privately owned  
 14 infrastructure. The incremental subsidence-related costs, expressed on an annual  
 15 basis, could be an unknown fraction of that cumulative cost.

#### 16 *Regional Changes to Municipal and Industrial Water Supplies*

17 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
 18 and SWP water supplies would be less under the No Action Alternative than  
 19 under the Second Basis of Comparison. The analysis assumed CVP and SWP  
 20 water deliveries, as described in Chapter 5, and determined the need for new  
 21 water supplies, changes in water storage and groundwater pumping, water  
 22 transfers, water shortage costs, and excess water savings. The factors and basis of  
 23 the analysis are described in detail in Appendix 19A, CWEST Model. The  
 24 analysis assumes that no new annual transfer supplies would be implemented until  
 25 shortages were greater than 5 percent. The costs of these shortages are included

1 in the analysis. It is assumed that some communities that do not have  
 2 alternative water supplies (e.g., cities of Huron and Coalinga) and would utilize  
 3 water transfers.

4 The average annual water supply costs over the 81-year hydrologic period for  
 5 M&I water supplies are presented in Tables 19.62 and 19.63 for the Sacramento  
 6 and San Joaquin Valley, respectively.

7 **Table 19.62 Changes in Municipal and Industrial Water Supply Costs for the**  
 8 **Sacramento Valley under the No Action Alternative as Compared to the Second**  
 9 **Basis of Comparison**

Differences in Total	No Action Alternative	Second Basis of Comparison	Changes
Average Annual CVP/SWP Deliveries (TAF)	447	463	-16
Delivery Cost (\$1,000)	\$8,031	\$8,317	-\$287
Assumed New Supply Deliveries (TAF)	0	0	0
Annualized New Supply Costs (\$1,000)	\$0	\$0	\$0
Water Storage Costs (\$1,000)	\$0	\$0	\$0
Lost Water Sales Revenues (\$1,000)	\$213	\$207	\$6
Transfer Costs (\$1,000)	\$739	\$517	\$222
Shortage Costs (\$1,000)	\$69	\$68	\$1
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) (\$1,000)	-\$3,858	-\$3,916	\$58
Excess Water Savings (\$1,000)	-\$2,275	-\$2,563	\$288
<b>Average Annual Changes in Water Supply Costs (\$1,000)</b>	<b>\$2,919</b>	<b>\$2,630</b>	<b>\$288</b>

10 Note: In 2012 dollars

11 **Table 19.63 Changes in Municipal and Industrial Water Supply Costs for the San**  
 12 **Joaquin Valley under the No Action Alternative as Compared to the Second Basis**  
 13 **of Comparison**

Differences in Total	No Action Alternative	Second Basis of Comparison	Changes
Average Annual CVP/SWP Deliveries (TAF)	214	237	-23
Delivery Cost (\$1,000)	\$3,460	\$3,854	-\$394
Assumed New Supply Deliveries (TAF)	2	0	2
Annualized New Supply Costs (\$1,000)	\$429	\$15	\$414
Water Storage Costs (\$1,000)	\$942	\$820	\$122
Lost Water Sales Revenues (\$1,000)	\$361	\$322	\$39
Transfer Costs (\$1,000)	\$2,673	\$2,623	\$50
Shortage Costs (\$1,000)	\$115	\$102	\$13
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) (\$1,000)	-\$15,377	-\$16,011	\$634
Excess Water Savings (\$1,000)	-\$1,029	-\$1,318	\$289
<b>Average Annual Changes in Water Supply Costs (\$1,000)</b>	<b>-\$8,427</b>	<b>-\$9,593</b>	<b>\$1,166</b>

14 Note: In 2012 dollars

15 The changes in M&I water supply costs would result in changes to employment  
 16 and regional economic output in the Sacramento and San Joaquin valleys, as

1 summarized in Tables 19.64 and 19.65, respectively. The M&I average annual  
 2 water supply operating expenses would increase by 0.11 and 0.39 percent in the  
 3 Sacramento Valley and the San Joaquin Valley, respectively; and therefore, the  
 4 results would be similar.

5 **Table 19.64 Changes in Municipal and Industrial Water Supply Related**  
 6 **Employment and Regional Economic Output for the Sacramento Valley under the**  
 7 **No Action Alternative as Compared to the Second Basis of Comparison**

Economic Sectors	Employment				Economic Output (\$ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	0.1	-1.7	-1.6
Mining & Logging	0	0	0	0	0.0	0.4	-0.3	0.1
Construction	0	0	0	0	0.0	29.0	-2.5	26.5
Manufacturing	0	0	0	0	0.0	3.1	-22.2	-19.1
Transportation, Warehousing & Utilities	1	0	0	1	286.4	2.8	-18.0	271.2
Wholesale Trade	0	0	0	0	0.0	1.0	-27.1	-26.1
Retail Trade	0	0	-1	-1	0.0	0.9	-46.6	-45.6
Information	0	0	0	0	0.0	3.4	-20.6	-17.2
Financial Activities	0	0	0	0	0.0	13.0	-147.7	-134.6
Services	0	0	-2	-1	0.0	30.8	-154.7	-123.9
Government	0	0	0	0	0.0	0.2	-3.8	-3.7
<b>Total</b>	<b>1</b>	<b>1</b>	<b>-3</b>	<b>-1</b>	<b>286.4</b>	<b>84.8</b>	<b>-445.2</b>	<b>-74.0</b>

8 Note: In 2012 dollars

9 **Table 19.65 Changes in Municipal and Industrial Water Supply Related**  
 10 **Employment and Regional Economic Output for the San Joaquin Valley under the**  
 11 **No Action Alternative as Compared to the Second Basis of Comparison**

Economic Sectors	Employment				Economic Output (\$thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	0.0	-6.7	-6.7
Mining & Logging	0	0	0	0	0.0	-0.4	-6.4	-6.8
Construction	0	0	0	0	0.0	-13.3	-5.6	-18.9
Manufacturing	0	0	0	0	0.0	-1.4	-46.4	-47.8
Transportation, Warehousing & Utilities	-1	0	0	-1	-140.8	-1.4	-44.7	-186.9
Wholesale Trade	0	0	0	0	0.0	-0.4	-39.0	-39.3
Retail Trade	0	0	-1	-1	0.0	-0.4	-97.4	-97.8
Information	0	0	0	0	0.0	-1.0	-27.0	-28.0
Financial Activities	0	0	-1	-1	0.0	-4.3	-263.7	-268.0
Services	0	0	-3	-3	0.0	-11.7	-292.3	-303.9
Government	0	0	0	0	0.0	-0.1	-12.9	-13.0
<b>Total</b>	<b>-1</b>	<b>0</b>	<b>-6</b>	<b>-7</b>	<b>-140.8</b>	<b>-34.3</b>	<b>-842.0</b>	<b>-1,017.2</b>

12 Note:  
 13 In 2012 dollars

1 *Regional Changes to Recreational Opportunities*

2 Recreational opportunities would decrease at San Luis Reservoir by 6 percent  
3 under the No Action Alternative as compared to the Second Basis of Comparison,  
4 as described in Chapter 15, Recreation Resources. Therefore, it is anticipated that  
5 recreational economic factors would be reduced under the No Action  
6 Alternative as compared to the Second Basis of Comparison.

7 *Effects Related to Cross Delta Water Transfers*

8 Potential effects to socioeconomic factors could be similar to those identified in a  
9 recent environmental analysis conducted by Reclamation for long-term water  
10 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c).  
11 Potential effects to socioeconomic factors were identified as adverse in the  
12 seller's service area related to loss of income to farm workers and the associated  
13 agriculturally-related businesses and retail enterprises if crop idling methods were  
14 used to provide transfer water. The analysis also identified that local sales taxes  
15 could decline due to the loss of household income. If groundwater substitution  
16 was used to provide transfer water, agricultural production values could decline  
17 due to additional cost of pumping. However, income from the water transfer  
18 could increase operating income for the sellers. The regional impact would  
19 depend upon the extent of lands involved in the water transfer program in any  
20 specific year.

21 Under the No Action Alternative, the timing of cross Delta water transfers would  
22 be limited to July through September and include annual volumetric limits, in  
23 accordance with the 2008 USFWS BO and 2009 NMFS BO. Under the Second  
24 Basis of Comparison, water could be transferred throughout the year without an  
25 annual volumetric limit. Overall, the potential for cross Delta water transfers  
26 would be less under the No Action Alternative than under the Second Basis of  
27 Comparison.

28 **19.4.3.1.3 San Francisco Bay Area Region**

29 *Regional Changes to Irrigated Agriculture*

30 It is anticipated that as in the Central Valley Region, reductions in CVP and SWP  
31 water supplies within the San Francisco Bay Area Region would not result in  
32 reductions in long-term irrigated acreage or land use changes due to the use of  
33 other water supplies. However, there could be a reduction in irrigated acreage in  
34 dry and critical dry years under the No Action Alternative as compared to the  
35 Second Basis of Comparison.

36 *Regional Changes to Municipal and Industrial Water Supplies*

37 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
38 and SWP water supplies would be less under the No Action Alternative than  
39 under the Second Basis of Comparison. The analysis assumed CVP and SWP  
40 water deliveries, as described in Chapter 5, and determined the need for new  
41 water supplies, changes in water storage and groundwater pumping, water  
42 transfers, water shortage costs, and excess water savings. The factors and basis of  
43 the analysis is described in detail in Appendix 19A, CWEST Model. The analysis

1 assumes that no new annual transfer supplies would be implemented until  
 2 shortages were greater than 5 percent. The costs of these shortages are included  
 3 in the analysis.

4 The average annual water supply operating expenses over the 81-year hydrologic  
 5 period for M&I water supplies would increase by \$7.276 million, or 1.75 percent,  
 6 as presented in Table 19.66; and therefore, the results would be similar under the  
 7 No Action Alternative and Second Basis of Comparison.

8 **Table 19.66 Changes in Municipal and Industrial Water Supply Costs for the San**  
 9 **Francisco Bay Area Region under the No Action Alternative as Compared to the**  
 10 **Second Basis of Comparison**

Differences in Total	No Action Alternative	Second Basis of Comparison	Changes
Average Annual CVP/SWP Deliveries (TAF)	396	445	-48
Delivery Cost (\$1,000)	\$11,044	\$12,515	-\$1,471
Assumed New Supply Deliveries (TAF)	18	16	2
Annualized New Supply Costs (\$1,000)	\$599	\$234	\$365
Water Storage Costs (\$1,000)	\$1,577	\$1,963	-\$386
Lost Water Sales Revenues (\$1,000)	\$4,286	\$1,595	\$2,691
Transfer Costs (\$1,000)	\$5,722	\$1,154	\$4,568
Shortage Costs (\$1,000)	\$1,410	\$523	\$887
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) (\$1,000)	-\$493	-\$792	\$298
Excess Water Savings (\$1,000)	-\$225	-\$549	\$324
<b>Average Annual Changes in Water Supply Costs (\$1,000)</b>	<b>\$23,919</b>	<b>\$16,643</b>	<b>\$7,276</b>

11 Note: In 2012 dollars

12 The changes in M&I water supply costs would result in changes to employment  
 13 and regional economic output, as summarized in Table 19.67.

1 **Table 19.67 Changes in Municipal and Industrial Water Supply Related**  
 2 **Employment and Regional Economic Output for the San Francisco Bay Area**  
 3 **Region under the No Action Alternative as Compared to the Second Basis of**  
 4 **Comparison**

Economic Sectors	Employment				Economic Output (\$ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	0.1	-7.9	-7.8
Mining & Logging	0	0	0	0	0.0	1.6	-5.0	-3.4
Construction	0	1	0	1	0.0	158.8	-37.1	121.7
Manufacturing	0	0	0	0	0.0	28.8	-478.0	-449.1
Transportation, Warehousing & Utilities	5	0	-1	4	1,492.4	11.2	-183.5	1,320.1
Wholesale Trade	0	0	-1	-1	0.0	5.0	-350.6	-345.7
Retail Trade	0	0	-6	-6	0.0	4.2	-567.2	-563.0
Information	0	0	-1	-1	0.0	16.8	-306.6	-289.8
Financial Activities	0	0	-5	-4	0.0	55.8	-1,740.5	-1,684.7
Services	0	1	-20	-19	0.0	133.7	-2,162.8	-2,029.1
Government	0	0	0	0	0.0	0.7	-55.1	-54.4
<b>Total</b>	<b>5</b>	<b>3</b>	<b>-35</b>	<b>-27</b>	<b>1,492.4</b>	<b>416.7</b>	<b>-5,894.3</b>	<b>-3,985.2</b>

5 Note: In 2012 dollars

6 *Regional Changes to Recreational Opportunities*

7 Changes in CVP and SWP water supplies and operations under the No Action  
 8 Alternative as compared to the Second Basis of Comparison generally would  
 9 result in lower reservoir elevations in reservoirs (up to 10 to 18 percent) that store  
 10 CVP and SWP water; and would result in reduced recreational economic factors  
 11 under the No Action Alternative as compared to the Second Basis of Comparison.

12 *Regional Changes to Salmon Fishing*

13 Changes in commercial and sport ocean salmon fishing primarily would be  
 14 related to the presence of fall-run Chinook Salmon from Central Valley  
 15 hatcheries. It is assumed that the production of hatchery fish would be similar  
 16 under the No Action Alternative and the Second Basis of Comparison. However,  
 17 survival of the fall-run Chinook Salmon hatchery fish to the Pacific Ocean could  
 18 be related to changes in CVP and SWP operations. As described in Chapter 9,  
 19 Fish and Aquatic Resources, there would be little change in through-Delta  
 20 survival by emigrating natural juvenile fall-run Chinook Salmon under the No  
 21 Action Alternative as compared to the Second Basis of Comparison. It is  
 22 assumed that the survival of the hatchery juvenile fall-run Chinook Salmon would  
 23 be similar to the survival of the natural juvenile fall-run Chinook Salmon.  
 24 Therefore, the availability of fish for commercial and sport ocean salmon fishing  
 25 and the associated economic conditions for the fishing industry would be similar  
 26 under the No Action Alternative and the Second Basis of Comparison.



1 **19.4.3.1.4 Central Coast Region**

2 *Regional Changes to Irrigated Agriculture*

3 It is anticipated that as in the Central Valley Region, reductions in CVP and SWP  
 4 water supplies within the Central Coast Region would not result in reductions in  
 5 long-term irrigated acreage or land use changes due to the use of other water  
 6 supplies. However, there could be a reduction in irrigated acreage in dry and  
 7 critical dry years under the No Action Alternative as compared to the Second  
 8 Basis of Comparison.

9 *Regional Changes to Municipal and Industrial Water Supplies*

10 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
 11 and SWP water supplies would be less under the No Action Alternative than  
 12 under the Second Basis of Comparison. The analysis assumed CVP and SWP  
 13 water deliveries, as described in Chapter 5, and determined the need for new  
 14 water supplies, changes in water storage and groundwater pumping, water  
 15 transfers, water shortage costs, and excess water savings. The factors and basis of  
 16 the analysis is described in detail in Appendix 19A, CWEST Model. The analysis  
 17 assumes that no new annual transfer supplies would be implemented until  
 18 shortages were greater than 5 percent. The costs of these shortages are included  
 19 in the analysis. It is assumed that some communities that do not have  
 20 alternative water supplies would utilize water transfers.

21 The average annual water supply operating expenses over the 81-year hydrologic  
 22 period for M&I water supplies would increase by 0.7 percent, as presented in  
 23 Table 19.68; and therefore, the results would be similar under the No Action  
 24 Alternative and Second Basis of Comparison.

25 **Table 19.68 Changes in Municipal and Industrial Water Supply Costs for the**  
 26 **Central Coast Region under the No Action Alternative as Compared to the Second**  
 27 **Basis of Comparison**

Differences in Total	No Action Alternative	Second Basis of Comparison	Changes
Average Annual CVP/SWP Deliveries (TAF)	44	54	-10
Delivery Cost (\$1,000)	\$6,663	\$8,174	-\$1,510
Assumed New Supply Deliveries (TAF)	0	0	0
Annualized New Supply Costs (\$1,000)	\$0	\$0	\$0
Water Storage Costs (\$1,000)	\$0	\$0	\$0
Lost Water Sales Revenues (\$1,000)	\$0	\$0	\$0
Transfer Costs (\$1,000)	\$0	\$0	\$0
Shortage Costs (\$1,000)	\$0	\$0	\$0
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) (\$1,000)	-\$8,068	-\$8,643	\$575
Excess Water Savings (\$1,000)	-\$2,970	-\$4,176	\$1,206
<b>Average Annual Changes in Water Supply Costs (\$1,000)</b>	<b>-\$4,374</b>	<b>-\$4,645</b>	<b>\$271</b>

28 Note: In 2012 dollars

1 The changes in M&I water supply costs would result in changes to employment  
 2 and regional economic output, as summarized in Table 19.69.

3 **Table 19.69 Changes in Municipal and Industrial Water Supply Related**  
 4 **Employment and Regional Economic Output for the Central Coast Region under**  
 5 **the No Action Alternative as Compared to the Second Basis of Comparison**

Economic Sectors	Employment				Economic Output (\$ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	0.6	-4.0	-3.4
Mining & Logging	0	0	0	0	0.0	6.4	-9.3	-2.9
Construction	0	2	0	2	0.0	201.9	-9.7	192.2
Manufacturing	0	0	0	0	0.0	26.8	-51.8	-25.0
Transportation, Warehousing & Utilities	6	0	0	6	1,510.8	17.0	-56.2	1,471.6
Wholesale Trade	0	0	0	0	0.0	4.8	-58.6	-53.8
Retail Trade	0	0	-1	-1	0.0	6.1	-118.5	-112.4
Information	0	0	0	0	0.0	12.0	-39.0	-27.0
Financial Activities	0	0	-1	-1	0.0	68.9	-352.0	-283.2
Services	0	2	-5	-3	0.0	167.1	-447.4	-280.3
Government	0	0	0	0	0.0	0.9	-13.2	-12.3
<b>Total</b>	<b>6</b>	<b>4</b>	<b>-8</b>	<b>2</b>	<b>1,510.8</b>	<b>512.7</b>	<b>-1,159.9</b>	<b>863.6</b>

6 Note: In 2012 dollars

7 *Regional Changes to Recreational Opportunities*

8 Changes in CVP and SWP water supplies and operations under the No Action  
 9 Alternative as compared to the Second Basis of Comparison generally would  
 10 result in lower reservoir elevations in reservoirs that store CVP and SWP water  
 11 (up to 10 to 18 percent) that store CVP and SWP water; and would result in  
 12 reduced recreational economic factors under the No Action Alternative as  
 13 compared to the Second Basis of Comparison..

14 **19.4.3.1.5 Southern California Region**

15 *Regional Changes to Irrigated Agriculture*

16 It is anticipated that as in the Central Valley Region, reductions in CVP and SWP  
 17 water supplies within the Southern California Region would not result in  
 18 reductions in long-term irrigated acreage or land use changes due to the use of  
 19 other water supplies. However, there could be a reduction in irrigated acreage in  
 20 dry and critical dry years under the No Action Alternative as compared to the  
 21 Second Basis of Comparison.

22 *Regional Changes to Municipal and Industrial Water Supplies*

23 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
 24 and SWP water supplies would be less under the No Action Alternative than  
 25 under the Second Basis of Comparison. The analysis assumed CVP and SWP

1 water deliveries, as described in Chapter 5, and determined the need for new  
 2 water supplies, changes in water storage and groundwater pumping, water  
 3 transfers, water shortage costs, and excess water savings. The factors and basis of  
 4 the analysis is described in detail in Appendix 19A, CWEST Model. The analysis  
 5 assumes that no new annual transfer supplies would be implemented until  
 6 shortages were greater than 5 percent. The costs of these shortages are included  
 7 in the analysis. It is assumed that some communities that do not have  
 8 alternative water supplies would utilize water transfers.

9 The average annual water supply costs over the 81-year hydrologic period for  
 10 M&I water supplies would increase by 2.14 percent, as presented in Table 19.70;  
 11 and therefore, the results would be similar under the No Action Alternative and  
 12 Second Basis of Comparison.

13 **Table 19.70 Changes in Municipal and Industrial Water Supply Costs for the**  
 14 **Southern California Region under the No Action Alternative as Compared to the**  
 15 **Second Basis of Comparison**

Differences in Total	No Action Alternative	Second Basis of Comparison	Changes
Average Annual CVP/SWP Deliveries (TAF)	1,932	2,394	-461
Delivery Cost (\$1,000)	\$239,692	\$296,795	-\$57,103
Assumed New Supply Deliveries (TAF)	47	11	35
Annualized New Supply Costs (\$1,000)	\$12,688	\$4,032	\$8,656
Water Storage Costs (\$1,000)	\$7,598	\$2,824	\$4,774
Lost Water Sales Revenues (\$1,000)	\$14,614	\$1,119	\$13,495
Transfer Costs (\$1,000)	\$11,484	\$3,705	\$7,779
Shortage Costs (\$1,000)	\$17,319	\$353	\$16,966
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) (\$1,000)	-\$57,474	-\$91,507	\$34,033
Excess Water Savings (\$1,000)	-\$4,629	-\$10,573	\$5,944
<b>Average Annual Changes in Water Supply Costs (\$1,000)</b>	<b>\$241,291</b>	<b>\$206,749</b>	<b>\$34,542</b>

16 Note: In 2012 dollars

17 The changes in M&I water supply costs would result in changes to employment  
 18 and regional economic output, as summarized in Table 19.71.

1 **Table 19.71 Changes in Municipal and Industrial Water Supply Related**  
 2 **Employment and Regional Economic Output for the Southern California Region**  
 3 **under the No Action Alternative as Compared to the Second Basis of Comparison**

Economic Sectors	Employment				Economic Output (\$ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	2	0	0.0	-12.5	272.7	260.2
Mining & Logging	0	-1	1	0	0.0	-164.2	369.0	204.8
Construction	0	-43	3	0	0.0	-5,205.5	395.5	-4,810.0
Manufacturing	0	-2	10	0	0.0	-1,452.6	6,814.5	5,361.9
Transportation, Warehousing & Utilities	-175	-2	12	-175	-43,673.4	-592.0	2,602.9	-41,662.5
Wholesale Trade	0	-1	20	0	0.0	-275.3	4,339.0	4,063.8
Retail Trade	0	-2	58	0	0.0	-170.6	5,106.3	4,935.7
Information	0	-1	6	0	0.0	-637.5	2,962.1	2,324.6
Financial Activities	0	-9	52	0	0.0	-2,528.7	17,797.9	15,269.1
Services	0	-46	212	0	0.0	-5,542.2	20,430.6	14,888.4
Government	0	0	3	0	0.0	-29.8	587.3	557.5
<b>Total</b>	<b>-175</b>	<b>-108</b>	<b>378</b>	<b>-175</b>	<b>-43,673.4</b>	<b>-16,611.0</b>	<b>61,677.8</b>	<b>1,393.5</b>

4 Note: In 2012 dollars

5 *Regional Changes to Recreational Opportunities*

6 Changes in CVP and SWP water supplies and operations under the No Action  
 7 Alternative as compared to the Second Basis of Comparison generally would  
 8 result in lower reservoir elevations in reservoirs that store CVP and SWP water,  
 9 (up to 10 to 18 percent) that store CVP and SWP water; and would result in  
 10 reduced recreational economic factors under the No Action Alternative as  
 11 compared to the Second Basis of Comparison..

12 **19.4.3.2 Alternative 1**

13 As described in Chapter 3, Description of Alternatives, Alternative 1 is identical  
 14 to the Second Basis of Comparison. As described in Chapter 4, Approach to  
 15 Environmental Analysis, Alternative 1 as compared to the No Action  
 16 Alternative and the Second Basis of Comparison. However, because  
 17 socioeconomic factors under Alternative 1 are identical to socioeconomic factors  
 18 under the Second Basis of Comparison; Alternative 1 is only compared to the No  
 19 Action Alternative.

20 **19.4.3.2.1 Alternative 1 Compared to the No Action Alternative**

21 *Trinity River Region*

22 *Regional Changes to Irrigated Agriculture*

23 There are no agricultural lands irrigated with CVP and SWP water supplies in the  
 24 Trinity River Region. Therefore, there would be no changes in irrigated lands  
 25 under Alternative 1 as compared to the No Action Alternative.

1        *Regional Changes to Municipal and Industrial Water Supplies*

2        The CVP would continue to release water in Trinity River for downstream  
3        beneficial uses, including water supplies under Alternative 1 as compared to the  
4        No Action Alternative. There are no CVP or SWP water contractors in the  
5        Trinity River Region.

6        *Regional Changes to Recreational Opportunities*

7        Recreational opportunities would be similar in the Trinity River Region under  
8        Alternative 1 as compared to the No Action Alternative as described in  
9        Chapter 15, Recreational Resources.

10       *Regional Changes to Salmon Fishing*

11       Trinity River flows would be similar under Alternative 1 as compared to the No  
12       Action Alternative. This could result in similar salmon harvest conditions by the  
13       Yurok and Hoopa Valley tribes.

14       *Central Valley Region*

15       *Regional Changes to Irrigated Agriculture*

16       As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
17       and SWP water supplies would be greater under Alternative 1 as compared to the  
18       No Action Alternative. It is anticipated that groundwater use would decrease in  
19       response to increased CVP and SWP water supplies in 2030; and sustainable  
20       groundwater management plans would not be fully implemented until the 2040s,  
21       as discussed in Chapter 12, Agricultural Resources.

22       The agricultural production value under long-term average conditions would be  
23       increased by less than 1 percent (\$1.6 million/year in the Sacramento Valley and  
24       \$0.5 million/year in the San Joaquin Valley) primarily due to a decrease in  
25       groundwater pumping of approximately 7 percent. The agricultural production  
26       value under dry and critical dry conditions also would be increased by less than  
27       1 percent (\$11.3 million/year in the Sacramento Valley and \$20.3 million/year in  
28       the San Joaquin Valley) primarily due to a decrease in groundwater pumping.

29       The overall increase in agricultural production values are less than 0.05 percent  
30       under long-term conditions; and, changes in employment and regional economic  
31       output would be minimal. Therefore, the analysis of employment and regional  
32       economic output is focused on dry and critical dry years.

33       The direct changes in agricultural production would result in changes to  
34       employment and regional economic output in the Sacramento and San Joaquin  
35       valleys, as summarized in Tables 19.72 and 19.73, respectively.

1 **Table 19.72 Changes in Agricultural-Related Employment and Regional Economic**  
 2 **Output for the Sacramento Valley under Alternative 1 as compared to the No**  
 3 **Action Alternative in Dry and Critical Dry Years**

Economic Sectors	Employment				Economic Output (\$ millions)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	87	21	0	108	11.3	1.3	0	12.7
Mining & Logging	0	0	0	0	0	0	0	0
Construction	0	1	0	1	0	0.1	0	0.2
Manufacturing	0	0	0	0	0	0.1	0	0.1
Transportation, Warehousing & Utilities	0	1	0	2	0	0.4	0.1	0.5
Wholesale Trade	0	1	1	2	0	0.2	0.1	0.3
Retail Trade	0	0	4	4	0	0	0.3	0.3
Information	0	0	0	0	0	0	0.1	0.1
Financial Activities	0	7	2	9	0	1.6	0.8	2.5
Services	0	3	12	15	0	0.3	1	1.3
Government	0	0	0	0	0	0.1	0	0.1
<b>Total</b>	<b>87</b>	<b>36</b>	<b>19</b>	<b>142</b>	<b>11.3</b>	<b>4.2</b>	<b>2.5</b>	<b>18.1</b>

4 Note: In 2012 dollars.

5 **Table 19.73 Changes in Agricultural-Related Employment and Regional Economic**  
 6 **Output for the San Joaquin Valley under Alternative 1 as compared to the No**  
 7 **Action Alternative in Dry and Critical Dry Years**

Economic Sectors	Employment				Economic Output (\$ millions)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	139	53	0	192	20.3	2.3	0.1	22.7
Mining & Logging	0	1	0	1	0	0.3	0	0.3
Construction	0	2	0	2	0	0.2	0	0.2
Manufacturing	0	1	0	2	0	1.8	0.3	2.1
Transportation, Warehousing & Utilities	0	3	1	4	0	0.8	0.2	1
Wholesale Trade	0	2	1	3	0	0.4	0.2	0.5
Retail Trade	0	0	7	8	0	0	0.6	0.6
Information	0	0	0	1	0	0.1	0.1	0.2
Financial Activities	0	12	3	15	0	2.7	1.5	4.1
Services	0	5	21	26	0	0.5	1.7	2.2
Government	0	1	0	1	0	0.2	0.1	0.3
<b>Total</b>	<b>139</b>	<b>79</b>	<b>35</b>	<b>254</b>	<b>20.3</b>	<b>9.2</b>	<b>4.9</b>	<b>34.4</b>

8 Note: In 2012 dollars.

1 As described in Chapter 11, Geology and Soils Resources, increased groundwater  
2 pumping under the long-term average conditions may result in an additional  
3 increment of subsidence in those areas within the Central Valley. The additional  
4 amount of subsidence and the economic costs associated with it have not been  
5 quantified in this EIS. However, total subsidence-related costs have been shown  
6 to be substantial, as reported by Borchers et al. (2014) who estimated that the cost  
7 of subsidence in San Joaquin Valley between 1955 and 1972 was more than  
8 \$1.3 billion (in 2013 dollars). These estimates are based on the impacts to major  
9 infrastructure in the region including the San Joaquin River, Delta Mendota  
10 Canal, Friant-Kern Canal and San Luis Canal in addition to privately owned  
11 infrastructure. The incremental subsidence-related costs, expressed on an annual  
12 basis, could be an unknown fraction of that cumulative cost.

13 *Regional Changes to Municipal and Industrial Water Supplies*

14 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
15 and SWP water supplies would increase under Alternative 1 as compared to the  
16 No Action Alternative. The analysis assumed CVP and SWP water deliveries, as  
17 described in Chapter 5, and determined the need for new water supplies, changes  
18 in water storage and groundwater pumping, water transfers, water shortage costs,  
19 and excess water savings. The factors and basis of the analysis are described in  
20 detail in Appendix 19A, CWEST Model. The analysis assumes that no new  
21 annual transfer supplies would be implemented until shortages were greater than  
22 5 percent. The costs of these shortages are included in the analysis. It is assumed  
23 that some communities that do not have alternative water supplies would utilize  
24 water transfers.

25 The average annual water supply costs over the 81-year hydrologic period for  
26 M&I water supplies are presented in Tables 19.74 and 19.75 for the Sacramento  
27 and San Joaquin Valley, respectively. The average annual water supply operating  
28 expenses would decrease by 0.11 and 0.39 percent in the Sacramento Valley and  
29 the San Joaquin Valley, respectively; and therefore, the results would be similar  
30 under Alternative 1 and the No Action Alternative.

1 **Table 19.74 Changes in Municipal and Industrial Water Supply Costs for the**  
 2 **Sacramento Valley under Alternative 1 as compared to the No Action Alternative**

Differences in Total	Alternative 1	No Action Alternative	Changes
Average Annual CVP/SWP Deliveries (TAF)	463	447	16
Delivery Cost (\$1,000)	\$8,317	\$8,031	\$287
Assumed New Supply Deliveries (TAF)	0	0	0
Annualized New Supply Costs (\$1,000)	\$0	\$0	\$0
Water Storage Costs (\$1,000)	\$0	\$0	\$0
Lost Water Sales Revenues (\$1,000)	\$207	\$213	-\$6
Transfer Costs (\$1,000)	\$517	\$739	-\$222
Shortage Costs (\$1,000)	\$68	\$69	-\$1
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) (\$1,000)	-\$3,916	-\$3,858	-\$58
Excess Water Savings (\$1,000)	-\$2,563	-\$2,275	-\$288
<b>Average Annual Changes in Water Supply Costs (\$1,000)</b>	<b>\$2,630</b>	<b>\$2,919</b>	<b>-\$288</b>

3 Note: In 2012 dollars

4 **Table 19.75 Changes in Municipal and Industrial Water Supply Costs for the San**  
 5 **Joaquin Valley under Alternative 1 as compared to the No Action Alternative**

Differences in Total	Alternative 1	No Action Alternative	Changes
Average Annual CVP/SWP Deliveries (TAF)	237	214	23
Delivery Cost (\$1,000)	\$3,854	\$3,460	\$394
Assumed New Supply Deliveries (TAF)	0	2	-2
Annualized New Supply Costs (\$1,000)	\$15	\$429	-\$414
Water Storage Costs (\$1,000)	\$820	\$942	-\$122
Lost Water Sales Revenues (\$1,000)	\$322	\$361	-\$39
Transfer Costs (\$1,000)	\$2,623	\$2,673	-\$50
Shortage Costs (\$1,000)	\$102	\$115	-\$13
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) (\$1,000)	-\$16,011	-\$15,377	-\$634
Excess Water Savings (\$1,000)	-\$1,318	-\$1,029	-\$289
<b>Average Annual Changes in Water Supply Costs (\$1,000)</b>	<b>-\$9,593</b>	<b>-\$8,427</b>	<b>-\$1,166</b>

6 The changes in M&I water supply costs would result in changes to employment  
 7 and regional economic output in the Sacramento and San Joaquin valleys, as  
 8 summarized in Tables 19.76 and 19.77, respectively.



1 **Table 19.76 Changes in Municipal and Industrial Water Supply Related**  
 2 **Employment and Regional Economic Output for the Sacramento Valley under**  
 3 **Alternative 1 as compared to the No Action Alternative**

Economic Sectors	Employment				Economic Output (\$ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	-0.1	1.7	1.6
Mining & Logging	0	0	0	0	0.0	-0.4	0.3	-0.1
Construction	0	0	0	0	0.0	-29.0	2.5	-26.5
Manufacturing	0	0	0	0	0.0	-3.1	22.2	19.1
Transportation, Warehousing & Utilities	-1	0	0	-1	-286.4	-2.8	18.0	-271.2
Wholesale Trade	0	0	0	0	0.0	-1.0	27.1	26.1
Retail Trade	0	0	1	1	0.0	-0.9	46.6	45.6
Information	0	0	0	0	0.0	-3.4	20.6	17.2
Financial Activities	0	0	0	0	0.0	-13.0	147.7	134.6
Services	0	0	2	-1	0.0	-30.8	154.7	123.9
Government	0	0	0	0	0.0	-0.2	3.8	3.7
<b>Total</b>	<b>-1</b>	<b>-1</b>	<b>3</b>	<b>-1</b>	<b>-286.4</b>	<b>-84.8</b>	<b>445.2</b>	<b>74.0</b>

4 Note: In 2012 dollars

5 **Table 19.77 Changes in Municipal and Industrial Water Supply Related**  
 6 **Employment and Regional Economic Output for the San Joaquin Valley under**  
 7 **Alternative 1 as compared to the No Action Alternative**

Economic Sectors	Employment				Economic Output (\$ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	0.0	6.7	6.7
Mining & Logging	0	0	0	0	0.0	0.4	6.4	6.8
Construction	0	0	0	0	0.0	13.3	5.6	18.9
Manufacturing	0	0	0	0	0.0	1.4	46.4	47.8
Transportation, Warehousing & Utilities	1	0	0	1	140.8	1.4	44.7	186.9
Wholesale Trade	0	0	0	0	0.0	0.4	39.0	39.3
Retail Trade	0	0	1	1	0.0	0.4	97.4	97.8
Information	0	0	0	0	0.0	1.0	27.0	28.0
Financial Activities	0	0	1	1	0.0	4.3	263.7	268.0
Services	0	0	3	3	0.0	11.7	292.3	303.9
Government	0	0	0	0	0.0	0.1	12.9	13.0
<b>Total</b>	<b>1</b>	<b>0</b>	<b>6</b>	<b>7</b>	<b>140.8</b>	<b>34.3</b>	<b>842.0</b>	<b>1,017.2</b>

8 Note: In 2012 dollars

9 *Regional Changes to Recreational Opportunities*

10 Recreational opportunities would increase at San Luis Reservoir by 6 percent  
 11 under Alternative 1 as compared to the No Action Alternative, as described in  
 12 Chapter 15, Recreation Resources. Therefore, it is anticipated that recreational

1 economic factors would be increased under Alternative 1 as compared to the No  
2 Action Alternative.

3 *Effects Related to Cross Delta Water Transfers*

4 Potential effects to socioeconomic factors could be similar to those identified in a  
5 recent environmental analysis conducted by Reclamation for long-term water  
6 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as  
7 described above under the No Action Alternative compared to the Second Basis  
8 of Comparison. For the purposes of this EIS, it is anticipated that similar  
9 conditions would occur during implementation of cross Delta water transfers  
10 under Alternative 1 and the No Action Alternative, and that impacts on  
11 socioeconomic factors could be adverse in the seller's service area.

12 Under Alternative 1, water could be transferred throughout the year without an  
13 annual volumetric limit. Under the No Action Alternative, the timing of cross  
14 Delta water transfers would be limited to July through September and include  
15 annual volumetric limits, in accordance with the 2008 USFWS BO and 2009  
16 NMFS BO. Overall, the potential for cross Delta water transfers would be  
17 increased under Alternative 1 as compared to the No Action Alternative.

18 *San Francisco Bay Area Region*

19 *Regional Changes to Irrigated Agriculture*

20 It is anticipated that as in the Central Valley Region, increases in CVP and SWP  
21 water supplies within the San Francisco Bay Area Region would not result in  
22 changes in long-term irrigated acreage or land use changes due to the use of other  
23 water supplies. However, there could be an increase in irrigated acreage in dry  
24 and critical dry years under Alternative 1 as compared to the No Action  
25 Alternative.

26 *Regional Changes to Municipal and Industrial Water Supplies*

27 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
28 and SWP water supplies would increase under Alternative 1 as compared to the  
29 No Action Alternative. The analysis assumed CVP and SWP water deliveries, as  
30 described in Chapter 5, and determined the need for new water supplies, changes  
31 in water storage and groundwater pumping, water transfers, water shortage costs,  
32 and excess water savings. The factors and basis of the analysis is described in  
33 detail in Appendix 19A, CWEST Model. The analysis assumes that no new  
34 annual transfer supplies would be implemented until shortages were greater than  
35 5 percent. The costs of these shortages are included in the analysis.

36 The average annual water supply operating expenses over the 81-year hydrologic  
37 period for M&I water supplies would decrease by 1.75 percent, as presented in  
38 Table 19.78; and therefore, the results would be similar under Alternative 1 and  
39 the No Action Alternative.

1 **Table 19.78 Changes in Municipal and Industrial Water Supply Costs for the San**  
 2 **Francisco Bay Area Region under Alternative 1 as compared to the No Action**  
 3 **Alternative**

Differences in Total	Alternative 1	No Action Alternative	Changes
Average Annual CVP/SWP Deliveries (TAF)	445	396	48
Delivery Cost (\$1,000)	\$12,515	\$11,044	\$1,471
Assumed New Supply Deliveries (TAF)	16	18	-2
Annualized New Supply Costs (\$1,000)	\$234	\$599	-\$365
Water Storage Costs (\$1,000)	\$1,963	\$1,577	\$386
Lost Water Sales Revenues (\$1,000)	\$1,595	\$4,286	-\$2,691
Transfer Costs (\$1,000)	\$1,154	\$5,722	-\$4,568
Shortage Costs (\$1,000)	\$523	\$1,410	-\$887
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) (\$1,000)	-\$792	-\$493	-\$298
Excess Water Savings (\$1,000)	-\$549	-\$225	-\$324
<b>Average Annual Changes in Water Supply Costs (\$1,000)</b>	<b>\$16,643</b>	<b>\$23,919</b>	<b>-\$7,276</b>

4 Note: In 2012 dollars

5 The changes in M&I water supply costs would result in changes to employment  
 6 and regional economic output, as summarized in Table 19.79.

7 **Table 19.79 Changes in Municipal and Industrial Water Supply Related**  
 8 **Employment and Regional Economic Output for the San Francisco Bay Area**  
 9 **Region under Alternative 1 as compared to the No Action Alternative**

Economic Sectors	Employment				Economic Output (\$ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	-0.1	7.9	7.8
Mining & Logging	0	0	0	0	0.0	-1.6	5.0	3.4
Construction	0	-1	0	-1	0.0	-158.8	37.1	-121.7
Manufacturing	0	0	0	0	0.0	-28.8	478.0	449.1
Transportation, Warehousing & Utilities	-5	0	1	-4	-1,492.4	-11.2	183.5	-1,320.1
Wholesale Trade	0	0	1	1	0.0	-5.0	350.6	345.7
Retail Trade	0	0	6	6	0.0	-4.2	567.2	563.0
Information	0	0	1	1	0.0	-16.8	306.6	289.8
Financial Activities	0	0	5	4	0.0	-55.8	1,740.5	1,684.7
Services	0	-1	20	19	0.0	-133.7	2,162.8	2,029.1
Government	0	0	0	0	0.0	-0.7	55.1	54.4
<b>Total</b>	<b>-5</b>	<b>-3</b>	<b>35</b>	<b>27</b>	<b>-1,492.4</b>	<b>-416.7</b>	<b>5,894.3</b>	<b>3,985.2</b>

10 Note: In 2012 dollars

1        *Regional Changes to Recreational Opportunities*

2        Changes in CVP and SWP water supplies and operations under Alternative 1 as  
3        compared to the No Action Alternative generally would result in higher reservoir  
4        elevations in reservoirs that store CVP and SWP water (up to 11 to 21 percent);  
5        and would result in increased recreational economic factors under Alternative 1 as  
6        compared to the No Action Alternative.

7        *Regional Changes to Salmon Fishing*

8        Changes in commercial and sport ocean salmon fishing primarily would be  
9        related to the presence of fall-run Chinook Salmon from Central Valley  
10       hatcheries. It is assumed that the production of hatchery fish would be similar  
11       under Alternative 1 and the No Action Alternative. However, survival of the fall-  
12       run Chinook Salmon hatchery fish to the Pacific Ocean could be related to  
13       changes in CVP and SWP operations. As described in Chapter 9, Fish and  
14       Aquatic Resources, there would be little change in through-Delta survival by  
15       emigrating natural juvenile fall-run Chinook Salmon under Alternative 1 and the  
16       No Action Alternative. It is assumed that the survival of the hatchery juvenile  
17       fall-run Chinook Salmon would be similar to the survival of the natural juvenile  
18       fall-run Chinook Salmon. Therefore, the availability of fish for commercial and  
19       sport ocean salmon fishing and the associated economic conditions for the fishing  
20       industry would be similar under Alternative 1 and the No Action Alternative.

21       *Central Coast Region*

22       *Regional Changes to Irrigated Agriculture*

23       It is anticipated that as in the Central Valley Region, increases in CVP and SWP  
24       water supplies within the Central Coast Region would not result in increases in  
25       long-term irrigated acreage or land use changes due to the use of other water  
26       supplies. However, there could be increased irrigated acreage in dry and critical  
27       dry years under Alternative 1 as compared to the No Action Alternative.

28       *Regional Changes to Municipal and Industrial Water Supplies*

29       As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
30       and SWP water supplies would be higher under Alternative 1 as compared to the  
31       No Action Alternative. The analysis assumed CVP and SWP water deliveries, as  
32       described in Chapter 5, and determined the need for new water supplies, changes  
33       in water storage and groundwater pumping, water transfers, water shortage costs,  
34       and excess water savings. The factors and basis of the analysis is described in  
35       detail in Appendix 19A, CWEST Model. The analysis assumes that no new  
36       annual transfer supplies would be implemented until shortages were greater than  
37       5 percent. The costs of these shortages are included in the analysis. It is assumed  
38       that some communities that do not have alternative water supplies would utilize  
39       water transfers.

40       The average annual water supply operating expenses over the 81-year hydrologic  
41       period for M&I water supplies would increase 0.7 percent, as presented in  
42       Table 19.80; and therefore, the results would be similar under Alternative 1 and  
43       the No Action Alternative.

1 **Table 19.80 Changes in Municipal and Industrial Water Supply Costs for the**  
 2 **Central Coast Region under Alternative 1 as compared to the No Action Alternative**

Differences in Total	Alternative 1	No Action Alternative	Changes
Average Annual CVP/SWP Deliveries (TAF)	54	44	10
Delivery Cost (\$1,000)	\$8,174	\$6,663	\$1,510
Assumed New Supply Deliveries (TAF)	0	0	0
Annualized New Supply Costs (\$1,000)	\$0	\$0	\$0
Water Storage Costs (\$1,000)	\$0	\$0	\$0
Lost Water Sales Revenues (\$1,000)	\$0	\$0	\$0
Transfer Costs (\$1,000)	\$0	\$0	\$0
Shortage Costs (\$1,000)	\$0	\$0	\$0
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) (\$1,000)	-\$8,643	-\$8,068	-\$575
Excess Water Savings (\$1,000)	-\$4,176	-\$2,970	-\$1,206
<b>Average Annual Changes in Water Supply Costs (\$1,000)</b>	<b>-\$4,645</b>	<b>-\$4,374</b>	<b>-\$271</b>

3 Note: In 2012 dollars

4 The changes in M&I water supply costs would result in changes to employment  
 5 and regional economic output, as summarized in Table 19.81.

6 **Table 19.81 Changes in Municipal and Industrial Water Supply Related**  
 7 **Employment and Regional Economic Output for the Central Coast Region under**  
 8 **Alternative 1 as compared to the No Action Alternative**

Economic Sectors	Employment				Economic Output (\$ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	-0.6	4.0	3.4
Mining & Logging	0	0	0	0	0.0	-6.4	9.3	2.9
Construction	0	-2	0	-2	0.0	-201.9	9.7	-192.2
Manufacturing	0	0	0	0	0.0	-26.8	51.8	25.0
Transportation, Warehousing & Utilities	-6	0	0	-6	-1,510.8	-17.0	56.2	-1,471.6
Wholesale Trade	0	0	0	0	0.0	-4.8	58.6	53.8
Retail Trade	0	0	1	1	0.0	-6.1	118.5	112.4
Information	0	0	0	0	0.0	-12.0	39.0	27.0
Financial Activities	0	0	1	1	0.0	-68.9	352.0	283.2
Services	0	-2	5	3	0.0	-167.1	447.4	280.3
Government	0	0	0	0	0.0	-0.9	13.2	12.3
<b>Total</b>	<b>-6</b>	<b>-4</b>	<b>8</b>	<b>-2</b>	<b>-1,510.8</b>	<b>-512.7</b>	<b>1,159.9</b>	<b>-863.6</b>

9 Note: In 2012 dollars

1           *Regional Changes to Recreational Opportunities*

2   Changes in CVP and SWP water supplies and operations under Alternative 1 as  
3   compared to the No Action Alternative generally would result in higher reservoir  
4   elevations in reservoirs that store CVP and SWP water (up to 11 to 21 percent);  
5   and would result in increased recreational economic factors under Alternative 1 as  
6   compared to the No Action Alternative.

7           *Southern California Region*

8           *Regional Changes to Irrigated Agriculture*

9   It is anticipated that as in the Central Valley Region, increases in CVP and SWP  
10   water supplies within the Southern California Region would not result in  
11   increases in long-term irrigated acreage or land use changes due to the use of  
12   other water supplies. However, there could be increased irrigated acreage in dry  
13   and critical dry years under Alternative 1 as compared to the No Action  
14   Alternative.

15           *Regional Changes to Municipal and Industrial Water Supplies*

16   As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
17   and SWP water supplies would be higher under Alternative 1 as compared to the  
18   No Action Alternative. The analysis assumed CVP and SWP water deliveries, as  
19   described in Chapter 5, and determined the need for new water supplies, changes  
20   in water storage and groundwater pumping, water transfers, water shortage costs,  
21   and excess water savings. The factors and basis of the analysis is described in  
22   detail in Appendix 19A, CWEST Model. The analysis assumes that no new  
23   annual transfer supplies would be implemented until shortages were greater than  
24   5 percent. The costs of these shortages are included in the analysis. It is assumed  
25   that some communities that do not have alternative water supplies would utilize  
26   water transfers.

27   The average annual water supply operating expenses over the 81-year hydrologic  
28   period for M&I water supplies would decrease 2.14 percent, as presented in  
29   Table 19.82; and therefore, the results would be similar under Alternative 1 and  
30   the No Action Alternative.

1 **Table 19.82 Changes in Municipal and Industrial Water Supply Costs for the**  
 2 **Southern California Region under Alternative 1 as compared to the No Action**  
 3 **Alternative**

Differences in Total	Alternative 1	No Action Alternative	Changes
Average Annual CVP/SWP Deliveries (TAF)	2,394	1,932	461
Delivery Cost (\$1,000)	\$296,795	\$239,692	\$57,103
Assumed New Supply Deliveries (TAF)	11	47	-35
Annualized New Supply Costs (\$1,000)	\$4,032	\$12,688	-\$8,656
Water Storage Costs (\$1,000)	\$2,824	\$7,598	-\$4,774
Lost Water Sales Revenues (\$1,000)	\$1,119	\$14,614	-\$13,495
Transfer Costs (\$1,000)	\$3,705	\$11,484	-\$7,779
Shortage Costs (\$1,000)	\$353	\$17,319	-\$16,966
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) (\$1,000)	-\$91,507	-\$57,474	-\$34,033
Excess Water Savings (\$1,000)	-\$10,573	-\$4,629	-\$5,944
<b>Average Annual Changes in Water Supply Costs (\$1,000)</b>	<b>\$206,749</b>	<b>\$241,291</b>	<b>-\$34,542</b>

4 Note: In 2012 dollars

5 The changes in M&I water supply costs would result in changes to employment  
 6 and regional economic output, as summarized in Table 19.83.

7 **Table 19.83 Changes in Municipal and Industrial Water Supply Related**  
 8 **Employment and Regional Economic Output for the Southern California Region**  
 9 **under Alternative 1 as compared to the No Action Alternative**

Economic Sectors	Employment				Economic Output (\$ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	-2	-1	0.0	12.5	-272.7	-260.2
Mining & Logging	0	1	-1	-1	0.0	164.2	-369.0	-204.8
Construction	0	43	-3	40	0.0	5,205.5	-395.5	4,810.0
Manufacturing	0	2	-10	-8	0.0	1,452.6	-6,814.5	-5,361.9
Transportation, Warehousing & Utilities	175	2	-12	166	43,673.4	592.0	-2,602.9	41,662.5
Wholesale Trade	0	1	-20	-19	0.0	275.3	-4,339.0	-4,063.8
Retail Trade	0	2	-58	-56	0.0	170.6	-5,106.3	-4,935.7
Information	0	1	-6	-5	0.0	637.5	-2,962.1	-2,324.6
Financial Activities	0	9	-52	-43	0.0	2,528.7	-17,797.9	-15,269.1
Services	0	46	-212	-166	0.0	5,542.2	-20,430.6	-14,888.4
Government	0	0	-3	-3	0.0	29.8	-587.3	-557.5
<b>Total</b>	<b>175</b>	<b>108</b>	<b>-378</b>	<b>-95</b>	<b>43,673.4</b>	<b>16,611.0</b>	<b>-61,677.8</b>	<b>-1,393.5</b>

10 Note: In 2012 dollars

1        *Regional Changes to Recreational Opportunities*

2        Changes in CVP and SWP water supplies and operations under Alternative 1 as  
3        compared to the No Action Alternative generally would result in higher reservoir  
4        elevations in reservoirs that store CVP and SWP water (up to 11 to 21 percent);  
5        and would result in increased recreational economic factors under Alternative 1 as  
6        compared to the No Action Alternative.

7        **19.4.3.2.2 Alternative 1 Compared to the Second Basis of Comparison**

8        As described in Chapter 3, Description of Alternatives, Alternative 1 is identical  
9        to the Second Basis of Comparison.

10       **19.4.3.3 Alternative 2**

11       The CVP and SWP operations under Alternative 2 are identical to the CVP and  
12       SWP operations under the No Action Alternative, therefore, Alternative 2 is only  
13       compared to the Second Basis of Comparison.

14       **19.4.3.3.1 Alternative 2 Compared to the Second Basis of Comparison**

15       The CVP and SWP operations under Alternative 2 are identical to the CVP and  
16       SWP operations under the No Action Alternative. Therefore, changes to  
17       socioeconomic factors under Alternatives 2 as compared to the Second Basis of  
18       Comparison would be the same as the impacts described in Section 12.4.3.1, No  
19       Action Alternative.

20       **19.4.3.4 Alternative 3**

21       As described in Chapter 3, Description of Alternatives, CVP and SWP operations  
22       under Alternative 3 are similar to the Second Basis of Comparison with modified  
23       Old and Middle River flow criteria and New Melones Reservoir operations and  
24       reductions in Striped Bass fishing opportunities. As described in Chapter 4,  
25       Approach to Environmental Analysis, Alternative 3 is compared to the No Action  
26       Alternative and the Second Basis of Comparison.

27       **19.4.3.4.1 Alternative 3 Compared to the No Action Alternative**

28       *Trinity River Region*

29              *Regional Changes to Irrigated Agriculture*

30       There are no agricultural lands irrigated with CVP and SWP water supplies in the  
31       Trinity River Region. Therefore, there would be no changes in irrigated lands  
32       under Alternative 3 as compared to the No Action Alternative.

33              *Regional Changes to Municipal and Industrial Water Supplies*

34       The CVP would continue to release water in Trinity River for downstream  
35       beneficial uses, including water supplies under Alternative 3 as compared to the  
36       No Action Alternative. There are no CVP or SWP water contractors in the  
37       Trinity River Region.



1        *Regional Changes to Recreational Opportunities*

2 Recreational opportunities would be similar in the Trinity River Region under  
3 Alternative 3 as compared to the No Action Alternative as described in  
4 Chapter 15, Recreational Resources.

5        *Regional Changes to Salmon Fishing*

6 Trinity River flows would be similar under Alternative 3 as compared to the No  
7 Action Alternative. This could result in similar salmon harvest conditions by the  
8 Yurok and Hoopa Valley tribes.

9        *Central Valley Region*

10       *Regional Changes to Irrigated Agriculture*

11 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
12 and SWP water supplies would be greater under Alternative 3 as compared to the  
13 No Action Alternative. It is anticipated that groundwater use would decrease in  
14 response to increased CVP and SWP water supplies in 2030; and sustainable  
15 groundwater management plans would not be fully implemented until the 2040s,  
16 as discussed in Chapter 12, Agricultural Resources.

17 The agricultural production value under long-term average conditions would be  
18 increased by less than 1 percent (\$1.2 million/year in the Sacramento Valley and  
19 \$0.3 million/year in the San Joaquin Valley) primarily due to a decrease in  
20 groundwater pumping of approximately 4 percent. The agricultural production  
21 value under dry and critical dry conditions also would be increased by less than  
22 1 percent (\$9.2 million/year in the Sacramento Valley and \$11.4 million/year in  
23 the San Joaquin Valley), primarily due to a decrease in groundwater pumping.

24 The overall increase in agricultural production values are less than 0.05 percent  
25 under long-term conditions; and, changes in employment and regional economic  
26 output would be minimal. Therefore, the analysis of employment and regional  
27 economic output is focused on dry and critical dry years.

28 The direct changes in agricultural production would result in changes to  
29 employment and regional economic output in the Sacramento and San Joaquin  
30 valleys, as summarized in Tables 19.84 and 19.85, respectively.

1 **Table 19.84 Changes in Agricultural-Related Employment and Regional Economic**  
 2 **Output for the Sacramento Valley under Alternative 3 as compared to the No**  
 3 **Action Alternative in Dry and Critical Dry Years**

Economic Sectors	Employment				Economic Output (\$ millions)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	69	18	0	86	9.2	1.1	0.0	10.3
Mining & Logging	0	0	0	0	0.0	0.0	0.0	0.0
Construction	0	1	0	1	0.0	0.1	0.0	0.1
Manufacturing	0	0	0	0	0.0	0.1	0.0	0.1
Transportation, Warehousing & Utilities	0	1	0	1	0.0	0.3	0.1	0.4
Wholesale Trade	0	1	0	1	0.0	0.2	0.1	0.3
Retail Trade	0	0	3	3	0.0	0.0	0.3	0.3
Information	0	0	0	0	0.0	0.0	0.1	0.1
Financial Activities	0	5	2	7	0.0	1.3	0.7	2.0
Services	0	3	10	13	0.0	0.2	0.9	1.1
Government	0	0	0	0	0.0	0.1	0.0	0.1
<b>Total</b>	<b>69</b>	<b>29</b>	<b>17</b>	<b>115</b>	<b>9.2</b>	<b>3.4</b>	<b>2.2</b>	<b>14.8</b>

4 Note: In 2012 dollars

5 **Table 19.85 Changes in Agricultural-Related Employment and Regional Economic**  
 6 **Output for the San Joaquin Valley under Alternative 3 as compared to the No**  
 7 **Action Alternative in Dry and Critical Dry Years**

Economic Sectors	Employment				Economic Output (\$ millions)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	103	26	0	130	11.4	1.2	0.0	12.7
Mining & Logging	0	1	0	1	0.0	0.2	0.0	0.2
Construction	0	1	0	1	0.0	0.1	0.0	0.1
Manufacturing	0	1	0	1	0.0	1.2	0.1	1.3
Transportation, Warehousing & Utilities	0	2	0	2	0.0	0.5	0.1	0.6
Wholesale Trade	0	1	0	1	0.0	0.2	0.1	0.3
Retail Trade	0	0	3	3	0.0	0.0	0.3	0.3
Information	0	0	0	0	0.0	0.0	0.1	0.1
Financial Activities	0	8	1	10	0.0	1.8	0.6	2.5
Services	0	3	9	12	0.0	0.3	0.7	1.0
Government	0	0	0	1	0.0	0.1	0.0	0.1
<b>Total</b>	<b>103</b>	<b>44</b>	<b>15</b>	<b>161</b>	<b>11.4</b>	<b>5.7</b>	<b>2.1</b>	<b>19.1</b>

8 Note: In 2012 dollars

1 As described in Chapter 11, Geology and Soils Resources, increased groundwater  
2 pumping under the long-term average conditions may result in an additional  
3 increment of subsidence in those areas within the Central Valley. The additional  
4 amount of subsidence and the economic costs associated with it have not been  
5 quantified in this EIS. However, total subsidence-related costs have been shown  
6 to be substantial, as reported by Borchers et al. (2014) who estimated that the cost  
7 of subsidence in San Joaquin Valley between 1955 and 1972 was more than  
8 \$1.3 billion (in 2013 dollars). These estimates are based on the impacts to major  
9 infrastructure in the region including the San Joaquin River, Delta Mendota  
10 Canal, Friant-Kern Canal and San Luis Canal in addition to privately owned  
11 infrastructure. The incremental subsidence-related costs, expressed on an annual  
12 basis, could be an unknown fraction of that cumulative cost.

13 *Regional Changes to Municipal and Industrial Water Supplies*

14 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
15 and SWP water supplies would increase under Alternative 3 as compared to the  
16 No Action Alternative. The analysis assumed CVP and SWP water deliveries, as  
17 described in Chapter 5, and determined the need for new water supplies, changes  
18 in water storage and groundwater pumping, water transfers, water shortage costs,  
19 and excess water savings. The factors and basis of the analysis is described in  
20 detail in Appendix 19A, CWEST Model. The analysis assumes that no new  
21 annual transfer supplies would be implemented until shortages were greater than  
22 5 percent. The costs of these shortages are included in the analysis. It is assumed  
23 that some communities that do not have alternative water supplies would utilize  
24 water transfers.

25 The average annual water supply costs over the 81-year hydrologic period for  
26 M&I water supplies are presented in Tables 19.86 and 19.87 for the Sacramento  
27 and San Joaquin Valley, respectively. Average annual water supply operating  
28 expenses would decrease by 0.07 and 0.5 percent in the Sacramento Valley and  
29 the San Joaquin Valley, respectively; and therefore, the results would be similar  
30 under Alternative 3 and the No Action Alternative.

1 **Table 19.86 Changes in Municipal and Industrial Water Supply Costs for the**  
 2 **Sacramento Valley under Alternative 3 as compared to the No Action Alternative**

Differences in Total	Alternative 3	No Action Alternative	Changes
Average Annual CVP/SWP Deliveries (TAF)	461	447	13
Delivery Cost (\$1,000)	\$8,285	\$8,031	\$255
Assumed New Supply Deliveries (TAF)	0	0	0
Annualized New Supply Costs (\$1,000)	\$0	\$0	\$0
Water Storage Costs (\$1,000)	\$0	\$0	\$0
Lost Water Sales Revenues (\$1,000)	\$243	\$213	\$30
Transfer Costs (\$1,000)	\$601	\$739	-\$138
Shortage Costs (\$1,000)	\$77	\$69	\$8
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) (\$1,000)	-\$3,938	-\$3,858	-\$81
Excess Water Savings (\$1,000)	-\$2,517	-\$2,275	-\$241
<b>Average Annual Changes in Water Supply Costs (\$1,000)</b>	<b>\$2,750</b>	<b>\$2,919</b>	<b>-\$169</b>

3 Note: In 2012 dollars

4 **Table 19.87 Changes in Municipal and Industrial Water Supply Costs for the**  
 5 **San Joaquin Valley under Alternative 3 as compared to the No Action Alternative**

Differences in Total	Alternative 3	No Action Alternative	Changes
Average Annual CVP/SWP Deliveries (TAF)	241	214	27
Delivery Cost (\$1,000)	\$3,896	\$3,460	\$436
Assumed New Supply Deliveries (TAF)	0	2	-2
Annualized New Supply Costs (\$1,000)	\$13	\$429	-\$417
Water Storage Costs (\$1,000)	\$465	\$942	-\$477
Lost Water Sales Revenues (\$1,000)	\$284	\$361	-\$78
Transfer Costs (\$1,000)	\$2,104	\$2,673	-\$568
Shortage Costs (\$1,000)	\$89	\$115	-\$26
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) (\$1,000)	-\$15,660	-\$15,377	-\$283
Excess Water Savings (\$1,000)	-\$1,378	-\$1,029	-\$349
<b>Average Annual Changes in Water Supply Costs (\$1,000)</b>	<b>-\$10,187</b>	<b>-\$8,427</b>	<b>-\$1,761</b>

6 Note: In 2012 dollars

7 The changes in M&I water supply costs would result in changes to employment  
 8 and regional economic output in the Sacramento and San Joaquin valleys, as  
 9 summarized in Tables 19.88 and 19.89, respectively.

1 **Table 19.88 Changes in Municipal and Industrial Water Supply Related**  
 2 **Employment and Regional Economic Output for the Sacramento Valley under**  
 3 **Alternative 3 as compared to the No Action Alternative**

Economic Sectors	Employment				Economic Output (\$ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	0.1	-1.2	-1.1
Mining & Logging	0	0	0	0	0.0	0.4	-0.2	0.2
Construction	0	0	0	0	0.0	25.8	-1.8	23.9
Manufacturing	0	0	0	0	0.0	2.8	-16.2	-13.5
Transportation, Warehousing & Utilities	1	0	0	1	254.4	2.5	-13.1	243.7
Wholesale Trade	0	0	0	0	0.0	0.9	-20.0	-19.1
Retail Trade	0	0	0	0	0.0	0.8	-33.8	-33.0
Information	0	0	0	0	0.0	3.0	-15.1	-12.1
Financial Activities	0	0	0	0	0.0	11.6	-107.7	-96.1
Services	0	0	-1	-1	0.0	27.4	-112.8	-85.4
Government	0	0	0	0	0.0	0.1	-2.8	-2.7
<b>Total</b>	<b>1</b>	<b>1</b>	<b>-2</b>	<b>0</b>	<b>254.4</b>	<b>75.3</b>	<b>-324.8</b>	<b>4.9</b>

4 Note: In 2012 dollars

5 **Table 19.89 Changes in Municipal and Industrial Water Supply Related**  
 6 **Employment and Regional Economic Output for the San Joaquin Valley under**  
 7 **Alternative 3 as compared to the No Action Alternative**

Economic Sectors	Employment				Economic Output (\$ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	-0.2	-8.9	-9.1
Mining & Logging	0	0	0	0	0.0	-1.2	-8.5	-9.7
Construction	0	0	0	0	0.0	-43.3	-7.4	-50.7
Manufacturing	0	0	0	0	0.0	-4.4	-62.0	-66.3
Transportation, Warehousing & Utilities	-2	0	0	-2	-457.3	-4.4	-59.6	-521.3
Wholesale Trade	0	0	0	0	0.0	-1.2	-51.6	-52.8
Retail Trade	0	0	-2	-2	0.0	-1.3	-130.7	-132.0
Information	0	0	0	0	0.0	-3.2	-36.0	-39.2
Financial Activities	0	0	-1	-1	0.0	-14.1	-352.2	-366.3
Services	0	0	-5	-5	0.0	-38.0	-391.1	-429.1
Government	0	0	0	0	0.0	-0.3	-17.2	-17.5
<b>Total</b>	<b>-2</b>	<b>-1</b>	<b>-8</b>	<b>-11</b>	<b>-457.3</b>	<b>-111.6</b>	<b>-1,125.2</b>	<b>-1,694.1</b>

8 Note: In 2012 dollars

9 *Regional Changes to Recreational Opportunities*

10 Recreational opportunities would be similar at San Luis Reservoir under  
 11 Alternative 3 as compared to the No Action Alternative, as described in  
 12 Chapter 15, Recreation Resources. Recreational opportunities related to Striped  
 13 Bass fishing would initially be increased when Alternative 3 is implemented.

1 However, by 2030, Striped Bass fishing opportunities would be reduced under  
 2 Alternative 3 as compared to the Second Basis of Comparison due to actions to  
 3 reduce predation. Therefore, it is anticipated that recreational economic factors  
 4 would be reduced under Alternative 3 as compared to the No Action Alternative.

5 *Effects Related to Cross Delta Water Transfers*

6 Potential effects to socioeconomic factors could be similar to those identified in a  
 7 recent environmental analysis conducted by Reclamation for long-term water  
 8 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as  
 9 described above under the No Action Alternative compared to the Second Basis  
 10 of Comparison. For the purposes of this EIS, it is anticipated that similar  
 11 conditions would occur during implementation of cross Delta water transfers  
 12 under Alternative 3 and the No Action Alternative, and that impacts on  
 13 socioeconomic factors could be adverse in the seller's service area.

14 Under Alternative 3, water could be transferred throughout the year without an  
 15 annual volumetric limit. Under the No Action Alternative, the timing of cross  
 16 Delta water transfers would be limited to July through September and include  
 17 annual volumetric limits, in accordance with the 2008 USFWS BO and 2009  
 18 NMFS BO. Overall, the potential for cross Delta water transfers would be  
 19 increased under Alternative 3 as compared to the No Action Alternative.

20 *San Francisco Bay Area Region*

21 *Regional Changes to Irrigated Agriculture*

22 It is anticipated that as in the Central Valley Region, increases in CVP and SWP  
 23 water supplies within the San Francisco Bay Area Region would not result in  
 24 changes in long-term irrigated acreage or land use changes due to the use of other  
 25 water supplies. However, there could be an increase in irrigated acreage in dry  
 26 and critical dry years under Alternative 3 as compared to the No Action  
 27 Alternative.

28 *Regional Changes to Municipal and Industrial Water Supplies*

29 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
 30 and SWP water supplies would increase under Alternative 3 as compared to the  
 31 No Action Alternative. The analysis assumed CVP and SWP water deliveries, as  
 32 described in Chapter 5, and determined the need for new water supplies, changes  
 33 in water storage and groundwater pumping, water transfers, water shortage costs,  
 34 and excess water savings. The factors and basis of the analysis is described in  
 35 detail in Appendix 19A, CWEST Model. The analysis assumes that no new  
 36 annual transfer supplies would be implemented until shortages were greater than  
 37 5 percent. The costs of these shortages are included in the analysis.

38 The average annual water supply operating expenses over the 81-year hydrologic  
 39 period for M&I water supplies would decrease by 1.23 percent, as presented in  
 40 Table 19.90; and therefore, the results would be similar under Alternative 3 and  
 41 the No Action Alternative.

1 **Table 19.90 Changes in Municipal and Industrial Water Supply Costs for the San**  
 2 **Francisco Bay Area Region under Alternative 3 as compared to the No Action**  
 3 **Alternative**

Differences in Total	Alternative 3	No Action Alternative	Changes
Average Annual CVP/SWP Deliveries (TAF)	431	396	34
Delivery Cost (\$1,000)	\$12,096	\$11,044	\$1,052
Assumed New Supply Deliveries (TAF)	18	18	0
Annualized New Supply Costs (\$1,000)	\$575	\$599	-\$24
Water Storage Costs (\$1,000)	\$2,303	\$1,577	\$726
Lost Water Sales Revenues (\$1,000)	\$2,381	\$4,286	-\$1,905
Transfer Costs (\$1,000)	\$1,826	\$5,722	-\$3,896
Shortage Costs (\$1,000)	\$743	\$1,410	-\$667
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) (\$1,000)	-\$726	-\$493	-\$232
Excess Water Savings (\$1,000)	-\$393	-\$225	-\$167
<b>Average Annual Changes in Water Supply Costs (\$1,000)</b>	<b>\$18,806</b>	<b>\$23,919</b>	<b>-\$5,113</b>

4 Note: In 2012 dollars

5 The changes in M&I water supply costs would result in changes to employment  
 6 and regional economic output, as summarized in Table 19.91.

7 **Table 19.91 Changes in Municipal and Industrial Water Supply Related**  
 8 **Employment and Regional Economic Output for the San Francisco Bay Area**  
 9 **Region under Alternative 3 as compared to the No Action Alternative**

Economic Sectors	Employment				Economic Output (\$ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	0.1	-6.0	-5.9
Mining & Logging	0	0	0	0	0.0	1.9	-3.8	-1.9
Construction	0	1	0	1	0.0	186.7	-28.2	158.6
Manufacturing	0	0	0	0	0.0	33.9	-363.5	-329.6
Transportation, Warehousing & Utilities	6	0	-1	5	1,754.5	13.2	-139.1	1,628.6
Wholesale Trade	0	0	-1	-1	0.0	5.8	-268.7	-262.9
Retail Trade	0	0	-5	-5	0.0	4.9	-428.6	-423.7
Information	0	0	0	0	0.0	19.8	-233.1	-213.4
Financial Activities	0	0	-3	-3	0.0	65.6	-1,320.3	-1,254.7
Services	0	1	-15	-14	0.0	157.2	-1,639.6	-1,482.4
Government	0	0	0	0	0.0	0.8	-41.8	-41.0
<b>Total</b>	<b>6</b>	<b>3</b>	<b>-26</b>	<b>-17</b>	<b>1,754.5</b>	<b>489.9</b>	<b>-4,472.7</b>	<b>-2,228.3</b>

10 Note: In 2012 dollars

11 *Regional Changes to Recreational Opportunities*

12 Changes in CVP and SWP water supplies and operations under Alternative 3 as  
 13 compared to the No Action Alternative generally would result in higher reservoir  
 14 elevations in reservoirs that store CVP and SWP water (up to 9 to 17 percent);

1 and would result in increased recreational economic factors under Alternative 3 as  
2 compared to the No Action Alternative.

3 *Regional Changes to Salmon Fishing*

4 Commercial and sport ocean salmon fishing would be reduced under  
5 Alternative 3 and the No Action Alternative due to increased commercial and  
6 sport ocean salmon harvests limits.

7 *Central Coast Region*

8 *Regional Changes to Irrigated Agriculture*

9 It is anticipated that as in the Central Valley Region, increases in CVP and SWP  
10 water supplies within the Central Coast Region would not result in increases in  
11 long-term irrigated acreage or land use changes due to the use of other water  
12 supplies. However, there could be increased irrigated acreage in dry and critical  
13 dry years under Alternative 3 as compared to the No Action Alternative.

14 *Regional Changes to Municipal and Industrial Water Supplies*

15 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
16 and SWP water supplies would be higher under Alternative 3 as compared to the  
17 No Action Alternative. The analysis assumed CVP and SWP water deliveries, as  
18 described in Chapter 5, and determined the need for new water supplies, changes  
19 in water storage and groundwater pumping, water transfers, water shortage costs,  
20 and excess water savings. The factors and basis of the analysis is described in  
21 detail in Appendix 19A, CWEST Model. The analysis assumes that no new  
22 annual transfer supplies would be implemented until shortages were greater than  
23 5 percent. The costs of these shortages are included in the analysis. It is assumed  
24 that some communities that do not have alternative water supplies would utilize  
25 water transfers.

26 The average annual water supply operating expenses over the 81-year hydrologic  
27 period for M&I water supplies would decrease by \$125,000, or 0.33 percent, as  
28 presented in Table 19.92; and therefore, the results would be similar under  
29 Alternative 3 and the No Action Alternative.



1 **Table 19.92 Changes in Municipal and Industrial Water Supply Costs for the**  
 2 **Central Coast Region under Alternative 3 as compared to the No Action Alternative**

Differences in Total	Alternative 3	No Action Alternative	Changes
Average Annual CVP/SWP Deliveries (TAF)	51	44	8
Delivery Cost (\$1,000)	\$7,814	\$6,663	\$1,151
Assumed New Supply Deliveries (TAF)	0	0	0
Annualized New Supply Costs (\$1,000)	\$0	\$0	\$0
Water Storage Costs (\$1,000)	\$0	\$0	\$0
Lost Water Sales Revenues (\$1,000)	\$0	\$0	\$0
Transfer Costs (\$1,000)	\$0	\$0	\$0
Shortage Costs (\$1,000)	\$0	\$0	\$0
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) (\$1,000)	-\$8,333	-\$8,068	-\$265
Excess Water Savings (\$1,000)	-\$3,980	-\$2,970	-\$1,010
<b>Average Annual Changes in Water Supply Costs (\$1,000)</b>	<b>-\$4,499</b>	<b>-\$4,374</b>	<b>-\$125</b>

3 Note: In 2012 dollars

4 The changes in M&I water supply costs would result in changes to employment  
 5 and regional economic output, as summarized in Table 19.93.

6 **Table 19.93 Changes in Municipal and Industrial Water Supply Related**  
 7 **Employment and Regional Economic Output for the Central Coast Region under**  
 8 **Alternative 3 as compared to the No Action Alternative**

Economic Sectors	Employment				Economic Output (\$ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	0.4	-2.8	-2.4
Mining & Logging	0	0	0	0	0.0	4.9	-6.5	-1.7
Construction	0	1	0	1	0.0	153.8	-6.8	147.0
Manufacturing	0	0	0	0	0.0	20.4	-36.5	-16.0
Transportation, Warehousing & Utilities	5	0	0	5	1,150.6	13.0	-39.5	1,124.0
Wholesale Trade	0	0	0	0	0.0	3.7	-41.4	-37.8
Retail Trade	0	0	-1	-1	0.0	4.7	-83.0	-78.4
Information	0	0	0	0	0.0	9.1	-27.4	-18.3
Financial Activities	0	0	-1	0	0.0	52.5	-247.3	-194.8
Services	0	1	-3	-2	0.0	127.3	-314.2	-186.9
Government	0	0	0	0	0.0	0.7	-9.3	-8.6
<b>Total</b>	<b>5</b>	<b>3</b>	<b>-6</b>	<b>2</b>	<b>1,150.6</b>	<b>390.4</b>	<b>-814.8</b>	<b>726.2</b>

9 Note: In 2012 dollars

1        *Regional Changes to Recreational Opportunities*

2        Changes in CVP and SWP water supplies and operations under Alternative 3 as  
3        compared to the No Action Alternative generally would result in higher reservoir  
4        elevations in reservoirs that store CVP and SWP water (up to 9 to 17 percent);  
5        and would result in increased recreational economic factors under Alternative 3 as  
6        compared to the No Action Alternative.

7        *Southern California Region*

8        *Regional Changes to Irrigated Agriculture*

9        It is anticipated that as in the Central Valley Region, increases in CVP and SWP  
10       water supplies within the Southern California Region would not result in  
11       increases in long-term irrigated acreage or land use changes due to the use of  
12       other water supplies. However, there could be increased irrigated acreage in dry  
13       and critical dry years under Alternative 3 as compared to the No Action  
14       Alternative.

15       *Regional Changes to Municipal and Industrial Water Supplies*

16       As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
17       and SWP water supplies would be higher under Alternative 3 as compared to the  
18       No Action Alternative. The analysis assumed CVP and SWP water deliveries, as  
19       described in Chapter 5, and determined the need for new water supplies, changes  
20       in water storage and groundwater pumping, water transfers, water shortage costs,  
21       and excess water savings. The factors and basis of the analysis is described in  
22       detail in Appendix 19A, CWEST Model. The analysis assumes that no new  
23       annual transfer supplies would be implemented until shortages were greater than  
24       5 percent. The costs of these shortages are included in the analysis. It is assumed  
25       that some communities that do not have alternative water supplies would utilize  
26       water transfers.

27       The average annual water supply costs over the 81-year hydrologic period for  
28       M&I water supplies would be \$4.94 million, or 0.31 percent, as presented in  
29       Table 19.94; and therefore, the results would be similar under Alternative 3 and  
30       the No Action Alternative.

1 **Table 19.94 Changes in Municipal and Industrial Water Supply Costs for the**  
 2 **Southern California Region under Alternative 3 as compared to the No Action**  
 3 **Alternative**

Differences in Total	Alternative 3	No Action Alternative	Changes
Average Annual CVP/SWP Deliveries (TAF)	2,241	1,932	308
Delivery Cost (\$1,000)	\$278,085	\$239,692	\$38,393
Assumed New Supply Deliveries (TAF)	40	47	-7
Annualized New Supply Costs (\$1,000)	\$10,584	\$12,688	-\$2,104
Water Storage Costs (\$1,000)	\$8,154	\$7,598	\$556
Lost Water Sales Revenues (\$1,000)	\$11,409	\$14,614	-\$3,205
Transfer Costs (\$1,000)	\$6,181	\$11,484	-\$5,303
Shortage Costs (\$1,000)	\$12,632	\$17,319	-\$4,687
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) (\$1,000)	-\$81,693	-\$57,474	-\$24,218
Excess Water Savings (\$1,000)	-\$9,005	-\$4,629	-\$4,376
<b>Average Annual Changes in Water Supply Costs (\$1,000)</b>	<b>\$236,347</b>	<b>\$241,291</b>	<b>-\$4,944</b>

4 Note: In 2012 dollars

5 The changes in M&I water supply costs would result in changes to employment  
 6 and regional economic output, as summarized in Table 19.95.

7 **Table 19.95 Changes in Municipal and Industrial Water Supply Related**  
 8 **Employment and Regional Economic Output for the Southern California under**  
 9 **Alternative 3 as compared to the No Action Alternative**

Economic Sectors	Employment				Economic Output (\$ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	-1	-1	0.0	10.5	-146.4	-135.8
Mining & Logging	0	1	-1	0	0.0	138.6	-199.8	-61.2
Construction	0	37	-2	35	0.0	4,391.6	-211.9	4,179.8
Manufacturing	0	2	-6	-3	0.0	1,225.5	-3,662.5	-2,437.0
Transportation, Warehousing & Utilities	148	2	-6	143	36,845.0	499.5	-1,389.7	35,954.8
Wholesale Trade	0	1	-11	-10	0.0	232.2	-2,405.6	-2,173.3
Retail Trade	0	2	-31	-29	0.0	143.9	-2,688.1	-2,544.2
Information	0	1	-3	-2	0.0	537.8	-1,595.7	-1,057.9
Financial Activities	0	7	-28	-20	0.0	2,133.4	-9,496.1	-7,362.8
Services	0	39	-113	-74	0.0	4,675.7	-10,892.2	-6,216.5
Government	0	0	-2	-1	0.0	25.1	-314.7	-289.6
<b>Total</b>	<b>148</b>	<b>91</b>	<b>-202</b>	<b>37</b>	<b>36,845.0</b>	<b>14,013.9</b>	<b>-33,002.7</b>	<b>17,856.2</b>

10 Note: In 2012 dollars

1        *Regional Changes to Recreational Opportunities*

2 Changes in CVP and SWP water supplies and operations under Alternative 3 as  
3 compared to the No Action Alternative generally would result in higher reservoir  
4 elevations in reservoirs that store CVP and SWP water (up to 9 to 17 percent);  
5 and would result in increased recreational economic factors under Alternative 3 as  
6 compared to the No Action Alternative.

7        **19.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison**

8        *Trinity River Region*

9        *Regional Changes to Irrigated Agriculture*

10 There are no agricultural lands irrigated with CVP and SWP water supplies in the  
11 Trinity River Region. Therefore, there would be no changes in irrigated lands  
12 under Alternative 3 as compared to the Second Basis of Comparison.

13        *Regional Changes to Municipal and Industrial Water Supplies*

14 The CVP would continue to release water in Trinity River for downstream  
15 beneficial uses, including water supplies under Alternative 3 and the Second Basis  
16 of Comparison. There are no CVP or SWP water contractors in the Trinity River  
17 Region.

18        *Regional Changes to Recreational Opportunities*

19 Recreational opportunities would be similar in the Trinity River Region under  
20 Alternative 3 as compared to the Second Basis of Comparison as described in  
21 Chapter 15, Recreational Resources.

22        *Regional Changes to Salmon Fishing*

23 Trinity River flows would be similar under Alternative 3 as compared to the  
24 Second Basis of Comparison. This could result in similar salmon harvest  
25 conditions by the Yurok and Hoopa Valley tribes.

26        *Central Valley Region*

27        *Regional Changes to Irrigated Agriculture*

28 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
29 and SWP water supplies would be less under Alternative 3 than under the Second  
30 Basis of Comparison. It is anticipated that groundwater use would increase in  
31 response to reduced CVP and SWP water supplies in 2030 because sustainable  
32 groundwater management plans would not be fully implemented until the 2040s,  
33 as discussed in Chapter 12, Agricultural Resources.

34 The agricultural production value under long-term average conditions would be  
35 reduced by less than 1 percent (\$0.3 million/year in the Sacramento Valley and  
36 \$0.3 million/year in the San Joaquin Valley) primarily due to an increase in  
37 groundwater pumping of approximately 2 percent. The agricultural production  
38 value under dry and critical dry conditions also would be reduced by less than  
39 1 percent (\$2.1 million/year in the Sacramento Valley and \$8.9 million/year in the  
40 San Joaquin Valley) primarily due to an increase in groundwater pumping.

1 The overall reduction in agricultural production values are less than 0.05 percent  
 2 under long-term conditions; and, changes in employment and regional economic  
 3 output would be minimal. Therefore, the analysis of employment and regional  
 4 economic output is focused on dry and critical dry years.

5 The direct changes in agricultural production would result in changes to  
 6 employment and regional economic output in the Sacramento and San Joaquin  
 7 valleys, as summarized in Tables 19.96 and 19.97, respectively.

8 **Table 19.96 Changes in Agricultural-Related Employment and Regional Economic**  
 9 **Output for the Sacramento Valley under Alternative 3 as Compared to the Second**  
 10 **Basis of Comparison in Dry and Critical Dry Years**

Economic Sectors	Employment				Economic Output (\$ millions)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	-18	-4	0	-22	-2.1	-0.2	0.0	-2.3
Mining & Logging	0	0	0	0	0.0	0.0	0.0	0.0
Construction	0	0	0	0	0.0	0.0	0.0	0.0
Manufacturing	0	0	0	0	0.0	0.0	0.0	0.0
Transportation, Warehousing & Utilities	0	0	0	0	0.0	-0.1	0.0	-0.1
Wholesale Trade	0	0	0	0	0.0	0.0	0.0	-0.1
Retail Trade	0	0	0	-1	0.0	0.0	0.0	0.0
Information	0	0	0	0	0.0	0.0	0.0	0.0
Financial Activities	0	-2	0	-2	0.0	-0.4	-0.1	-0.5
Services	0	-1	-1	-2	0.0	-0.1	-0.1	-0.2
Government	0	0	0	0	0.0	0.0	0.0	0.0
<b>Total</b>	<b>-18</b>	<b>-7</b>	<b>-2</b>	<b>-27</b>	<b>-2.1</b>	<b>-0.9</b>	<b>-0.3</b>	<b>-3.3</b>

11 Note: In 2012 dollars

1 **Table 19.97 Changes in Agricultural-Related Employment and Regional Economic**  
 2 **Output for the San Joaquin Valley under Alternative 3 as Compared to the Second**  
 3 **Basis of Comparison in Dry and Critical Dry Years**

Economic Sectors	Employment				Economic Output (\$ millions)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	-36	-26	0	-63	-8.9	-1.1	0.0	-10.0
Mining & Logging	0	0	0	0	0.0	-0.1	0.0	-0.1
Construction	0	-1	0	-1	0.0	-0.1	0.0	-0.1
Manufacturing	0	0	0	-1	0.0	-0.7	-0.2	-0.8
Transportation, Warehousing & Utilities	0	-1	-1	-2	0.0	-0.3	-0.1	-0.5
Wholesale Trade	0	-1	-1	-1	0.0	-0.1	-0.1	-0.2
Retail Trade	0	0	-4	-4	0.0	0.0	-0.4	-0.4
Information	0	0	0	0	0.0	0.0	-0.1	-0.1
Financial Activities	0	-4	-2	-5	0.0	-0.8	-0.9	-1.7
Services	0	-2	-12	-14	0.0	-0.2	-1.0	-1.2
Government	0	0	0	0	0.0	-0.1	0.0	-0.1
<b>Total</b>	<b>-36</b>	<b>-36</b>	<b>-20</b>	<b>-92</b>	<b>-8.9</b>	<b>-3.5</b>	<b>-2.8</b>	<b>-15.3</b>

4 Note: In 2012 dollars

5 As described in Chapter 11, Geology and Soils Resources, increased groundwater  
 6 pumping under the long-term average conditions may result in an additional  
 7 increment of subsidence in those areas within the Central Valley. The additional  
 8 amount of subsidence and the economic costs associated with it have not been  
 9 quantified in this EIS. However, total subsidence-related costs have been shown  
 10 to be substantial, as reported by Borchers et al. (2014) who estimated that the cost  
 11 of subsidence in San Joaquin Valley between 1955 and 1972 was more than \$1.3  
 12 billion (in 2013 dollars). These estimates are based on the impacts to major  
 13 infrastructure in the region including the San Joaquin River, Delta Mendota  
 14 Canal, Friant-Kern Canal and San Luis Canal in addition to privately owned  
 15 infrastructure. The incremental subsidence-related costs, expressed on an annual  
 16 basis, could be an unknown fraction of that cumulative cost.

#### 17 *Regional Changes to Municipal and Industrial Water Supplies*

18 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
 19 and SWP water supplies would be similar in the Sacramento Valley and greater in  
 20 the San Joaquin Valley under Alternative 3 than under the Second Basis of  
 21 Comparison. The analysis assumed CVP and SWP water deliveries, as described  
 22 in Chapter 5, and determined the need for new water supplies, changes in water  
 23 storage and groundwater pumping, water transfers, water shortage costs, and  
 24 excess water savings. The factors and basis of the analysis is described in detail  
 25 in Appendix 19A, CWEST Model. The analysis assumes that no new annual  
 26 transfer supplies would be implemented until shortages were greater than  
 27 5 percent. The costs of these shortages are included in the analysis. It is assumed

1 that some communities that do not have alternative water supplies would utilize  
 2 water transfers.

3 The average annual water supply operating expenses over the 81-year hydrologic  
 4 period for M&I water supplies are presented in Tables 19.98 and 19.99 for the  
 5 Sacramento and San Joaquin Valley, respectively. Average annual water supply  
 6 operating costs would increase in the Sacramento Valley by 0.05 percent,  
 7 decrease in the San Joaquin Valley by 0.2 percent; and therefore, the results  
 8 would be similar under Alternative 3 and the Second Basis of Comparison.

9 **Table 19.98 Changes in Municipal and Industrial Water Supply Costs for the**  
 10 **Sacramento Valley under Alternative 3 as Compared to the Second Basis of**  
 11 **Comparison**

Differences in Total	Alternative 3	Second Basis of Comparison	Changes
Average Annual CVP/SWP Deliveries (TAF)	461	463	-2
Delivery Cost (\$1,000)	\$8,285	\$8,317	-\$32
Assumed New Supply Deliveries (TAF)	0	0	0
Annualized New Supply Costs (\$1,000)	\$0	\$0	\$0
Water Storage Costs (\$1,000)	\$0	\$0	\$0
Lost Water Sales Revenues (\$1,000)	\$243	\$207	\$35
Transfer Costs (\$1,000)	\$601	\$517	\$84
Shortage Costs (\$1,000)	\$77	\$68	\$9
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) (\$1,000)	-\$3,938	-\$3,916	-\$23
Excess Water Savings (\$1,000)	-\$2,517	-\$2,563	\$46
<b>Average Annual Changes in Water Supply Costs (\$1,000)</b>	<b>\$2,750</b>	<b>\$2,630</b>	<b>\$119</b>

12 Note: In 2012 dollars

13 **Table 19.99 Changes in Municipal and Industrial Water Supply Costs for the San**  
 14 **Joaquin Valley under Alternative 3 as Compared to the Second Basis of**  
 15 **Comparison**

Differences in Total	Alternative 3	Second Basis of Comparison	Changes
Average Annual CVP/SWP Deliveries (TAF)	241	237	4
Delivery Cost (\$1,000)	\$3,896	\$3,854	\$42
Assumed New Supply Deliveries (TAF)	0	0	0
Annualized New Supply Costs (\$1,000)	\$13	\$15	-\$3
Water Storage Costs (\$1,000)	\$465	\$820	-\$355
Lost Water Sales Revenues (\$1,000)	\$284	\$322	-\$39
Transfer Costs (\$1,000)	\$2,104	\$2,623	-\$518
Shortage Costs (\$1,000)	\$89	\$102	-\$13
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) (\$1,000)	-\$15,660	-\$16,011	\$351
Excess Water Savings (\$1,000)	-\$1,378	-\$1,318	-\$59
<b>Average Annual Changes in Water Supply Costs (\$1,000)</b>	<b>-\$10,187</b>	<b>-\$9,593</b>	<b>-\$595</b>

16 Note: In 2012 dollars

1 The changes in M&I water supply costs would result in changes to employment  
 2 and regional economic output in the Sacramento and San Joaquin valleys, as  
 3 summarized in Tables 19.100 and 19.101, respectively.

4 **Table 19.100 Changes in Municipal and Industrial Water Supply Related**  
 5 **Employment and Regional Economic Output for the Sacramento Valley under**  
 6 **Alternative 3 as Compared to the Second Basis of Comparison**

Economic Sectors	Employment				Economic Output (\$ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	0.0	0.5	0.5
Mining & Logging	0	0	0	0	0.0	0.0	0.1	0.0
Construction	0	0	0	0	0.0	-3.5	0.7	-2.8
Manufacturing	0	0	0	0	0.0	-0.4	6.4	6.0
Transportation, Warehousing & Utilities	0	0	0	0	-34.6	-0.3	5.2	-29.7
Wholesale Trade	0	0	0	0	0.0	-0.1	7.7	7.6
Retail Trade	0	0	0	0	0.0	-0.1	13.6	13.5
Information	0	0	0	0	0.0	-0.4	6.0	5.5
Financial Activities	0	0	0	0	0.0	-1.6	42.9	41.3
Services	0	0	0	0	0.0	-3.7	45.0	41.2
Government	0	0	0	0	0.0	0.0	1.1	1.1
<b>Total</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>-34.6</b>	<b>-10.2</b>	<b>129.2</b>	<b>84.4</b>

7 Note: In 2012 dollars

8 **Table 19.101 Changes in Municipal and Industrial Water Supply Related**  
 9 **Employment and Regional Economic Output for the San Joaquin Valley under**  
 10 **Alternative 3 as Compared to the Second Basis of Comparison**

Economic Sectors	Employment				Economic Output (\$ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	-0.1	-2.3	-2.4
Mining & Logging	0	0	0	0	0.0	-0.8	-2.1	-3.0
Construction	0	0	0	0	0.0	-29.9	-1.9	-31.8
Manufacturing	0	0	0	0	0.0	-3.0	-15.5	-18.6
Transportation, Warehousing & Utilities	-1	0	0	-1	-315.8	-3.0	-14.9	-333.7
Wholesale Trade	0	0	0	0	0.0	-0.8	-12.7	-13.5
Retail Trade	0	0	0	0	0.0	-0.9	-33.4	-34.3
Information	0	0	0	0	0.0	-2.2	-9.0	-11.2
Financial Activities	0	0	0	0	0.0	-9.7	-88.6	-98.4
Services	0	0	-1	-1	0.0	-26.2	-99.0	-125.2
Government	0	0	0	0	0.0	-0.2	-4.3	-4.5
<b>Total</b>	<b>-1</b>	<b>-1</b>	<b>-2</b>	<b>-4</b>	<b>-315.8</b>	<b>-77.0</b>	<b>-283.5</b>	<b>-676.3</b>

11 Note: In 2012 dollars



1            *Regional Changes to Recreational Opportunities*

2 Recreational opportunities would be similar at San Luis Reservoir under  
3 Alternative 3 as compared to the Second Basis of Comparison, as described in  
4 Chapter 15, Recreation Resources. Recreational opportunities related to Striped  
5 Bass fishing would initially be increased when Alternative 3 is implemented.  
6 However, by 2030, Striped Bass fishing opportunities would be reduced under  
7 Alternative 3 as compared to the Second Basis of Comparison due to actions to  
8 reduce predation. Therefore, it is anticipated that recreational economic factors  
9 would be reduced under Alternative 3 as compared to the Second Basis of  
10 Comparison.

11            *Effects Related to Cross Delta Water Transfers*

12 Potential effects to socioeconomic factors could be similar to those identified in a  
13 recent environmental analysis conducted by Reclamation for long-term water  
14 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as  
15 described above under the No Action Alternative compared to the Second Basis  
16 of Comparison. For the purposes of this EIS, it is anticipated that similar  
17 conditions would occur during implementation of cross Delta water transfers  
18 under Alternative 3 and the Second Basis of Comparison, and that impacts on  
19 socioeconomic factors could be adverse in the seller's service area.

20 Under Alternative 3 and Second Basis of Comparison, water could be transferred  
21 throughout the year without an annual volumetric limit. Overall, the potential for  
22 cross Delta water transfers would be similar under Alternative 3 as compared to  
23 the Second Basis of Comparison.

24 *San Francisco Bay Area Region*

25            *Regional Changes to Irrigated Agriculture*

26 It is anticipated that as in the Central Valley Region, reductions in CVP and SWP  
27 water supplies within the San Francisco Bay Area Region would not result in  
28 reductions in long-term irrigated acreage or land use changes due to the use of  
29 other water supplies. However, there could be a reduction in irrigated acreage in  
30 dry and critical dry years under Alternative 3 as compared to the Second Basis of  
31 Comparison.

32            *Regional Changes to Municipal and Industrial Water Supplies*

33 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
34 and SWP water supplies would be less under Alternative 3 than under the Second  
35 Basis of Comparison. The analysis assumed CVP and SWP water deliveries, as  
36 described in Chapter 5, and determined the need for new water supplies, changes  
37 in water storage and groundwater pumping, water transfers, water shortage costs,  
38 and excess water savings. The factors and basis of the analysis is described in  
39 detail in Appendix 19A, CWEST Model. The analysis assumes that no new  
40 annual transfer supplies would be implemented until shortages were greater than  
41 5 percent. The costs of these shortages are included in the analysis.

42 The average annual water supply operating expenses over the 81-year hydrologic  
43 period for M&I water supplies would increase by \$2.16 million, or 0.52 percent,

1 as presented in Table 19.102; and therefore, the results would be similar under  
 2 Alternative 3 and the Second Basis of Comparison.

3 **Table 19.102 Changes in Municipal and Industrial Water Supply Costs for the San**  
 4 **Francisco Bay Area Region under Alternative 3 as Compared to the Second Basis**  
 5 **of Comparison**

Differences in Total	Alternative 3	Second Basis of Comparison	Changes
Average Annual CVP/SWP Deliveries (TAF)	431	445	-14
Delivery Cost (\$1,000)	\$12,096	\$12,515	-\$419
Assumed New Supply Deliveries (TAF)	18	16	2
Annualized New Supply Costs (\$1,000)	\$575	\$234	\$342
Water Storage Costs (\$1,000)	\$2,303	\$1,963	\$340
Lost Water Sales Revenues (\$1,000)	\$2,381	\$1,595	\$786
Transfer Costs (\$1,000)	\$1,826	\$1,154	\$672
Shortage Costs (\$1,000)	\$743	\$523	\$221
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) (\$1,000)	-\$726	-\$792	\$66
Excess Water Savings (\$1,000)	-\$393	-\$549	\$156
<b>Average Annual Changes in Water Supply Costs (\$1,000)</b>	<b>\$18,806</b>	<b>\$16,643</b>	<b>\$2,163</b>

6 Note: In 2012 dollars

7 The changes in M&I water supply costs would result in changes to employment  
 8 and regional economic output, as summarized in Table 19.103.

9 **Table 19.103 Changes in Municipal and Industrial Water Supply Related**  
 10 **Employment and Regional Economic Output for the San Francisco Bay Area**  
 11 **Region under Alternative 3 as Compared to the Second Basis of Comparison**

Economic Sectors	Employment				Economic Output (\$ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	0.0	1.9	1.9
Mining & Logging	0	0	0	0	0.0	0.3	1.2	1.5
Construction	0	0	0	0	0.0	28.0	9.0	36.9
Manufacturing	0	0	0	0	0.0	5.1	114.4	119.5
Transportation, Warehousing & Utilities	1	0	0	1	262.6	2.0	44.3	308.9
Wholesale Trade	0	0	0	0	0.0	0.9	81.9	82.8
Retail Trade	0	0	2	2	0.0	0.7	138.5	139.3
Information	0	0	0	0	0.0	3.0	73.5	76.4
Financial Activities	0	0	1	1	0.0	9.8	420.2	430.0
Services	0	0	5	5	0.0	23.5	523.1	546.7
Government	0	0	0	0	0.0	0.1	13.3	13.4
<b>Total</b>	<b>1</b>	<b>0</b>	<b>8</b>	<b>10</b>	<b>262.6</b>	<b>73.3</b>	<b>1,421.3</b>	<b>1,757.2</b>

12 Note: In 2012 dollars

1        *Regional Changes to Recreational Opportunities*

2 Changes in CVP and SWP water supplies and operations under Alternative 3 as  
3 compared to the Second Basis of Comparison generally would result in similar  
4 reservoir elevations in reservoirs that store CVP and SWP water and similar  
5 recreational economic factors under Alternative 3 as compared to the Second  
6 Basis of Comparison.

7        *Regional Changes to Salmon Fishing*

8 Commercial and sport ocean salmon fishing would be reduced under  
9 Alternative 3 and the Second Basis of Comparison due to increased commercial  
10 and sport ocean salmon harvests limits.

11        *Central Coast Region*

12        *Regional Changes to Irrigated Agriculture*

13 It is anticipated that as in the Central Valley Region, reductions in CVP and SWP  
14 water supplies within the Central Coast Region would not result in reductions in  
15 long-term irrigated acreage or land use changes due to the use of other water  
16 supplies. However, there could be a reduction in irrigated acreage in dry and  
17 critical dry years under Alternative 3 as compared to the Second Basis of  
18 Comparison.

19        *Regional Changes to Municipal and Industrial Water Supplies*

20 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
21 and SWP water supplies would be less under Alternative 3 than under the Second  
22 Basis of Comparison. The analysis assumed CVP and SWP water deliveries, as  
23 described in Chapter 5, and determined the need for new water supplies, changes  
24 in water storage and groundwater pumping, water transfers, water shortage costs,  
25 and excess water savings. The factors and basis of the analysis is described in  
26 detail in Appendix 19A, CWEST Model. The analysis assumes that no new  
27 annual transfer supplies would be implemented until shortages were greater than  
28 5 percent. The costs of these shortages are included in the analysis. It is assumed  
29 that some communities that do not have alternative water supplies would utilize  
30 water transfers.

31 The average annual water supply operating expenses over the 81-year hydrologic  
32 period for M&I water supplies would increase by \$146,000, or 0.38 percent, as  
33 presented in Table 19.104; and therefore, the results would be similar under  
34 Alternative 3 and the Second Basis of Comparison.

**Table 19.104 Changes in Municipal and Industrial Water Supply Costs for the Central Coast Region under Alternative 3 as Compared to the Second Basis of Comparison**

Differences in Total	Alternative 3	Second Basis of Comparison	Changes
Average Annual CVP/SWP Deliveries (TAF)	51	54	-2
Delivery Cost (\$1,000)	\$7,814	\$8,174	-\$360
Assumed New Supply Deliveries (TAF)	0	0	0
Annualized New Supply Costs (\$1,000)	\$0	\$0	\$0
Water Storage Costs (\$1,000)	\$0	\$0	\$0
Lost Water Sales Revenues (\$1,000)	\$0	\$0	\$0
Transfer Costs (\$1,000)	\$0	\$0	\$0
Shortage Costs (\$1,000)	\$0	\$0	\$0
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) (\$1,000)	-\$8,333	-\$8,643	\$310
Excess Water Savings (\$1,000)	-\$3,980	-\$4,176	\$196
<b>Average Annual Changes in Water Supply Costs (\$1,000)</b>	<b>-\$4,499</b>	<b>-\$4,645</b>	<b>\$146</b>

Note: In 2012 dollars

The changes in M&I water supply costs would result in changes to employment and regional economic output, as summarized in Table 19.105.

**Table 19.105 Changes in Municipal and Industrial Water Supply Related Employment and Regional Economic Output for the Central Coast Region under Alternative 3 as Compared to the Second Basis of Comparison**

Economic Sectors	Employment				Economic Output (\$ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	-0.1	1.2	1.0
Mining & Logging	0	0	0	0	0.0	-1.5	2.8	1.2
Construction	0	0	0	0	0.0	-48.1	2.9	-45.2
Manufacturing	0	0	0	0	0.0	-6.4	15.4	9.0
Transportation, Warehousing & Utilities	-2	0	0	-2	-359.9	-4.1	16.7	-347.2
Wholesale Trade	0	0	0	0	0.0	-1.2	17.2	16.1
Retail Trade	0	0	0	0	0.0	-1.5	35.5	34.1
Information	0	0	0	0	0.0	-2.9	11.6	8.8
Financial Activities	0	0	0	0	0.0	-16.4	104.9	88.5
Services	0	0	1	1	0.0	-39.8	133.4	93.6
Government	0	0	0	0	0.0	-0.2	3.9	3.7
<b>Total</b>	<b>-2</b>	<b>-1</b>	<b>2</b>	<b>0</b>	<b>-359.9</b>	<b>-122.1</b>	<b>345.5</b>	<b>-136.5</b>

Note: In 2012 dollars

#### *Regional Changes to Recreational Opportunities*

Changes in CVP and SWP water supplies and operations under Alternative 3 as compared to the Second Basis of Comparison generally would result in similar reservoir elevations in reservoirs that store CVP and SWP water and similar

1 recreational economic factors under Alternative 3 as compared to the Second  
 2 Basis of Comparison.

3 *Southern California Region*

4 *Regional Changes to Irrigated Agriculture*

5 It is anticipated that as in the Central Valley Region, reductions in CVP and SWP  
 6 water supplies within the Southern California Region would not result in  
 7 reductions in long-term irrigated acreage or land use changes due to the use of  
 8 other water supplies. However, there could be a reduction in irrigated acreage in  
 9 dry and critical dry years under Alternative 3 as compared to the Second Basis of  
 10 Comparison.

11 *Regional Changes to Municipal and Industrial Water Supplies*

12 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
 13 and SWP water supplies would be less under Alternative 3 than under the Second  
 14 Basis of Comparison. The analysis assumed CVP and SWP water deliveries, as  
 15 described in Chapter 5, and determined the need for new water supplies, changes  
 16 in water storage and groundwater pumping, water transfers, water shortage costs,  
 17 and excess water savings. The factors and basis of the analysis is described in  
 18 detail in Appendix 19A, CWEST Model. The analysis assumes that no new  
 19 annual transfer supplies would be implemented until shortages were greater than  
 20 5 percent. The costs of these shortages are included in the analysis. It is assumed  
 21 that some communities that do not have alternative water supplies would utilize  
 22 water transfers.

23 The average annual water supply costs over the 81-year hydrologic period for  
 24 M&I water supplies would increase by 1.83 percent, as presented in Table 19.106;  
 25 and therefore, the results would be similar under Alternative 3 and the Second  
 26 Basis of Comparison.

27 **Table 19.106 Changes in Municipal and Industrial Water Supply Costs for the**  
 28 **Southern California Region under Alternative 3 as Compared to the Second Basis**  
 29 **of Comparison**

Differences in Total	Alternative 3	Second Basis of Comparison	Changes
Average Annual CVP/SWP Deliveries (TAF)	2,241	2,394	-153
Delivery Cost (\$1,000)	\$278,085	\$296,795	-\$18,710
Assumed New Supply Deliveries (TAF)	40	11	28
Annualized New Supply Costs (\$1,000)	\$10,584	\$4,032	\$6,552
Water Storage Costs (\$1,000)	\$8,154	\$2,824	\$5,330
Lost Water Sales Revenues (\$1,000)	\$11,409	\$1,119	\$10,289
Transfer Costs (\$1,000)	\$6,181	\$3,705	\$2,476
Shortage Costs (\$1,000)	\$12,632	\$353	\$12,279
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) (\$1,000)	-\$81,693	-\$91,507	\$9,814
Excess Water Savings (\$1,000)	-\$9,005	-\$10,573	\$1,568
<b>Average Annual Changes in Water Supply Costs (\$1,000)</b>	<b>\$236,347</b>	<b>\$206,749</b>	<b>\$29,598</b>

30 Note: In 2012 dollars

1 The changes in M&I water supply costs would result in changes to employment  
2 and regional economic output, as summarized in Table 19.107.

3 **Table 19.107 Changes in Municipal and Industrial Water Supply Related**  
4 **Employment and Regional Economic Output for the Southern California Region**  
5 **under Alternative 3 as Compared to the Second Basis of Comparison**

Economic Sectors	Employment				Economic Output (\$ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	1	1	0.0	-2.0	126.3	124.4
Mining & Logging	0	0	1	0	0.0	-25.7	169.2	143.5
Construction	0	-7	1	-5	0.0	-813.9	183.7	-630.2
Manufacturing	0	0	5	4	0.0	-227.1	3,152.0	2,924.9
Transportation, Warehousing & Utilities	-27	0	5	-22	-6,828.3	-92.6	1,213.1	-5,707.8
Wholesale Trade	0	0	9	9	0.0	-43.0	1,933.5	1,890.4
Retail Trade	0	0	27	27	0.0	-26.7	2,418.2	2,391.5
Information	0	0	3	3	0.0	-99.7	1,366.4	1,266.7
Financial Activities	0	-1	24	23	0.0	-395.4	8,301.7	7,906.3
Services	0	-7	99	92	0.0	-866.5	9,538.4	8,671.9
Government	0	0	1	1	0.0	-4.7	272.6	268.0
<b>Total</b>	<b>-27</b>	<b>-17</b>	<b>177</b>	<b>132</b>	<b>-6,828.3</b>	<b>-2,597.1</b>	<b>28,675.1</b>	<b>19,249.7</b>

6 Note: In 2012 dollars

#### 7 *Regional Changes to Recreational Opportunities*

8 Changes in CVP and SWP water supplies and operations under Alternative 3 as  
9 compared to the Second Basis of Comparison generally would result in similar  
10 reservoir elevations in reservoirs that store CVP and SWP water and similar  
11 recreational economic factors under Alternative 3 as compared to the Second  
12 Basis of Comparison.

#### 13 **19.4.3.5 Alternative 4**

14 The CVP and SWP operations under Alternative 4 are identical to the CVP and  
15 SWP operations under the Second Basis of Comparison and Alternative 1, as  
16 described in Chapter 3, Description of Alternatives. In addition, Alternative 4  
17 includes Striped Bass predation control which would reduce recreational  
18 opportunities. The non-recreational socioeconomic factors under Alternative 4  
19 would be identical to the conditions under the Second Basis of Comparison.  
20 Alternative 4 is compared to the No Action Alternative and the Second Basis of  
21 Comparison.

#### 22 **19.4.3.5.1 Alternative 4 Compared to the No Action Alternative**

23 The CVP and SWP operations under Alternative 4 are identical to the CVP and  
24 SWP operations under the Second Basis of Comparison and Alternative 1.  
25 Therefore, changes in non-recreational socioeconomic factors under Alternative 4  
26 as compared to the No Action Alternative would be the similar to impacts  
27 described in Section 12.4.3.2.1, Alternative 1 Compared to the No Action

1 Alternative. Recreational opportunities related to Striped Bass fishing would  
2 initially be increased when Alternative 4 is implemented. However, by 2030,  
3 Striped Bass fishing opportunities would be reduced under Alternative 4 as  
4 compared to the No Action Alternative due to actions to reduce predation.  
5 Commercial and sport ocean salmon fishing opportunities would be reduced  
6 under Alternative 4 as compared to the No Action Alternative due to increased  
7 harvest limitations.

#### 8 **19.4.3.5.2 Alternative 4 Compared to the Second Basis of Comparison**

9 As described in Chapter 3, Description of Alternatives, socioeconomic factors  
10 under Alternative 4 are the same as non-recreational socioeconomic factors under  
11 the Second Basis of Comparison. Recreational opportunities related to Striped  
12 Bass fishing would initially be increased when Alternative 4 is implemented.  
13 However, by 2030, Striped Bass fishing opportunities would be reduced under  
14 Alternative 4 as compared to the Second Basis of Comparison due to actions to  
15 reduce predation. Commercial and sport ocean salmon fishing opportunities  
16 would be reduced under Alternative 4 as compared to the Second Basis of  
17 Comparison due to increased harvest limitations.

#### 18 **19.4.3.6 Alternative 5**

19 As described in Chapter 3, Description of Alternatives, CVP and SWP operations  
20 under Alternative 5 are similar to the No Action Alternative with modified Old  
21 and Middle River flow criteria and New Melones Reservoir operations. As  
22 described in Chapter 4, Approach to Environmental Analysis, Alternative 5 is  
23 compared to the No Action Alternative and the Second Basis of Comparison.

#### 24 **19.4.3.6.1 Alternative 5 Compared to the No Action Alternative**

##### 25 *Trinity River Region*

##### 26 *Regional Changes to Irrigated Agriculture*

27 There are no agricultural lands irrigated with CVP and SWP water supplies in the  
28 Trinity River Region. Therefore, there would be no changes in irrigated lands  
29 under Alternative 5 as compared to the No Action Alternative.

##### 30 *Regional Changes to Municipal and Industrial Water Supplies*

31 The CVP would continue to release water in Trinity River for downstream  
32 beneficial uses, including water supplies under Alternative 5 as compared to the  
33 No Action Alternative. There are no CVP or SWP water contractors in the  
34 Trinity River Region.

##### 35 *Regional Changes to Recreational Opportunities*

36 Recreational opportunities would be similar in the Trinity River Region under  
37 Alternative 5 as compared to the No Action Alternative as described in  
38 Chapter 15, Recreational Resources.

1 *Regional Changes to Salmon Fishing*

2 Trinity River flows would be similar under Alternative 5 as compared to the No  
3 Action Alternative. This could result in similar salmon harvest conditions by the  
4 Yurok and Hoopa Valley tribes.

5 *Central Valley Region*

6 *Regional Changes to Irrigated Agriculture*

7 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
8 and SWP water supplies would be similar under Alternative 5 and the No Action  
9 Alternative. It is anticipated that groundwater use would be similar and  
10 sustainable groundwater management plans would not be fully implemented until  
11 the 2040s, as discussed in Chapter 12, Agricultural Resources.

12 The agricultural production value under long-term average conditions would be  
13 the same under Alternative 5 as the No Action Alternative. The agricultural  
14 production value under dry and critical dry conditions also would be reduced by  
15 less than 1 percent (\$0.8 million/year increase in the Sacramento Valley and \$2.7  
16 million/year decrease in the San Joaquin Valley), although groundwater pumping  
17 is not anticipated to change.

18 The overall decrease in agricultural production values are less than 0.05 percent  
19 under long-term conditions; and, changes in employment and regional economic  
20 output would be minimal. Therefore, the analysis of employment and regional  
21 economic output is focused on dry and critical dry years.

22 The direct changes in agricultural production would result in changes to  
23 employment and regional economic output in the Sacramento and San Joaquin  
24 valleys, as summarized in Tables 19.108 and 19.109, respectively.

25 **Table 19.108 Changes in Agricultural-Related Employment and Regional Economic**  
26 **Output for the Sacramento Valley under Alternative 5 as compared to the No**  
27 **Action Alternative in Dry and Critical Dry Years**

Economic Sectors	Employment				Economic Output (\$ millions)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	3	2	0	4	0.8	0.1	0.0	0.9
Mining & Logging	0	0	0	0	0.0	0.0	0.0	0.0
Construction	0	0	0	0	0.0	0.0	0.0	0.0
Manufacturing	0	0	0	0	0.0	0.0	0.0	0.0
Transportation, Warehousing & Utilities	0	0	0	0	0.0	0.0	0.0	0.0
Wholesale Trade	0	0	0	0	0.0	0.0	0.0	0.0
Retail Trade	0	0	0	0	0.0	0.0	0.0	0.0
Information	0	0	0	0	0.0	0.0	0.0	0.0
Financial Activities	0	0	0	0	0.0	0.1	0.1	0.2
Services	0	0	1	2	0.0	0.0	0.1	0.1
Government	0	0	0	0	0.0	0.0	0.0	0.0
<b>Total</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>7</b>	<b>0.8</b>	<b>0.2</b>	<b>0.3</b>	<b>1.3</b>

28 Note: In 2012 dollars



1 **Table 19.109 Changes in Agricultural-Related Employment and Regional Economic**  
 2 **Output for the San Joaquin Valley under Alternative 5 as compared to the No**  
 3 **Action Alternative in Dry and Critical Dry Years**

Economic Sectors	Employment				Economic Output (\$ millions)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	-5	-9	0	-14	-2.7	-0.4	0.0	-3.0
Mining & Logging	0	0	0	0	0.0	0.0	0.0	0.0
Construction	0	0	0	0	0.0	0.0	0.0	0.0
Manufacturing	0	0	0	0	0.0	-0.2	-0.1	-0.2
Transportation, Warehousing & Utilities	0	0	0	-1	0.0	-0.1	0.0	-0.1
Wholesale Trade	0	0	0	0	0.0	0.0	0.0	-0.1
Retail Trade	0	0	-2	-2	0.0	0.0	-0.1	-0.1
Information	0	0	0	0	0.0	0.0	0.0	0.0
Financial Activities	0	-1	-1	-1	0.0	-0.2	-0.3	-0.5
Services	0	-1	-4	-5	0.0	-0.1	-0.4	-0.4
Government	0	0	0	0	0.0	0.0	0.0	0.0
<b>Total</b>	<b>-5</b>	<b>-11</b>	<b>-7</b>	<b>-24</b>	<b>-2.7</b>	<b>-0.9</b>	<b>-1.0</b>	<b>-4.6</b>

4 Note: In 2012 dollars

5 As described in Chapter 11, Geology and Soils Resources, increased groundwater  
 6 pumping under the long-term average conditions may result in an additional  
 7 increment of subsidence in those areas within the Central Valley. The additional  
 8 amount of subsidence and the economic costs associated with it have not been  
 9 quantified in this EIS. However, total subsidence-related costs have been shown  
 10 to be substantial, as reported by Borchers et al. (2014) who estimated that the cost  
 11 of subsidence in San Joaquin Valley between 1955 and 1972 was more than  
 12 \$1.3 billion (in 2013 dollars). These estimates are based on the impacts to major  
 13 infrastructure in the region including the San Joaquin River, Delta Mendota  
 14 Canal, Friant-Kern Canal and San Luis Canal in addition to privately owned  
 15 infrastructure. The incremental subsidence-related costs, expressed on an annual  
 16 basis, could be an unknown fraction of that cumulative cost.

17 *Regional Changes to Municipal and Industrial Water Supplies*

18 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
 19 and SWP water supplies would be similar in the Sacramento Valley and lower in  
 20 the San Joaquin Valley under Alternative 5 and the No Action Alternative. The  
 21 analysis assumed CVP and SWP water deliveries, as described in Chapter 5, and  
 22 determined the need for new water supplies, changes in water storage and  
 23 groundwater pumping, water transfers, water shortage costs, and excess water  
 24 savings. The factors and basis of the analysis is described in detail in  
 25 Appendix 19A, CWEST Model. The analysis assumes that no new annual  
 26 transfer supplies would be implemented until shortages were greater than  
 27 5 percent. The costs of these shortages are included in the analysis. It is assumed  
 28 that some communities that do not have alternative water supplies would utilize  
 29 water transfers.

1 The average annual water supply costs over the 81-year hydrologic period for  
 2 M&I water supplies are presented in Tables 19.110 and 19.111 for the  
 3 Sacramento and San Joaquin Valley, respectively. Average annual water supply  
 4 operating expenses would be similar (within 0.05 percent change) for the  
 5 Sacramento Valley, and increase by 0.07 percent in the San Joaquin Valley; and  
 6 therefore, the results would be similar under Alternative 5 and the No Action  
 7 Alternative.

8 **Table 19.110 Changes in Municipal and Industrial Water Supply Costs for the**  
 9 **Sacramento Valley under Alternative 5 as compared to the No Action Alternative**

Differences in Total	Alternative 5	No Action Alternative	Changes
Average Annual CVP/SWP Deliveries (TAF)	447	447	-1
Delivery Cost (\$1,000)	\$8,022	\$8,031	-\$8
Assumed New Supply Deliveries (TAF)	0	0	0
Annualized New Supply Costs (\$1,000)	\$0	\$0	\$0
Water Storage Costs (\$1,000)	\$0	\$0	\$0
Lost Water Sales Revenues (\$1,000)	\$204	\$213	-\$9
Transfer Costs (\$1,000)	\$752	\$739	\$12
Shortage Costs (\$1,000)	\$68	\$69	-\$2
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) (\$1,000)	-\$3,856	-\$3,858	\$1
Excess Water Savings (\$1,000)	-\$2,266	-\$2,275	\$10
<b>Average Annual Changes in Water Supply Costs (\$1,000)</b>	<b>\$2,924</b>	<b>\$2,919</b>	<b>\$5</b>

10 Note: In 2012 dollars

11 **Table 19.111 Changes in Municipal and Industrial Water Supply Costs for the San**  
 12 **Joaquin Valley under Alternative 5 as compared to the No Action Alternative**

Differences in Total	Alternative 5	No Action Alternative	Changes
Average Annual CVP/SWP Deliveries (TAF)	211	214	-3
Delivery Cost (\$1,000)	\$3,411	\$3,460	-\$49
Assumed New Supply Deliveries (TAF)	2	2	1
Annualized New Supply Costs (\$1,000)	\$601	\$429	\$171
Water Storage Costs (\$1,000)	\$966	\$942	\$24
Lost Water Sales Revenues (\$1,000)	\$361	\$361	\$0
Transfer Costs (\$1,000)	\$2,661	\$2,673	-\$12
Shortage Costs (\$1,000)	\$115	\$115	\$0
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) (\$1,000)	-\$15,329	-\$15,377	\$49
Excess Water Savings (\$1,000)	-\$996	-\$1,029	\$33
<b>Average Annual Changes in Water Supply Costs (\$1,000)</b>	<b>-\$8,211</b>	<b>-\$8,427</b>	<b>\$215</b>

13 Note: In 2012 dollars

14 The changes in M&I water supply costs would result in changes to employment  
 15 and regional economic output in the Sacramento and San Joaquin valleys, as  
 16 summarized in Tables 19.112 and 19.113, respectively.

1 **Table 19.112 Changes in Municipal and Industrial Water Supply Related**  
 2 **Employment and Regional Economic Output for the Sacramento Valley under**  
 3 **Alternative 5 as compared to the No Action Alternative**

Economic Sectors	Employment				Economic Output (\$ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	0.0	0.0	0.0
Mining & Logging	0	0	0	0	0.0	0.0	0.0	0.0
Construction	0	0	0	0	0.0	-0.8	0.1	-0.7
Manufacturing	0	0	0	0	0.0	-0.1	0.6	0.5
Transportation, Warehousing & Utilities	0	0	0	0	-7.8	-0.1	0.5	-7.4
Wholesale Trade	0	0	0	0	0.0	0.0	0.7	0.7
Retail Trade	0	0	0	0	0.0	0.0	1.2	1.1
Information	0	0	0	0	0.0	-0.1	0.5	0.4
Financial Activities	0	0	0	0	0.0	-0.4	3.7	3.4
Services	0	0	0	0	0.0	-0.8	3.9	3.0
Government	0	0	0	0	0.0	0.0	0.1	0.1
<b>Total</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>-7.8</b>	<b>-2.3</b>	<b>11.2</b>	<b>1.1</b>

4 Note: In 2012 dollars

5 **Table 19.113 Changes in Municipal and Industrial Water Supply Related**  
 6 **Employment and Regional Economic Output for the San Joaquin Valley under**  
 7 **Alternative 5 as compared to the No Action Alternative**

Economic Sectors	Employment				Economic Output (\$ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	0.1	0.7	0.8
Mining & Logging	0	0	0	0	0.0	0.4	0.7	1.0
Construction	0	0	0	0	0.0	13.9	0.6	14.5
Manufacturing	0	0	0	0	0.0	1.4	4.8	6.2
Transportation, Warehousing & Utilities	1	0	0	1	146.6	1.4	4.6	152.6
Wholesale Trade	0	0	0	0	0.0	0.4	3.9	4.3
Retail Trade	0	0	0	0	0.0	0.4	10.6	11.0
Information	0	0	0	0	0.0	1.0	2.8	3.8
Financial Activities	0	0	0	0	0.0	4.5	27.7	32.3
Services	0	0	0	0	0.0	12.2	31.1	43.3
Government	0	0	0	0	0.0	0.1	1.3	1.5
<b>Total</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>146.6</b>	<b>35.8</b>	<b>88.8</b>	<b>271.2</b>

8 Note: In 2012 dollars

9 *Regional Changes to Recreational Opportunities*

10 Recreational opportunities at San Luis Reservoir would be similar under  
 11 Alternative 5 as compared to the No Action Alternative, as described in  
 12 Chapter 15, Recreation Resources. Therefore, it is anticipated that recreational

1 economic factors would be similar under Alternative 5 as compared to the No  
2 Action Alternative.

3 *Effects Related to Cross Delta Water Transfers*

4 Potential effects to socioeconomic factors could be similar to those identified in a  
5 recent environmental analysis conducted by Reclamation for long-term water  
6 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as  
7 described above under the No Action Alternative compared to the Second Basis  
8 of Comparison. For the purposes of this EIS, it is anticipated that similar  
9 conditions would occur during implementation of cross Delta water transfers  
10 under Alternative 5 and the No Action Alternative, and that impacts on  
11 socioeconomic factors could be adverse in the seller's service area.

12 Under Alternative 5 and the No Action Alternative, the timing of cross Delta  
13 water transfers would be limited to July through September and include annual  
14 volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO.  
15 Overall, the potential for cross Delta water transfers would be similar under  
16 Alternative 5 and the No Action Alternative.

17 *San Francisco Bay Area Region*

18 *Regional Changes to Irrigated Agriculture*

19 It is anticipated that as in the Central Valley Region, CVP and SWP water  
20 supplies within the San Francisco Bay Area Region would be similar under  
21 Alternative 5 and the No Action Alternative, and would not result in changes in  
22 irrigated acreage or land use changes due to the use of other water supplies.

23 *Regional Changes to Municipal and Industrial Water Supplies*

24 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
25 and SWP water supplies would be lower under Alternative 5 and the No Action  
26 Alternative. The analysis assumed CVP and SWP water deliveries, as described  
27 in Chapter 5, and determined the need for new water supplies, changes in water  
28 storage and groundwater pumping, water transfers, water shortage costs, and  
29 excess water savings. The factors and basis of the analysis is described in detail  
30 in Appendix 19A, CWEST Model. The analysis assumes that no new annual  
31 transfer supplies would be implemented until shortages were greater than  
32 5 percent. The costs of these shortages are included in the analysis.

33 The average annual water supply operating expenses over the 81-year hydrologic  
34 period for M&I water supplies would be increase by 0.1 percent, as presented in  
35 Table 19.114; and therefore, the results would be similar under Alternative 5 and  
36 the No Action Alternative.

1 **Table 19.114 Changes in Municipal and Industrial Water Supply Costs for the San**  
 2 **Francisco Bay Area Region under Alternative 5 as compared to the No Action**  
 3 **Alternative**

Differences in Total	Alternative 5	No Action Alternative	Changes
Average Annual CVP/SWP Deliveries (TAF)	394	396	-3
Delivery Cost (\$1,000)	\$10,962	\$11,044	-\$82
Assumed New Supply Deliveries (TAF)	18	18	0
Annualized New Supply Costs (\$1,000)	\$599	\$599	\$0
Water Storage Costs (\$1,000)	\$1,495	\$1,577	-\$81
Lost Water Sales Revenues (\$1,000)	\$4,360	\$4,286	\$74
Transfer Costs (\$1,000)	\$6,156	\$5,722	\$434
Shortage Costs (\$1,000)	\$1,450	\$1,410	\$40
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) (\$1,000)	-\$470	-\$493	\$24
Excess Water Savings (\$1,000)	-\$225	-\$225	\$0
<b>Average Annual Changes in Water Supply Costs (\$1,000)</b>	<b>\$24,328</b>	<b>\$23,919</b>	<b>\$409</b>

4 Note: In 2012 dollars

5 The changes in M&I water supply costs would result in changes to employment  
 6 and regional economic output, as summarized in Table 19.115.

7 **Table 19.115 Changes in Municipal and Industrial Water Supply Related**  
 8 **Employment and Regional Economic Output for the San Francisco Bay Area**  
 9 **Region under Alternative 5 as compared to the No Action Alternative**

Economic Sectors	Employment				Economic Output (\$ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	0.0	0.5	0.5
Mining & Logging	0	0	0	0	0.0	-0.2	0.3	0.1
Construction	0	0	0	0	0.0	-17.4	2.4	-15.0
Manufacturing	0	0	0	0	0.0	-3.2	30.9	27.8
Transportation, Warehousing & Utilities	-1	0	0	-1	-163.1	-1.2	11.8	-152.5
Wholesale Trade	0	0	0	0	0.0	-0.5	22.9	22.4
Retail Trade	0	0	0	0	0.0	-0.5	36.4	35.9
Information	0	0	0	0	0.0	-1.8	19.8	18.0
Financial Activities	0	0	0	0	0.0	-6.1	112.3	106.2
Services	0	0	1	1	0.0	-14.6	139.4	124.8
Government	0	0	0	0	0.0	-0.1	3.6	3.5
<b>Total</b>	<b>-1</b>	<b>0</b>	<b>2</b>	<b>1</b>	<b>-163.1</b>	<b>-45.5</b>	<b>380.3</b>	<b>171.7</b>

10 Note: In 2012 dollars

1        *Regional Changes to Recreational Opportunities*

2        Changes in CVP and SWP water supplies and operations under Alternative 5 as  
3        compared to the No Action Alternative generally would result in similar reservoir  
4        elevations in reservoirs that store CVP and SWP water and similar recreational  
5        economic factors under Alternative 5 as compared o the No Action Alternative.

6        *Regional Changes to Salmon Fishing*

7        Changes in commercial and sport ocean salmon fishing primarily would be  
8        related to the presence of fall-run Chinook Salmon from Central Valley  
9        hatcheries. It is assumed that the production of hatchery fish would be similar  
10       under Alternative 15 and the No Action Alternative. However, survival of the  
11       fall-run Chinook Salmon hatchery fish to the Pacific Ocean could be related to  
12       changes in CVP and SWP operations. As described in Chapter 9, Fish and  
13       Aquatic Resources, there would be little change in through-Delta survival by  
14       emigrating natural juvenile fall-run Chinook Salmon under Alternative 5 and the  
15       No Action Alternative. It is assumed that the survival of the hatchery juvenile  
16       fall-run Chinook Salmon would be similar to the survival of the natural juvenile  
17       fall-run Chinook Salmon. Therefore, the availability of fish for commercial and  
18       sport ocean salmon fishing and the associated economic conditions for the fishing  
19       industry would be similar under Alternative 5 and the No Action Alternative.

20       *Central Coast Region*

21       *Regional Changes to Irrigated Agriculture*

22       It is anticipated that as in the Central Valley Region, increases in CVP and SWP  
23       water supplies within the Central Coast Region would be lower under  
24       Alternative 5 and the No Action Alternative, and would not result in changes in  
25       irrigated acreage or land use changes due to the use of other water supplies.

26       *Regional Changes to Municipal and Industrial Water Supplies*

27       As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
28       and SWP water supplies would be similar under Alternative 5 and the No Action  
29       Alternative. The analysis assumed CVP and SWP water deliveries, as described  
30       in Chapter 5, and determined the need for new water supplies, changes in water  
31       storage and groundwater pumping, water transfers, water shortage costs, and  
32       excess water savings. The factors and basis of the analysis is described in detail  
33       in Appendix 19A, CWEST Model. The analysis assumes that no new annual  
34       transfer supplies would be implemented until shortages were greater than  
35       5 percent. The costs of these shortages are included in the analysis. It is assumed  
36       that some communities that do not have alternative water supplies would utilize  
37       water transfers.

38       The average annual water supply operating expenses over the 81-year hydrologic  
39       period for M&I water supplies would increase by 0.06 percent, as presented in  
40       Table 19.116; and therefore, the results would be similar under Alternative 5 and  
41       the No Action Alternative.

1 **Table 19.116 Changes in Municipal and Industrial Water Supply Costs for the**  
 2 **Central Coast Region under Alternative 5 as compared to the No Action Alternative**

Differences in Total	Alternative 5	No Action Alternative	Changes
Average Annual CVP/SWP Deliveries (TAF)	43	44	-1
Delivery Cost (\$1,000)	\$6,567	\$6,663	-\$97
Assumed New Supply Deliveries (TAF)	0	0	0
Annualized New Supply Costs (\$1,000)	\$0	\$0	\$0
Water Storage Costs (\$1,000)	\$0	\$0	\$0
Lost Water Sales Revenues (\$1,000)	\$0	\$0	\$0
Transfer Costs (\$1,000)	\$0	\$0	\$0
Shortage Costs (\$1,000)	\$0	\$0	\$0
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) (\$1,000)	-\$8,018	-\$8,068	\$50
Excess Water Savings (\$1,000)	-\$2,899	-\$2,970	\$70
<b>Average Annual Changes in Water Supply Costs (\$1,000)</b>	<b>-\$4,350</b>	<b>-\$4,374</b>	<b>\$23</b>

3 Note: In 2012 dollars

4 The changes in M&I water supply costs would result in changes to employment  
 5 and regional economic output, as summarized in Table 19.117.

6 **Table 19.117 Changes in Municipal and Industrial Water Supply Related**  
 7 **Employment and Regional Economic Output for the Central Coast Region under**  
 8 **Alternative 5 as compared to the No Action Alternative**

Economic Sectors	Employment				Economic Output (\$ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	0.0	0.3	0.2
Mining & Logging	0	0	0	0	0.0	-0.4	0.6	0.2
Construction	0	0	0	0	0.0	-13.0	0.7	-12.3
Manufacturing	0	0	0	0	0.0	-1.7	3.5	1.8
Transportation, Warehousing & Utilities	0	0	0	0	-97.1	-1.1	3.9	-94.3
Wholesale Trade	0	0	0	0	0.0	-0.3	4.0	3.7
Retail Trade	0	0	0	0	0.0	-0.4	8.1	7.8
Information	0	0	0	0	0.0	-0.8	2.7	1.9
Financial Activities	0	0	0	0	0.0	-4.4	24.1	19.7
Services	0	0	0	0	0.0	-10.7	30.7	19.9
Government	0	0	0	0	0.0	-0.1	0.9	0.8
<b>Total</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>-97.1</b>	<b>-32.9</b>	<b>79.5</b>	<b>-50.5</b>

9 Note: In 2012 dollars

10 *Regional Changes to Recreational Opportunities*

11 Changes in CVP and SWP water supplies and operations under Alternative 5 as  
 12 compared to the No Action Alternative generally would result in similar reservoir

1 elevations in reservoirs that store CVP and SWP water and similar recreational  
 2 economic factors under Alternative 5 as compared to the No Action Alternative.

3 *Southern California Region*

4 *Regional Changes to Irrigated Agriculture*

5 It is anticipated that as in the Central Valley Region, increases in CVP and SWP  
 6 water supplies within the Southern California Region would be similar under  
 7 Alternative 5 and the No Action Alternative, and would not result in changes in  
 8 irrigated acreage or land use changes due to the use of other water supplies.

9 *Regional Changes to Municipal and Industrial Water Supplies*

10 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
 11 and SWP water supplies would be lower under Alternative 5 and the No Action  
 12 Alternative. The analysis assumed CVP and SWP water deliveries, as described  
 13 in Chapter 5, and determined the need for new water supplies, changes in water  
 14 storage and groundwater pumping, water transfers, water shortage costs, and  
 15 excess water savings. The factors and basis of the analysis is described in detail  
 16 in Appendix 19A, CWEST Model. The analysis assumes that no new annual  
 17 transfer supplies would be implemented until shortages were greater than  
 18 5 percent. The costs of these shortages are included in the analysis. It is assumed  
 19 that some communities that do not have alternative water supplies would utilize  
 20 water transfers.

21 The average annual water supply operating expenses over the 81-year hydrologic  
 22 period for M&I water supplies would be increase by 0.37 percent, as presented in  
 23 Table 19.118; and therefore, the results would be similar under Alternative 5 and  
 24 the No Action Alternative.

25 **Table 19.118 Changes in Municipal and Industrial Water Supply Costs for the**  
 26 **Southern California Region under Alternative 5 as compared to the No Action**  
 27 **Alternative**

Differences in Total	Alternative 5	No Action Alternative	Changes
Average Annual CVP/SWP Deliveries (TAF)	1,912	1,932	-20
Delivery Cost (\$1,000)	\$237,118	\$239,692	-\$2,575
Assumed New Supply Deliveries (TAF)	81	47	34
Annualized New Supply Costs (\$1,000)	\$24,191	\$12,688	\$11,503
Water Storage Costs (\$1,000)	\$7,474	\$7,598	-\$124
Lost Water Sales Revenues (\$1,000)	\$14,206	\$14,614	-\$408
Transfer Costs (\$1,000)	\$10,505	\$11,484	-\$979
Shortage Costs (\$1,000)	\$16,662	\$17,319	-\$657
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) (\$1,000)	-\$58,323	-\$57,474	-\$849
Excess Water Savings (\$1,000)	-\$4,588	-\$4,629	\$41
<b>Average Annual Changes in Water Supply Costs (\$1,000)</b>	<b>\$247,243</b>	<b>\$241,291</b>	<b>\$5,952</b>

28 Note: In 2012 dollars



1 The changes in M&I water supply costs would result in changes to employment  
 2 and regional economic output, as summarized in Table 19.119.

3 **Table 19.119 Changes in Municipal and Industrial Water Supply Related**  
 4 **Employment and Regional Economic Output for the Southern California under**  
 5 **Alternative 5 as compared to the No Action Alternative**

Economic Sectors	Employment				Economic Output (\$ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	2.5	3.3	5.9
Mining & Logging	0	0	0	0	0.0	33.1	3.3	36.4
Construction	0	9	0	9	0.0	1,049.4	5.1	1,054.5
Manufacturing	0	0	0	1	0.0	292.8	80.2	373.0
Transportation, Warehousing & Utilities	35	0	0	36	8,804.2	119.3	37.0	8,960.5
Wholesale Trade	0	0	0	0	0.0	55.5	-0.2	55.3
Retail Trade	0	0	1	2	0.0	34.4	99.3	133.7
Information	0	0	0	0	0.0	128.5	32.2	160.8
Financial Activities	0	2	1	2	0.0	509.8	257.7	767.4
Services	0	9	3	13	0.0	1,117.3	301.8	1,419.1
Government	0	0	0	0	0.0	6.0	7.6	13.6
<b>Total</b>	<b>35</b>	<b>22</b>	<b>6</b>	<b>63</b>	<b>8,804.2</b>	<b>3,348.6</b>	<b>827.3</b>	<b>12,980.1</b>

6 Note: In 2012 dollars

7 *Regional Changes to Recreational Opportunities*

8 Changes in CVP and SWP water supplies and operations under Alternative 5 as  
 9 compared to the No Action Alternative generally would result in similar reservoir  
 10 elevations in reservoirs that store CVP and SWP water and similar recreational  
 11 economic factors under Alternative 5 as compared to the No Action Alternative.

12 **19.4.3.6.2 Alternative 5 Compared to the Second Basis of Comparison**

13 *Trinity River Region*

14 *Regional Changes to Irrigated Agriculture*

15 There are no agricultural lands irrigated with CVP and SWP water supplies in the  
 16 Trinity River Region. Therefore, there would be no changes in irrigated lands  
 17 under Alternative 5 as compared to the Second Basis of Comparison.

18 *Regional Changes to Municipal and Industrial Water Supplies*

19 The CVP would continue to release water in Trinity River for downstream  
 20 beneficial uses, including water supplies under Alternative 5 and the Second Basis  
 21 of Comparison. There are no CVP or SWP water contractors in the Trinity River  
 22 Region.

23 *Regional Changes to Recreational Opportunities*

24 Recreational opportunities would be similar in the Trinity River Region under  
 25 Alternative 5 as compared to the Second Basis of Comparison as described in  
 26 Chapter 15, Recreational Resources.

1        *Regional Changes to Salmon Fishing*

2        Trinity River flows would be similar under Alternative 5 as compared to the  
3        Second Basis of Comparison. This could result in similar salmon harvest  
4        conditions by the Yurok and Hoopa Valley tribes.

5        *Central Valley Region*

6        *Regional Changes to Irrigated Agriculture*

7        As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
8        and SWP water supplies would be less under Alternative 5 than under the Second  
9        Basis of Comparison. It is anticipated that groundwater use would increase in  
10       response to reduced CVP and SWP water supplies in 2030 because sustainable  
11       groundwater management plans would not be fully implemented until the 2040s,  
12       as discussed in Chapter 12, Agricultural Resources.

13       The agricultural production value under long-term average conditions would be  
14       reduced by less than 1 percent (\$1.5 million/year in the Sacramento Valley and  
15       \$0.7 million/year in the San Joaquin Valley) primarily due to an increase in  
16       groundwater pumping of approximately 6 percent. The agricultural production  
17       value under dry and critical dry conditions also would be reduced by less than  
18       1 percent (\$10.5 million/year in the Sacramento Valley and \$22.9 million/year in  
19       the San Joaquin Valley) primarily due to an increase in groundwater pumping.

20       The overall reduction in agricultural production values are less than 0.05 percent  
21       under long-term conditions; and, changes in employment and regional economic  
22       output would be minimal. Therefore, the analysis of employment and regional  
23       economic output is focused on dry and critical dry years.

24       The direct changes in agricultural production would result in changes to  
25       employment and regional economic output in the Sacramento and San Joaquin  
26       valleys, as summarized in Tables 19.120 and 19.121, respectively.

1 **Table 19.120 Changes in Agricultural-Related Employment and Regional Economic**  
 2 **Output for the Sacramento Valley under Alternative 5 as Compared to the Second**  
 3 **Basis of Comparison in Dry and Critical Dry Years**

Economic Sectors	Employment				Economic Output (\$ millions)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	-84	-20	0	-104	-10.5	-1.2	0.0	-11.8
Mining & Logging	0	0	0	0	0.0	0.0	0.0	0.0
Construction	0	-1	0	-1	0.0	-0.1	0.0	-0.1
Manufacturing	0	0	0	0	0.0	-0.1	0.0	-0.1
Transportation, Warehousing & Utilities	0	-1	0	-2	0.0	-0.3	-0.1	-0.5
Wholesale Trade	0	-1	0	-1	0.0	-0.2	-0.1	-0.3
Retail Trade	0	0	-3	-4	0.0	0.0	-0.3	-0.3
Information	0	0	0	0	0.0	0.0	-0.1	-0.1
Financial Activities	0	-7	-2	-8	0.0	-1.6	-0.7	-2.3
Services	0	-3	-10	-13	0.0	-0.3	-0.9	-1.1
Government	0	0	0	0	0.0	-0.1	0.0	-0.1
<b>Total</b>	<b>-84</b>	<b>-34</b>	<b>-17</b>	<b>-135</b>	<b>-10.5</b>	<b>-4.0</b>	<b>-2.2</b>	<b>-16.8</b>

4 Note: In 2012 dollars

5 **Table 19.121 Changes in Agricultural-Related Employment and Regional Economic**  
 6 **Output for the San Joaquin Valley under Alternative 5 as Compared to the Second**  
 7 **Basis of Comparison in Dry and Critical Dry Years**

Economic Sectors	Employment				Economic Output (\$ millions)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	-145	-61	0	-206	-22.9	-2.7	-0.1	-25.7
Mining & Logging	0	-1	0	-1	0.0	-0.3	0.0	-0.4
Construction	0	-2	0	-2	0.0	-0.2	0.0	-0.2
Manufacturing	0	-1	-1	-2	0.0	-2.0	-0.4	-2.4
Transportation, Warehousing & Utilities	0	-3	-1	-4	0.0	-0.9	-0.3	-1.2
Wholesale Trade	0	-2	-1	-3	0.0	-0.4	-0.2	-0.6
Retail Trade	0	0	-9	-9	0.0	0.0	-0.7	-0.8
Information	0	0	0	-1	0.0	-0.1	-0.2	-0.2
Financial Activities	0	-13	-4	-16	0.0	-2.8	-1.8	-4.6
Services	0	-6	-25	-31	0.0	-0.6	-2.1	-2.7
Government	0	-1	0	-1	0.0	-0.2	-0.1	-0.3
<b>Total</b>	<b>-145</b>	<b>-90</b>	<b>-42</b>	<b>-277</b>	<b>-22.9</b>	<b>-10.2</b>	<b>-5.9</b>	<b>-39.0</b>

8 Note: In 2012 dollars

9 As described in Chapter 11, Geology and Soils Resources, increased groundwater  
 10 pumping under the long-term average conditions may result in an additional  
 11 increment of subsidence in those areas within the Central Valley. The additional

1 amount of subsidence and the economic costs associated with it have not been  
 2 quantified in this EIS. However, total subsidence-related costs have been shown  
 3 to be substantial, as reported by Borchers et al. (2014) who estimated that the cost  
 4 of subsidence in San Joaquin Valley between 1955 and 1972 was more than  
 5 \$1.3 billion (in 2013 dollars). These estimates are based on the impacts to major  
 6 infrastructure in the region including the San Joaquin River, Delta Mendota  
 7 Canal, Friant-Kern Canal and San Luis Canal in addition to privately owned  
 8 infrastructure. The incremental subsidence-related costs, expressed on an annual  
 9 basis, could be an unknown fraction of that cumulative cost.

10 *Regional Changes to Municipal and Industrial Water Supplies*

11 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
 12 and SWP water supplies would be less under Alternative 5 than under the Second  
 13 Basis of Comparison. The analysis assumed CVP and SWP water deliveries, as  
 14 described in Chapter 5, and determined the need for new water supplies, changes  
 15 in water storage and groundwater pumping, water transfers, water shortage costs,  
 16 and excess water savings. The factors and basis of the analysis is described in  
 17 detail in Appendix 19A, CWEST Model. The analysis assumes that no new  
 18 annual transfer supplies would be implemented until shortages were greater than  
 19 5 percent. The costs of these shortages are included in the analysis. It is assumed  
 20 that some communities that do not have alternative water supplies would utilize  
 21 water transfers.

22 The average annual water supply costs over the 81-year hydrologic period for  
 23 M&I water supplies are presented in Tables 19.122 and 19.123 for the  
 24 Sacramento and San Joaquin Valley, respectively. Average annual water supply  
 25 operating expenses would increase by 0.11 and 0.47 percent in the Sacramento  
 26 Valley and the San Joaquin Valley, respectively; and therefore, the results would  
 27 be similar under Alternative 5 and the Second Basis of Comparison.

28 **Table 19.122 Changes in Municipal and Industrial Water Supply Costs for the**  
 29 **Sacramento Valley under Alternative 5 as Compared to the Second Basis of**  
 30 **Comparison**

Differences in Total	Alternative 5	Second Basis of Comparison	Changes
Average Annual CVP/SWP Deliveries (TAF)	447	463	-16
Delivery Cost (\$1,000)	\$8,022	\$8,317	-\$295
Assumed New Supply Deliveries (TAF)	0	0	0
Annualized New Supply Costs (\$1,000)	\$0	\$0	\$0
Water Storage Costs (\$1,000)	\$0	\$0	\$0
Lost Water Sales Revenues (\$1,000)	\$204	\$207	-\$3
Transfer Costs (\$1,000)	\$752	\$517	\$235
Shortage Costs (\$1,000)	\$68	\$68	-\$1
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) (\$1,000)	-\$3,856	-\$3,916	\$60
Excess Water Savings (\$1,000)	-\$2,266	-\$2,563	\$298
<b>Average Annual Changes in Water Supply Costs (\$1,000)</b>	<b>\$2,924</b>	<b>\$2,630</b>	<b>\$293</b>

31 Note: In 2012 dollars

1 **Table 19.123 Changes in Municipal and Industrial Water Supply Costs for the San**  
 2 **Joaquin Valley under Alternative 5 as Compared to the Second Basis of**  
 3 **Comparison**

Differences in Total	Alternative 5	Second Basis of Comparison	Changes
Average Annual CVP/SWP Deliveries (TAF)	211	237	-26
Delivery Cost (\$1,000)	\$3,411	\$3,854	-\$443
Assumed New Supply Deliveries (TAF)	2	0	2
Annualized New Supply Costs (\$1,000)	\$601	\$15	\$585
Water Storage Costs (\$1,000)	\$966	\$820	\$146
Lost Water Sales Revenues (\$1,000)	\$361	\$322	\$39
Transfer Costs (\$1,000)	\$2,661	\$2,623	\$38
Shortage Costs (\$1,000)	\$115	\$102	\$13
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) (\$1,000)	-\$15,329	-\$16,011	\$683
Excess Water Savings (\$1,000)	-\$996	-\$1,318	\$322
<b>Average Annual Changes in Water Supply Costs (\$1,000)</b>	<b>-\$8,211</b>	<b>-\$9,593</b>	<b>\$1,381</b>

4 Note: In 2012 dollars

5 The changes in M&I water supply costs would result in changes to employment  
 6 and regional economic output in the Sacramento and San Joaquin valleys, as  
 7 summarized in Tables 19.124 and 19.125, respectively.

8 **Table 19.124 Changes in Municipal and Industrial Water Supply Related**  
 9 **Employment and Regional Economic Output for the Sacramento Valley under**  
 10 **Alternative 5 as Compared to the Second Basis of Comparison**

Economic Sectors	Employment				Economic Output (\$ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	-0.1	1.7	1.6
Mining & Logging	0	0	0	0	0.0	-0.4	0.3	-0.1
Construction	0	0	0	0	0.0	-29.9	2.6	-27.3
Manufacturing	0	0	0	0	0.0	-3.2	22.7	19.5
Transportation, Warehousing & Utilities	-1	0	0	-1	-295.2	-2.9	18.4	-279.6
Wholesale Trade	0	0	0	0	0.0	-1.0	27.8	26.8
Retail Trade	0	0	1	1	0.0	-0.9	47.7	46.8
Information	0	0	0	0	0.0	-3.5	21.1	17.6
Financial Activities	0	0	0	0	0.0	-13.4	151.3	137.9
Services	0	0	2	1	0.0	-31.8	158.5	126.8
Government	0	0	0	0	0.0	-0.2	3.9	3.8
<b>Total</b>	<b>-1</b>	<b>-1</b>	<b>3</b>	<b>1</b>	<b>-295.2</b>	<b>-87.3</b>	<b>456.1</b>	<b>73.6</b>

11 Note: In 2012 dollars

1 **Table 19.125 Changes in Municipal and Industrial Water Supply Related**  
 2 **Employment and Regional Economic Output for the San Joaquin Valley under**  
 3 **Alternative 5 as Compared to the Second Basis of Comparison**

Economic Sectors	Employment				Economic Output (\$ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	0.1	7.4	7.5
Mining & Logging	0	0	0	0	0.0	0.8	7.1	7.8
Construction	0	0	0	0	0.0	27.2	6.1	33.4
Manufacturing	0	0	0	0	0.0	2.8	51.3	54.1
Transportation, Warehousing & Utilities	1	0	0	1	287.4	2.8	49.4	339.5
Wholesale Trade	0	0	0	0	0.0	0.7	42.9	43.6
Retail Trade	0	0	1	1	0.0	0.8	107.9	108.7
Information	0	0	0	0	0.0	2.0	29.8	31.8
Financial Activities	0	0	1	1	0.0	8.9	291.4	300.3
Services	0	0	4	4	0.0	23.9	323.4	347.2
Government	0	0	0	0	0.0	0.2	14.2	14.5
<b>Total</b>	<b>1</b>	<b>1</b>	<b>6</b>	<b>8</b>	<b>287.4</b>	<b>70.1</b>	<b>930.8</b>	<b>1,288.4</b>

4 Note: In 2012 dollars

5 *Regional Changes to Recreational Opportunities*

6 Recreational opportunities would decrease by 6 to 9 percent under Alternative 5  
 7 as compared to the Second Basis of Comparison, depending upon water year type,  
 8 , as described in Chapter 15, Recreation Resources. Therefore, it is anticipated  
 9 that recreational economic factors would be reduced under Alternative 5 as  
 10 compared to the Second Basis of Comparison.

11 *Effects Related to Cross Delta Water Transfers*

12 Potential effects to socioeconomic factors could be similar to those identified in a  
 13 recent environmental analysis conducted by Reclamation for long-term water  
 14 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as  
 15 described above under the No Action Alternative compared to the Second Basis  
 16 of Comparison. For the purposes of this EIS, it is anticipated that similar  
 17 conditions would occur during implementation of cross Delta water transfers  
 18 under Alternative 5 and the Second Basis of Comparison, and that impacts on  
 19 socioeconomic factors could be adverse in the seller's service area.

20 Under Alternative 5, the timing of cross Delta water transfers would be limited to  
 21 July through September and include annual volumetric limits, in accordance with  
 22 the 2008 USFWS BO and 2009 NMFS BO. Under Second Basis of Comparison,  
 23 water could be transferred throughout the year without an annual volumetric limit.  
 24 Overall, the potential for cross Delta water transfers would be decreased under  
 25 Alternative 5 as compared to the Second Basis of Comparison.

1 *San Francisco Bay Area Region*

2 *Regional Changes to Irrigated Agriculture*

3 It is anticipated that as in the Central Valley Region, reductions in CVP and SWP  
 4 water supplies within the San Francisco Bay Area Region would not result in  
 5 reductions in long-term irrigated acreage or land use changes due to the use of  
 6 other water supplies. However, there could be a reduction in irrigated acreage in  
 7 dry and critical dry years under Alternative 5 as compared to the Second Basis of  
 8 Comparison.

9 *Regional Changes to Municipal and Industrial Water Supplies*

10 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
 11 and SWP water supplies would be less under Alternative 5 than under the Second  
 12 Basis of Comparison. The analysis assumed CVP and SWP water deliveries, as  
 13 described in Chapter 5, and determined the need for new water supplies, changes  
 14 in water storage and groundwater pumping, water transfers, water shortage costs,  
 15 and excess water savings. The factors and basis of the analysis is described in  
 16 detail in Appendix 19A, CWEST Model. The analysis assumes that no new  
 17 annual transfer supplies would be implemented until shortages were greater than  
 18 5 percent. The costs of these shortages are included in the analysis.

19 The average annual water supply costs over the 81-year hydrologic period for  
 20 M&I water supplies would increase by 1.85 percent, as presented in Table 19.126;  
 21 and therefore, the results would be similar under Alternative 5 and the Second  
 22 Basis of Comparison.

23 **Table 19.126 Changes in Municipal and Industrial Water Supply Costs for the San**  
 24 **Francisco Bay Area Region under Alternative 5 as Compared to the Second Basis**  
 25 **of Comparison**

Differences in Total	Alternative 5	Second Basis of Comparison	Changes
Average Annual CVP/SWP Deliveries (TAF)	394	445	-51
Delivery Cost (\$1,000)	\$10,962	\$12,515	-\$1,553
Assumed New Supply Deliveries (TAF)	18	16	2
Annualized New Supply Costs (\$1,000)	\$599	\$234	\$365
Water Storage Costs (\$1,000)	\$1,495	\$1,963	-\$467
Lost Water Sales Revenues (\$1,000)	\$4,360	\$1,595	\$2,765
Transfer Costs (\$1,000)	\$6,156	\$1,154	\$5,002
Shortage Costs (\$1,000)	\$1,450	\$523	\$927
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) (\$1,000)	-\$470	-\$792	\$322
Excess Water Savings (\$1,000)	-\$225	-\$549	\$324
<b>Average Annual Changes in Water Supply Costs (\$1,000)</b>	<b>\$24,328</b>	<b>\$16,643</b>	<b>\$7,686</b>

26 Note: In 2012 dollars

27 The changes in M&I water supply costs would result in changes to employment  
 28 and regional economic output, as summarized in Table 19.127.

1 **Table 19.127 Changes in Municipal and Industrial Water Supply Related**  
 2 **Employment and Regional Economic Output for the San Francisco Bay Area**  
 3 **Region under Alternative 5 as Compared to the Second Basis of Comparison**

Economic Sectors	Employment				Economic Output (\$ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	-0.1	8.4	8.3
Mining & Logging	0	0	0	0	0.0	-1.7	5.3	3.5
Construction	0	-1	0	-1	0.0	-176.1	39.5	-136.6
Manufacturing	0	0	1	0	0.0	-32.0	509.0	477.0
Transportation, Warehousing & Utilities	-6	0	1	-5	-1,654.5	-12.4	195.3	-1,471.6
Wholesale Trade	0	0	2	1	0.0	-5.5	373.6	368.1
Retail Trade	0	0	7	7	0.0	-4.7	603.7	599.0
Information	0	0	1	1	0.0	-18.6	326.5	307.9
Financial Activities	0	0	5	5	0.0	-61.9	1,853.1	1,791.2
Services	0	-1	22	20	0.0	-148.2	2,302.6	2,154.4
Government	0	0	0	0	0.0	-0.7	58.7	57.9
<b>Total</b>	<b>-6</b>	<b>-3</b>	<b>37</b>	<b>29</b>	<b>-1,654.5</b>	<b>-462.0</b>	<b>6,275.6</b>	<b>4,159.1</b>

4 Note: In 2012 dollars

5 *Regional Changes to Recreational Opportunities*

6 Changes in CVP and SWP water supplies and operations under Alternative 5 as  
 7 compared to the Second Basis of Comparison generally would result in lower  
 8 reservoir elevations in reservoirs that store CVP and SWP water (up to 10 to  
 9 18 percent); and would result in decreased recreational economic factors under  
 10 Alternative 5 as compared to the Second Basis of Comparison.

11 *Regional Changes to Salmon Fishing*

12 Changes in commercial and sport ocean salmon fishing primarily would be  
 13 related to the presence of fall-run Chinook Salmon from Central Valley  
 14 hatcheries. It is assumed that the production of hatchery fish would be similar  
 15 under Alternative 5 and the Second Basis of Comparison. However, survival of  
 16 the fall-run Chinook Salmon hatchery fish to the Pacific Ocean could be related to  
 17 changes in CVP and SWP operations. As described in Chapter 9, Fish and  
 18 Aquatic Resources, there would be little change in through-Delta survival by  
 19 emigrating natural juvenile fall-run Chinook Salmon under Alternative 5 as  
 20 compared to the Second Basis of Comparison. It is assumed that the survival of  
 21 the hatchery juvenile fall-run Chinook Salmon would be similar to the survival of  
 22 the natural juvenile fall-run Chinook Salmon. Therefore, the availability of fish  
 23 for commercial and sport ocean salmon fishing and the associated economic  
 24 conditions for the fishing industry would be similar under Alternative 5 and the  
 25 Second Basis of Comparison.



1 *Central Coast Region*

2 *Regional Changes to Irrigated Agriculture*

3 It is anticipated that as in the Central Valley Region, reductions in CVP and SWP  
 4 water supplies within the Central Coast Region would not result in reductions in  
 5 long-term irrigated acreage or land use changes due to the use of other water  
 6 supplies. However, there could be a reduction in irrigated acreage in dry and  
 7 critical dry years under Alternative 5 as compared to the Second Basis of  
 8 Comparison.

9 *Regional Changes to Municipal and Industrial Water Supplies*

10 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
 11 and SWP water supplies would be less under Alternative 5 than under the Second  
 12 Basis of Comparison. The analysis assumed CVP and SWP water deliveries, as  
 13 described in Chapter 5, and determined the need for new water supplies, changes  
 14 in water storage and groundwater pumping, water transfers, water shortage costs,  
 15 and excess water savings. The factors and basis of the analysis is described in  
 16 detail in Appendix 19A, CWEST Model. The analysis assumes that no new  
 17 annual transfer supplies would be implemented until shortages were greater than  
 18 5 percent. The costs of these shortages are included in the analysis. It is assumed  
 19 that some communities that do not have alternative water supplies would utilize  
 20 water transfers.

21 The average annual water supply operating expenses over the 81-year hydrologic  
 22 period for M&I water supplies would increase by 0.77 percent, as presented in  
 23 Table 19.128; and therefore, the results would be similar under Alternative 5 and  
 24 the Second Basis of Comparison.

25 **Table 19.128 Changes in Municipal and Industrial Water Supply Costs for the**  
 26 **Central Coast Region under Alternative 5 as Compared to the Second Basis of**  
 27 **Comparison**

Differences in Total	Alternative 5	Second Basis of Comparison	Changes
Average Annual CVP/SWP Deliveries (TAF)	43	54	-11
Delivery Cost (\$1,000)	\$6,567	\$8,174	-\$1,607
Assumed New Supply Deliveries (TAF)	0	0	0
Annualized New Supply Costs (\$1,000)	\$0	\$0	\$0
Water Storage Costs (\$1,000)	\$0	\$0	\$0
Lost Water Sales Revenues (\$1,000)	\$0	\$0	\$0
Transfer Costs (\$1,000)	\$0	\$0	\$0
Shortage Costs (\$1,000)	\$0	\$0	\$0
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) (\$1,000)	-\$8,018	-\$8,643	\$625
Excess Water Savings (\$1,000)	-\$2,899	-\$4,176	\$1,277
<b>Average Annual Changes in Water Supply Costs (\$1,000)</b>	<b>-\$4,350</b>	<b>-\$4,645</b>	<b>\$295</b>

28 Note: In 2012 dollars

1 The changes in M&I water supply costs would result in changes to employment  
2 and regional economic output, as summarized in Table 19.129.

3 **Table 19.129 Changes in Municipal and Industrial Water Supply Related**  
4 **Employment and Regional Economic Output for the Central Coast Region under**  
5 **Alternative 5 as Compared to the Second Basis of Comparison**

Economic Sectors	Employment				Economic Output (\$ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0	0.0	-0.6	4.3	3.7
Mining & Logging	0	0	0	0	0.0	-6.8	9.9	3.1
Construction	0	-2	0	-2	0.0	-214.8	10.4	-204.4
Manufacturing	0	0	0	0	0.0	-28.6	55.4	26.8
Transportation, Warehousing & Utilities	-7	0	0	-7	-1,606.9	-18.1	60.1	-1,565.0
Wholesale Trade	0	0	0	0	0.0	-5.1	62.7	57.5
Retail Trade	0	0	1	1	0.0	-6.5	126.7	120.2
Information	0	0	0	0	0.0	-12.8	41.7	29.0
Financial Activities	0	0	1	1	0.0	-73.3	376.2	303.0
Services	0	-2	5	3	0.0	-177.8	478.2	300.4
Government	0	0	0	0	0.0	-1.0	14.1	13.1
<b>Total</b>	<b>-7</b>	<b>-4</b>	<b>9</b>	<b>-2</b>	<b>-1,606.9</b>	<b>-545.3</b>	<b>1,239.6</b>	<b>-912.6</b>

6 Note: In 2012 dollars

#### 7 *Regional Changes to Recreational Opportunities*

8 Changes in CVP and SWP water supplies and operations under Alternative 5 as  
9 compared to the Second Basis of Comparison generally would result in lower  
10 reservoir elevations in reservoirs that store CVP and SWP water (up to 10 to  
11 18 percent); and would result in decreased recreational economic factors under  
12 Alternative 5 as compared to the Second Basis of Comparison.

#### 13 *Southern California Region*

##### 14 *Regional Changes to Irrigated Agriculture*

15 It is anticipated that as in the Central Valley Region, reductions in CVP and SWP  
16 water supplies within the Southern California Region would not result in  
17 reductions in long-term irrigated acreage or land use changes due to the use of  
18 other water supplies. However, there could be a reduction in irrigated acreage in  
19 dry and critical dry years under Alternative 5 as compared to the Second Basis of  
20 Comparison.

##### 21 *Regional Changes to Municipal and Industrial Water Supplies*

22 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP  
23 and SWP water supplies would be less under Alternative 5 than under the Second  
24 Basis of Comparison. The analysis assumed CVP and SWP water deliveries, as  
25 described in Chapter 5, and determined the need for new water supplies, changes  
26 in water storage and groundwater pumping, water transfers, water shortage costs,  
27 and excess water savings. The factors and basis of the analysis is described in  
28 detail in Appendix 19A, CWEST Model. The analysis assumes that no new

1 annual transfer supplies would be implemented until shortages were greater than  
 2 5 percent. The costs of these shortages are included in the analysis. It is assumed  
 3 that some communities that do not have alternative water supplies would utilize  
 4 water transfers.

5 The average annual water supply operating expenses over the 81-year hydrologic  
 6 period for M&I water supplies would increase by 2.5 percent, as presented in  
 7 Table 19.130; and therefore, the results would be similar under Alternative 5 and  
 8 the Second Basis of Comparison.

9 **Table 19.130 Changes in Municipal and Industrial Water Supply Costs for the**  
 10 **Southern California Region under Alternative 5 as Compared to the Second Basis**  
 11 **of Comparison**

Differences in Total	Alternative 5	Second Basis of Comparison	Changes
Average Annual CVP/SWP Deliveries (TAF)	1,912	2,394	-482
Delivery Cost (\$1,000)	\$237,118	\$296,795	-\$59,677
Assumed New Supply Deliveries (TAF)	81	11	70
Annualized New Supply Costs (\$1,000)	\$24,191	\$4,032	\$20,159
Water Storage Costs (\$1,000)	\$7,474	\$2,824	\$4,649
Lost Water Sales Revenues (\$1,000)	\$14,206	\$1,119	\$13,087
Transfer Costs (\$1,000)	\$10,505	\$3,705	\$6,800
Shortage Costs (\$1,000)	\$16,662	\$353	\$16,309
Groundwater Pumping Savings (due to reductions in Groundwater Pumping) (\$1,000)	-\$58,323	-\$91,507	\$33,183
Excess Water Savings (\$1,000)	-\$4,588	-\$10,573	\$5,985
<b>Average Annual Changes in Water Supply Costs (\$1,000)</b>	<b>\$247,243</b>	<b>\$206,749</b>	<b>\$40,495</b>

12 Note: In 2012 dollars

13 The changes in M&I water supply costs would result in changes to employment  
 14 and regional economic output, as summarized in Table 19.131.

1 **Table 19.131 Changes in Municipal and Industrial Water Supply Related**  
 2 **Employment and Regional Economic Output for the Southern California Region**  
 3 **under Alternative 5 as Compared to the Second Basis of Comparison**

Economic Sectors	Employment				Economic Output (\$ thousands)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Agriculture	0	0	2	1	0.0	-10.0	276.1	266.1
Mining & Logging	0	0	1	1	0.0	-131.1	372.3	241.2
Construction	0	-35	3	-32	0.0	-4,156.1	400.7	-3,755.4
Manufacturing	0	-2	10	9	0.0	-1,159.8	6,894.7	5,734.9
Transportation, Warehousing & Utilities	-140	-2	12	-130	-34,869.2	-472.7	2,639.9	-32,702.0
Wholesale Trade	0	-1	20	19	0.0	-219.8	4,338.8	4,119.1
Retail Trade	0	-2	59	58	0.0	-136.2	5,205.5	5,069.3
Information	0	-1	7	6	0.0	-509.0	2,994.4	2,485.4
Financial Activities	0	-7	52	45	0.0	-2,019.0	18,055.5	16,036.5
Services	0	-37	215	178	0.0	-4,424.9	20,732.4	16,307.5
Government	0	0	3	3	0.0	-23.8	594.9	571.1
<b>Total</b>	<b>-140</b>	<b>-86</b>	<b>384</b>	<b>158</b>	<b>-34,869.2</b>	<b>-13,262.4</b>	<b>62,505.2</b>	<b>14,373.6</b>

4 Note: In 2012 dollars

5 *Regional Changes to Recreational Opportunities*

6 Changes in CVP and SWP water supplies and operations under Alternative 5 as  
 7 compared to the Second Basis of Comparison generally would result in lower  
 8 reservoir elevations in reservoirs that store CVP and SWP water (up to 10 to  
 9 18 percent); and would result in decreased recreational economic factors under  
 10 Alternative 5 as compared to the Second Basis of Comparison.

11 **19.4.3.7 Summary of Environmental Consequences**

12 The results of the environmental consequences of implementation of Alternatives  
 13 1 through 5 as compared to the No Action Alternative and the Second Basis of  
 14 Comparison are presented in Tables 19.132 and 19.133.

1 **Table 19.132 Comparison of Alternatives 1 through 5 to No Action Alternative**

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	Agricultural and M&I water-related employment would be similar. M&I water supply operating expenses would be similar. Recreational economic factors would increase or be similar related to use of reservoirs that store CVP and SWP water.	None needed
Alternative 2	No effects on socioeconomic factors.	None needed
Alternative 3	Agricultural and M&I water-related employment would be similar. M&I water supply operating expenses would be similar. Recreational economic factors would increase or be similar related to use of reservoirs that store CVP and SWP water. Reduced recreational economic factors related to Striped Bass fishing. Reduced commercial and sport ocean salmon fishing due to increased harvest limitations.	None identified at this time to reduce economic effects of reduced Striped Bass fishing and ocean salmon.
Alternative 4	Same effects as described for Alternative 1 compared to the No Action Alternative for non-recreational economic factors. Reduced recreational economic factors related to Striped Bass fishing. Reduced commercial and sport ocean salmon fishing due to increased harvest limitations.	None identified at this time to reduce economic effects of reduced Striped Bass fishing or ocean salmon fishing.
Alternative 5	Agricultural and M&I water-related employment would be similar. M&I water supply operating expenses would be similar. Recreational economic factors would be similar related to use of reservoirs that store CVP and SWP water.	None needed

2 Note: Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools,  
 3 incremental differences of 5 percent or less between alternatives and the No Action Alternative are considered  
 4 to be "similar."

1 **Table 19.133 Comparison of No Action Alternative and Alternatives 1 through 5 to**  
 2 **Second Basis of Comparison**

Alternative	Potential Change	Consideration for Mitigation Measures
No Action Alternative	Agricultural and M&I water-related employment would be similar. M&I water supply operating expenses would be similar. Recreational economic factors would decrease at San Luis Reservoir and at of reservoirs that store CVP and SWP water in the San Francisco Bay Area and Central Coast regions.	Not considered for this comparison.
Alternative 1	No effects on socioeconomic factors.	Not considered for this comparison.
Alternative 2	Same effects as described for No Action Alternative as compared to the Second Basis of Comparison.	Not considered for this comparison.
Alternative 3	Agricultural and M&I water-related employment would be similar. M&I water supply operating expenses would be similar. Recreational economic factors would be similar related to use of reservoirs that store CVP and SWP water. Reduced recreational economic factors related to Striped Bass fishing. Reduced commercial and sport ocean salmon fishing due to increased harvest limitations. Recreational economic factors would be similar.	Not considered for this comparison.
Alternative 4	No effects on non-recreational socioeconomic factors. Reduced recreational economic factors related to Striped Bass fishing. Reduced commercial and sport ocean salmon fishing due to increased harvest limitations.	Not considered for this comparison.
Alternative 5	Agricultural and M&I water-related employment would be similar. M&I water supply operating expenses would be similar. Recreational economic factors would decrease at San Luis Reservoir and at of reservoirs that store CVP and SWP water in the San Francisco Bay Area, Central Coast, and Southern California regions. Reduced recreational economic factors related to Striped Bass fishing. Reduced commercial and sport ocean salmon fishing due to increased harvest limitations.	Not considered for this comparison.

3 Note: Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools,  
 4 incremental differences of 5 percent or less between alternatives and the No Action Alternative are considered  
 5 to be "similar."

1     **19.4.3.8 Potential Mitigation Measures**

2 Mitigation measures are presented in this section to avoid, minimize, rectify,  
3 reduce, eliminate, or compensate for adverse environmental effects of  
4 Alternatives 1 through 5 as compared to the No Action Alternative. Mitigation  
5 measures were not included to address adverse impacts under the alternatives as  
6 compared to the Second Basis of Comparison because this analysis was included  
7 in this EIS for information purposes only.

8 Changes in CVP and SWP operations under Alternatives 1 through 5 as compared  
9 to the No Action Alternative would not result in adverse changes in  
10 socioeconomic factors related to the average annual agricultural production or  
11 M&I water supply operating expenses as compared to the No Action Alternative.  
12 However, implementation of Alternatives 3 and 4 would result in adverse changes  
13 in recreational Striped Bass and sport ocean salmon fishing opportunities.

14     **19.4.3.8.1 Recreational Fishing Opportunities**

15 Under Alternatives 3 and 4, fishing opportunities for Striped Bass and commercial  
16 and sport ocean salmon fishing would be reduced as compared to the No Action  
17 Alternative. Mitigation measures are not identified at this time to reduce the  
18 impact to the Striped Bass and ocean salmon fishing opportunities.

19     **19.4.3.9 Cumulative Effects Analysis**

20 As described in Chapter 3, the cumulative effects analysis considers projects,  
21 programs, and policies that are not speculative; and are based upon known or  
22 reasonably foreseeable long-range plans, regulations, operating agreements, or  
23 other information that establishes them as reasonably foreseeable.

24 The cumulative effects analysis Alternatives 1 through 5 for Socioeconomics are  
25 summarized in Table 19.134.

1 **Table 19.134 Summary of Cumulative Effects on Socioeconomics of Alternatives 1**  
 2 **through 5 as Compared to the No Action Alternative**

Scenarios	Actions	Cumulative Effects of Actions
<p>Past &amp; Present, and Future Actions included in the No Action Alternative and in all Alternatives in Year 2030</p>	<p>Consistent with Affected Environment conditions plus:</p> <p>Actions in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the Biological Opinions, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives), including climate change and sea level rise</p> <p>Actions not included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the Biological Opinions, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives):</p> <ul style="list-style-type: none"> <li>• Implementation of Federal and state policies and programs, including Clean Water Act (e.g., Total Maximum Daily Loads); Safe Drinking Water Act; Clean Air Act; and flood management programs</li> <li>• General plans for 2030.</li> <li>• Trinity River Restoration Program.</li> <li>• Central Valley Project Improvement Act programs</li> <li>• Folsom Dam Water Control Manual Update</li> <li>• FERC Relicensing for the Middle Fork of the American River Project</li> <li>• San Joaquin River Restoration Program</li> <li>• Contra Loma Recreation Resource Management Plan</li> <li>• San Luis Reservoir State Recreation Area Resource Management Plan/General Plan</li> </ul>	<p><u>These effects would be the same in all alternatives.</u></p> <p>Climate change and sea level rise and development under the general plans are anticipated to reduce carryover storage in reservoirs in a manner that would reduce CVP and SWP water supply availability and recreational opportunities at some reservoirs that store CVP and SWP water, and could reduce the opportunities for ocean salmon fishing.</p> <p>Other actions, including restoration projects, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to improve recreational opportunities and salmon populations that could improve ocean salmon fishing.</p>
<p>Future Actions considered as Cumulative Effects Actions in all Alternatives in Year 2030</p>	<p>Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives):</p> <ul style="list-style-type: none"> <li>• Bay-Delta Water Quality Control Plan Update</li> <li>• FERC Relicensing Projects</li> <li>• Bay Delta Conservation Plan (including the California WaterFix alternative)</li> <li>• Shasta Lake Water Resources, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations</li> </ul>	<p><u>These effects would be the same in all alternatives.</u></p> <p>Some of the future reasonably foreseeable actions to improve water quality and FERC Relicensing projects could improve recreational opportunities and salmon populations that could improve ocean salmon fishing.</p> <p>Other actions, such as expanded or new reservoirs would improve water supply availability and recreational opportunities.</p>



Scenarios	Actions	Cumulative Effects of Actions
	<ul style="list-style-type: none"> <li>• El Dorado Water and Power Authority Supplemental Water Rights Project</li> <li>• Semitropic Water Storage District Delta Wetlands</li> <li>• North Bay Aqueduct Alternative Intake</li> <li>• Irrigated Lands Regulatory Program</li> </ul>	
<p>No Action Alternative with Associated Cumulative Effects Actions in Year 2030</p>	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO</p>	<p>Implementation of No Action Alternative would result in changes stream flows. Changes in stream flows would in turn in changes in water supply availability, recreational opportunities, and salmon populations. Changes in salmon populations would affect ocean salmon fishing as compared to historical conditions prior to the BOs.</p>
<p>Alternative 1 with Associated Cumulative Effects Actions in Year 2030</p>	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)</p>	<p>Implementation of Alternative 1 with reasonably foreseeable actions would result in similar agricultural and M&amp;I water supply economics, and similar or improved reservoir recreational opportunities compared to the No Action Alternative with these added actions.</p>
<p>Alternative 2 with Associated Cumulative Effects Actions in Year 2030</p>	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions No implementation of structural improvements or other actions that require further study to develop a more detailed action description.</p>	<p>Implementation of Alternative 2 with reasonably foreseeable actions for recreational opportunities would be the same as for the No Action Alternative with these added actions.</p>
<p>Alternative 3 with Associated Cumulative Effects Actions in Year 2030</p>	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant) Slight increase in positive Old and Middle River flows in the winter and spring months Increased bag limits for Striped Bass and Pikeminnow Increased ocean salmon fishing harvest limitations</p>	<p>Implementation of Alternative 3 with reasonably foreseeable actions would result in similar agricultural and M&amp;I water supply economics, and similar or improved reservoir recreational opportunities as for the No Action Alternative with these added actions. Recreational opportunities related to Striped Bass fishing would initially be increased; however by 2030 recreational fishing related to Striped Bass would be reduced. Opportunities related to commercial and sport ocean salmon fishing would be reduced.</p>

<b>Scenarios</b>	<b>Actions</b>	<b>Cumulative Effects of Actions</b>
Alternative 4 with Associated Cumulative Effects in Year 2030	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)</p> <p>Increased bag limits for Striped Bass and Pikeminnow</p> <p>Increased ocean salmon fishing harvest limitations</p>	<p>Implementation of Alternative 4 with these reasonably foreseeable actions would result in similar agricultural and M&amp;I water supply economics, and similar or improved reservoir recreational opportunities as for the No Action Alternative with these added actions.</p> <p>Recreational opportunities related to Striped Bass fishing would initially be increased; however by 2030 recreational fishing related to Striped Bass would be reduced.</p> <p>Opportunities related to commercial and sport ocean salmon fishing would be reduced.</p>
Alternative 5 with Associated Cumulative Effects in Year 2030	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO</p> <p>Positive Old and Middle River flows and increased Delta outflow in spring months</p>	<p>Implementation of Alternative 5 with reasonably foreseeable actions would result in similar agricultural and M&amp;I water supply economics, and similar reservoir recreational opportunities as for the No Action Alternative with these added actions.</p>

1

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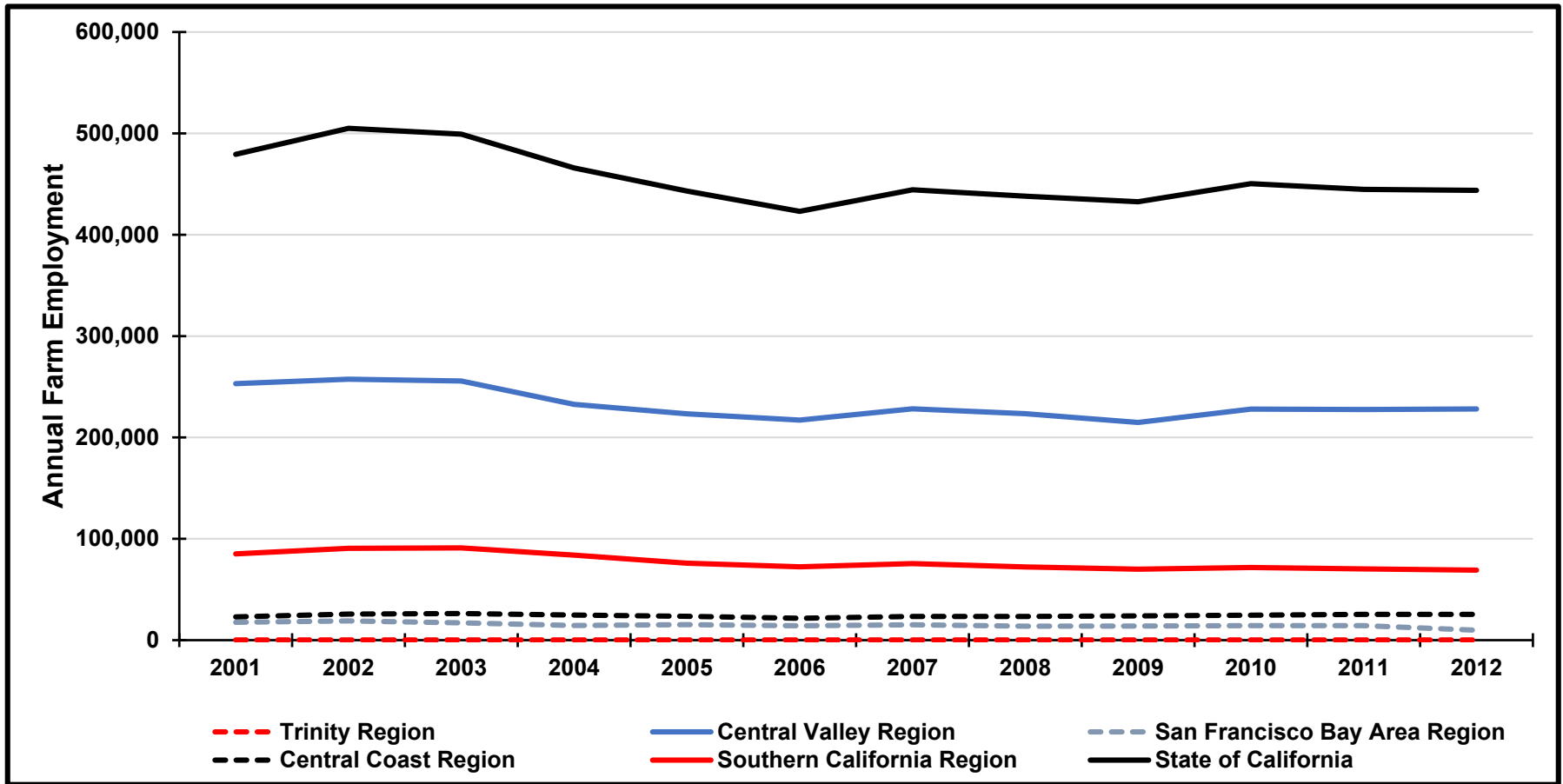


Figure 19.1 Farm Employment in Counties within the Study Area

Source: BEA 2014a

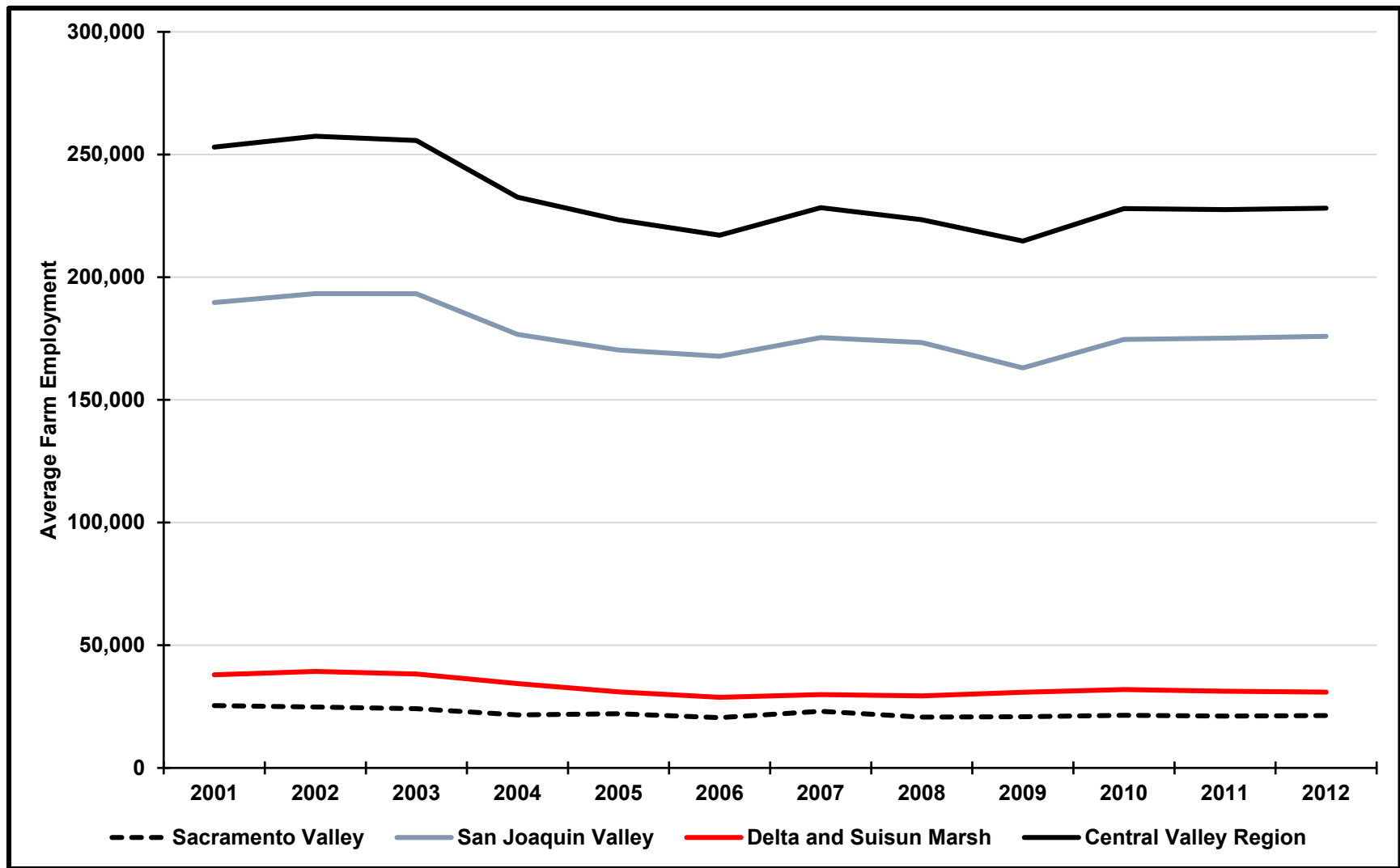


Figure 19.2 Farm Employment in Counties within the Central Valley Region

Source: BEA 2014a

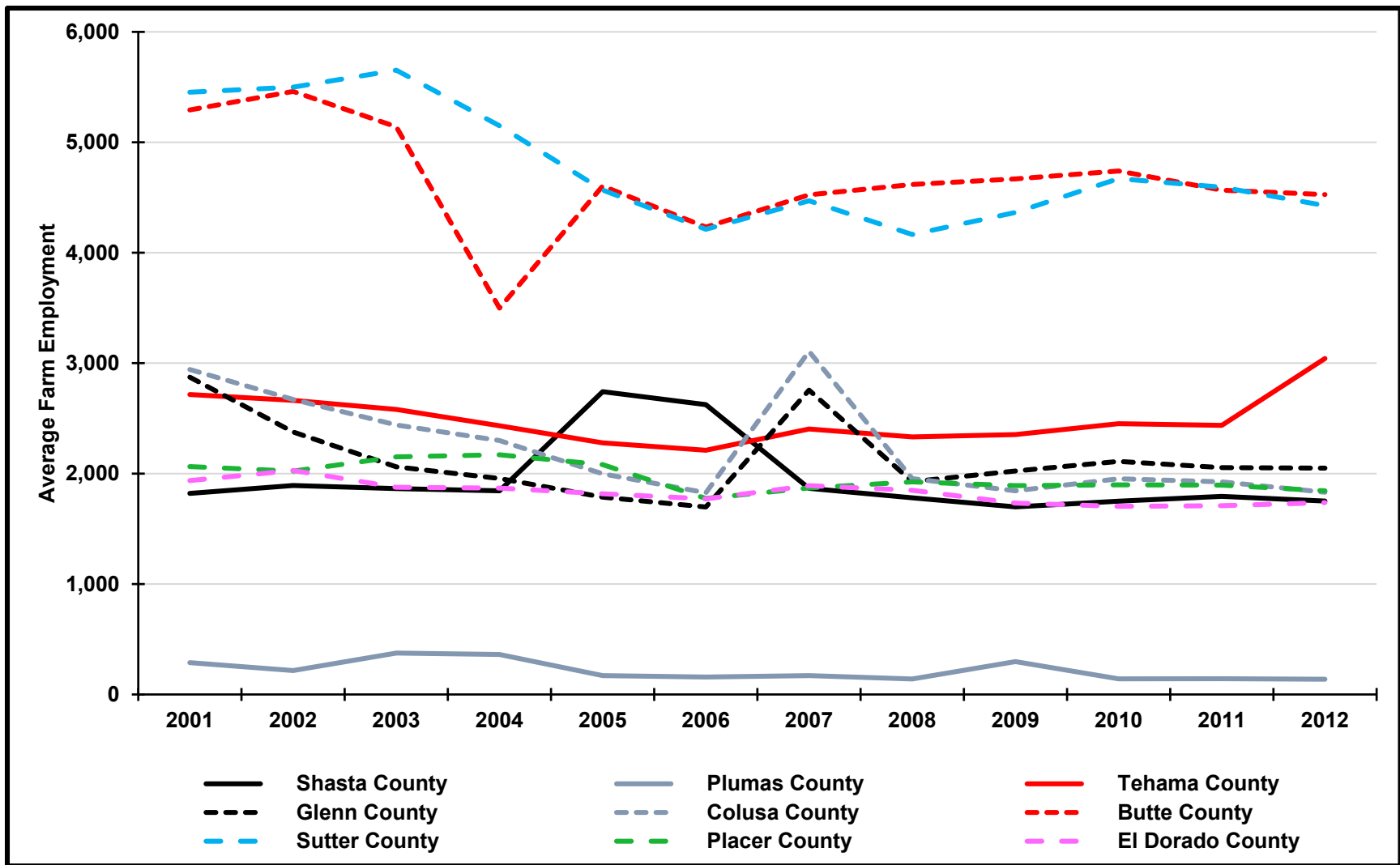


Figure 19.3 Farm Employment in Counties within the Sacramento Valley Portion of the Central Valley Region

Source: BEA 2014a

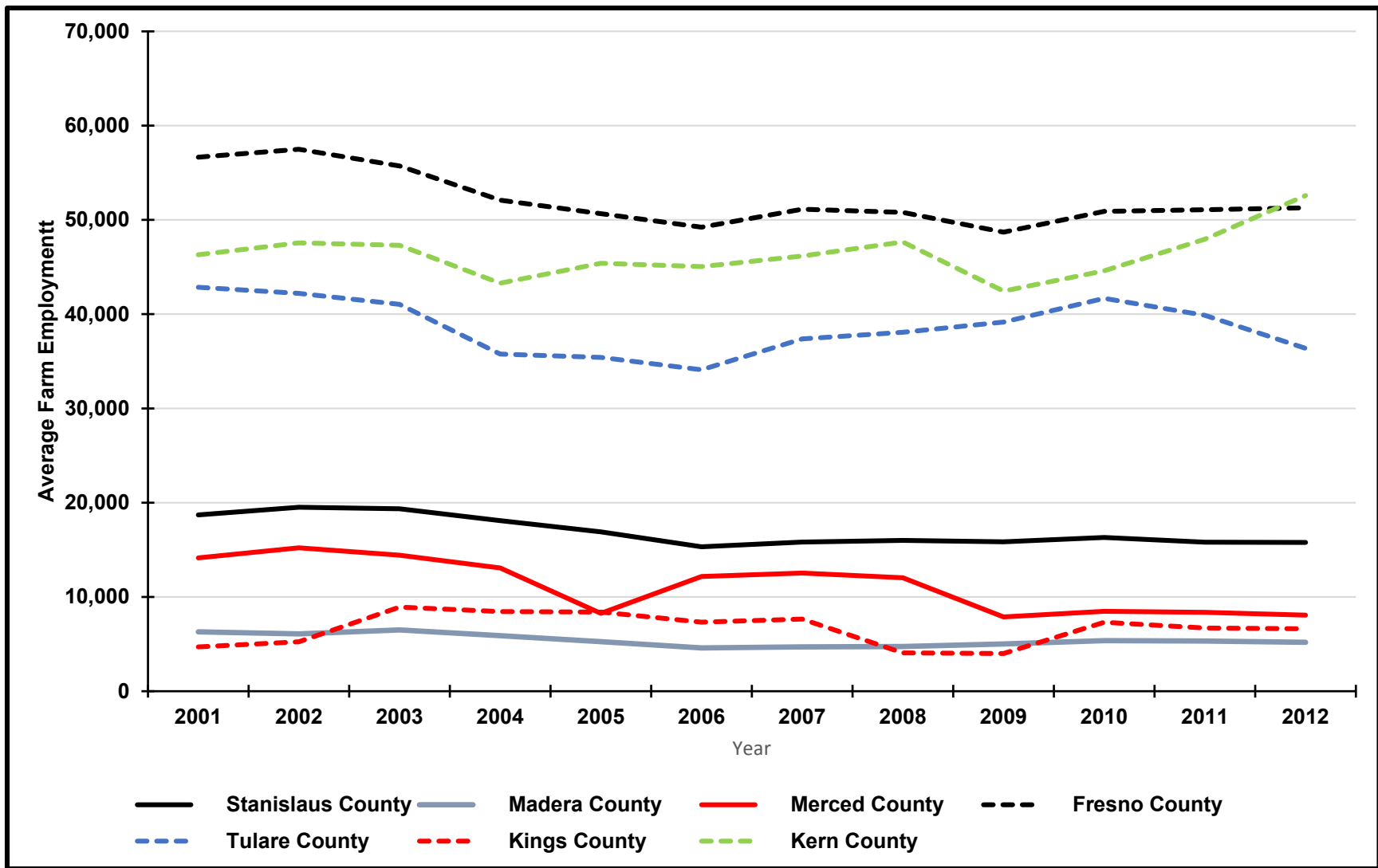


Figure 19.4 Farm Employment in Counties within the San Joaquin Valley Portion of the Central Valley Region

Source: BEA 2014a

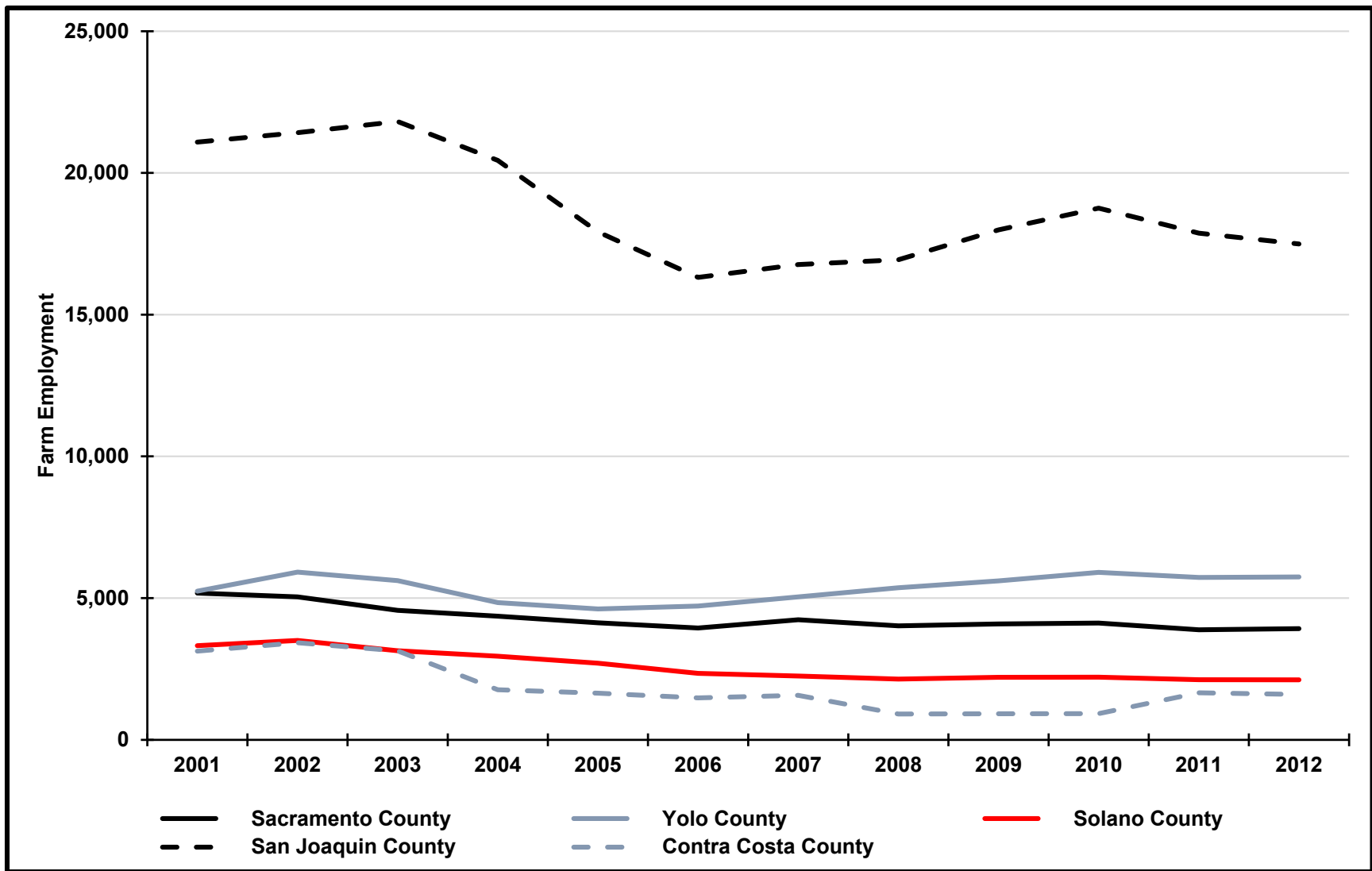


Figure 19.5 Farm Employment in Counties within the Delta and Suisun Marsh Portion of the Central Valley Region

Source: BEA 2014a



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## Chapter 20

# 1 Indian Trust Assets

## 2 20.1 Introduction

3 This chapter describes Indian Trust Assets (ITAs) in the study area and potential  
 4 changes that could occur as a result of implementing the alternatives evaluated in  
 5 this Environmental Impact Statement (EIS). Implementation of the alternatives  
 6 could affect ITAs through potential changes to the operation of the Central Valley  
 7 Project (CVP) and State Water Project (SWP) and ecosystem restoration.

## 8 20.2 Regulatory Environment and Compliance 9 Requirements

10 Potential actions that could be implemented under the alternatives evaluated in  
 11 this EIS could affect ITAs in the areas along the rivers and reservoirs directly  
 12 impacted by changes in the operation of CVP or SWP reservoirs and in the  
 13 vicinity of lands served by CVP and SWP water supplies. Actions located on  
 14 public agency lands, or implemented, funded, or approved by Federal and state  
 15 agencies, would need to be compliant with appropriate Federal and state agency  
 16 policies and regulations, as summarized in Chapter 4, Approach to Environmental  
 17 Analyses.

18 The Federal Indian Trust Asset policies, summarized below and in Chapter 4,  
 19 have been used to identify potential areas of change to ITAs that could occur due  
 20 to changes in long-term operation of the CVP and/or SWP facilities.

21 The ITAs are legal interests in property held in trust by the U.S. for federally-  
 22 recognized Indian tribes or individual Indians. An Indian trust has three  
 23 components: (1) the trustee, (2) the beneficiary, and (3) the trust asset. ITAs can  
 24 include land, minerals, federally-reserved hunting and fishing rights, federally-  
 25 reserved water rights, and in-stream flows associated with trust land.  
 26 Beneficiaries of the Indian trust relationship are federally-recognized Indian tribes  
 27 with trust land; the U.S. is the trustee. By definition, ITAs cannot be sold, leased,  
 28 or otherwise encumbered without approval of the U.S. The characterization and  
 29 application of the U.S. trust relationship have been defined by case law that  
 30 interprets Congressional acts, executive orders, and historic treaty provisions.

31 The federal government, through treaty, statute or regulation, may take on  
 32 specific, enforceable fiduciary obligations that give rise to a trust responsibility to  
 33 federally recognized tribes and individual Indians possessing trust assets. Courts  
 34 have recognized an enforceable federal fiduciary duty with respect to federal  
 35 supervision of Indian money or natural resources, held in trust by the federal  
 36 government, where specific treaties, statutes or regulations create such a  
 37 fiduciary duty.

1 Consistent with President William J. Clinton’s 1994 memorandum, “Government-  
 2 to-Government Relations with Native American Tribal Governments,” Bureau of  
 3 Reclamation (Reclamation) assesses the effect of its programs on tribal trust  
 4 resources and federally-recognized tribal governments. Reclamation is tasked to  
 5 actively engage federally-recognized tribal governments and consult with such  
 6 tribes on government-to-government level when its actions affect ITAs (Federal  
 7 Register, Vol. 59, No. 85, May 4, 1994, pages 22951-22952). The U.S.  
 8 Department of the Interior (DOI) Departmental Manual Part 512.2 ascribes the  
 9 responsibility for ensuring protection of ITAs to the heads of bureaus and offices.  
 10 DOI is required to carry out activities in a manner that protects ITAs and avoids  
 11 adverse effects whenever possible.

12 **20.3 Affected Environment**

13 The U.S. Government's trust responsibility for Indian resources requires  
 14 Reclamation and other agencies to take measures to protect and maintain trust  
 15 resources. These responsibilities include taking reasonable actions to preserve  
 16 and restore tribal resources.

17 In compliance with 36 Code of Federal Register 800.4(a) (4), Reclamation sent  
 18 letters to the federally-recognized Indian tribes in the study area, including most  
 19 of the tribes listed in Table 20.1, to request their input regarding the identification  
 20 of any properties to which they might attach religious and cultural significance to  
 21 within the area of potential effect.

22 **Table 20.1 Federally Recognized Tribes in the Vicinity of the Study Area**

Federally Recognized Tribe	EIS Geographical Region	County	In the Vicinity of this Community
Hoopa Valley Tribal Council	Trinity River	Trinity and Humboldt	Hoopa
Resighini Rancheria Tribe	Trinity River	Del Norte	Klamath
Yurok Tribe of the Yurok Reservation	Trinity River	Trinity, Humboldt, and Del Norte	Klamath
Pit River Tribe	Central Valley	Shasta	Burney
Redding Rancheria Tribe	Central Valley	Shasta	Redding
Paskenta Band of Nomlaki Indians of California	Central Valley	Tehama and Glenn	Corning and Orland
Grindstone Indian Rancheria of Wintun-Wailaki Indians of California	Central Valley	Glenn	Elk Creek

<b>Federally Recognized Tribe</b>	<b>EIS Geographical Region</b>	<b>County</b>	<b>In the Vicinity of this Community</b>
Cachil Dehe Band of Wintun Indians of the Colusa Indian Community of the Colusa Rancheria	Central Valley	Colusa	Colusa
Cortina Indian Rancheria of Wintun Indians of California	Central Valley	Colusa	Williams
Tyme Maidu of Berry Creek Rancheria	Central Valley	Butte	Oroville
Konkow Maidu of Mooretown Rancheria	Central Valley	Butte	Oroville
Enterprise Rancheria of Maidu Indians of California	Central Valley	Butte	Oroville
Mechoopda Indian Tribe of Chico Rancheria	Central Valley	Butte	Chico
Miwok Maidu United Auburn Indian Community of the Auburn Rancheria	Central Valley	Placer	Placer
United Auburn Indian Community of the Auburn Rancheria of California	Central Valley	Placer	Rocklin
Shingle Springs Band of Miwok Indians, including Shingle Springs Rancheria	Central Valley	El Dorado and Nevada County	Shingle Springs
Buena Vista Rancheria of Me-Wuk	Central Valley	Sacramento	Sacramento
Wilton Miwok Indians of the Wilton Rancheria	Central Valley	Sacramento	Elk Grove
Yocha Dehe Wintun Nation	Central Valley	Yolo	Brooks
Northfork Rancheria of Mono Indians of California	Central Valley	Madera	North Fork
Picayune Rancheria of Chukchansi Indians of California	Central Valley	Madera	Coarsegold
California Valley Miwok Tribe	Central Valley	San Joaquin	Stockton
Big Sandy Rancheria of Mono Indians of California	Central Valley	Fresno	Auberry

Chapter 20: Indian Trust Assets

<b>Federally Recognized Tribe</b>	<b>EIS Geographical Region</b>	<b>County</b>	<b>In the Vicinity of this Community</b>
Table Mountain Rancheria	Central Valley	Fresno	Friant
Santa Rosa Indian Community of Santa Rosa Rancheria	Central Valley	Kings	Lemoore
Tule River Indian Tribe of the Tule River Reservation of the Yokut Indians	Central Valley	Tulare	Porterville
Santa Ynez Band of Chumash Mission Indians of Santa Ynez Reservation	Central Coast	Santa Barbara	Santa Ynez
Cahuilla Band of Mission Indians of the Cahuilla Reservation	Southern California	San Diego	Anza
Campo Band of Diegueno Mission Indians of the Campo Indian Reservation	Southern California	San Diego	Campo
Capitan Grande Band of Diegueno Mission Indians of California (Barona Reservation and Viejas Reservation)	Southern California	San Diego	Alpine
Ewiiapaayp Band of Kumeyaay Indians	Southern California	San Diego	Alpine
Iipay Nation of Santa Ysabel	Southern California	San Diego	Santa Ysabel
Inaja Band of Diegueno Mission Indians of the Inaja and Cosmit Reservation	Southern California	San Diego	Escondido
Jamul Indian Village of California	Southern California	San Diego	Jamul
La Jolla Band of Luiseño Indians	Southern California	San Diego	Pauma Valley
La Posta Band of Diegueno Mission Indians of the La Posta Indian Reservation	Southern California	San Diego	Boulevard
Los Coyotes Band of Cahuilla and Cupeno Indians	Southern California	San Diego	Warner Springs

<b>Federally Recognized Tribe</b>	<b>EIS Geographical Region</b>	<b>County</b>	<b>In the Vicinity of this Community</b>
Manzanita Band of Diegueno Mission Indians of the Manzanita Reservation	Southern California	San Diego	Boulevard
Mesa Grande Band of Diegueno Mission Indians of the Mesa Grande Reservation	Southern California	San Diego	Santa Ysabel
Pala Band of Luiseño Mission Indians of the Pala Reservation	Southern California	San Diego	Pala
Pauma Band of Luiseño Mission Indians of the Pauma & Yuima Reservation	Southern California	San Diego	Pauma Valley
Rincon Band of Luiseño Mission Indians of the Rincon Reservation	Southern California	San Diego	Valley Center
San Pasqual Band of Diegueno Mission Indians of California	Southern California	San Diego	Valley Center
Sycuan Band of the Kumeyaay Nation	Southern California	San Diego	El Cajon
Agua Caliente Band of Cahuilla Indians of the Agua Caliente Indian Reservation	Southern California	Riverside	Palm Springs
Augustine Band of Cahuilla Indians	Southern California	Riverside	Coachella
Cabazon Band of Mission Indians	Southern California	Riverside	Indio
Morongo Band of Mission Indians	Southern California	Riverside	Banning
Pechanga Band of Luiseño Mission Indians of the Pechanga Reservation	Southern California	Riverside	Temecula
Ramona Band of Cahuilla	Southern California	Riverside	Anza
Santa Rosa Band of Cahuilla Indians	Southern California	Riverside	Mountain Center
Soboba Band of Luiseño Indians	Southern California	Riverside	San Jacinto

<b>Federally Recognized Tribe</b>	<b>EIS Geographical Region</b>	<b>County</b>	<b>In the Vicinity of this Community</b>
Torres-Martinez Desert Cahuilla Indians	Southern California	Riverside	Thermal
Twenty-Nine Palms Band of Mission Indians of California	Southern California	Riverside and San Bernardino	Coachella
Chemehuevi Indian Tribe of the Chemehuevi Reservation	Southern California	San Bernardino	Needles
San Manuel Band of Mission Indians	Southern California	San Bernardino	Highland
Big Lagoon Rancheria	Not within study area	Humboldt	Arcata
Blue Lake Rancheria	Not within study area	Humboldt	Blue Lake
Karuk Tribe	Not within study area	Siskiyou	Happy Camp
Greenville Rancheria of Maidu Indians	Not within study area	Plumas and Tehama	Greenville
Susanville Indian Rancheria	Not within study area	Lassen	Susanville
Lytton Rancheria	Not within study area	Sonoma	Santa Rosa
Chicken Ranch Rancheria of Me-Wuk Indians of California	Not within study area	Tuolumne	Jamestown
Cold Springs Rancheria of Mono Indians	Not within study area	Fresno	Tollhouse
Colorado River Indian Tribes of the Colorado River Indian Reservation	Not within study area	Riverside	Parker, Arizona

1 **20.4 Impact Analysis**

2 This section describes the potential mechanisms for change to ITAs, quantitative  
 3 and qualitative analytical methods, effects of the analyses, potential mitigation  
 4 measures, and cumulative effects.

1 **20.4.1 Potential Mechanisms for Change and Analytical Tools**

2 As described in Chapter 4, Approach to Environmental Analysis, the  
3 environmental consequences assessment considers changes in conditions related  
4 to changes in CVP and SWP operation under the alternatives as compared to the  
5 No Action Alternative and Second Basis of Comparison.

6 Changes in CVP and SWP operation under the alternatives as compared to the No  
7 Action Alternative and Second Basis of Comparison could change water  
8 elevations within the CVP and SWP reservoirs, flow patterns in the rivers  
9 downstream of CVP and SWP reservoirs, and CVP and SWP water deliveries.  
10 Impacts to existing ITAs would be considered adverse if the action:

- 11 • Interfered with the exercise of a federally reserved water right, or degrade  
12 water quality where there is a federally reserved water right
- 13 • Interfered with the use, value, occupancy, character or enjoyment of an ITA
- 14 • Failed to protect ITAs from loss, damage, waste, depletion, or other negative  
15 effects

16 **20.4.1.1 Changes in CVP and SWP Reservoir Elevation**

17 There are no ITAs within any of the reservoir inundation areas (DWR 2005;  
18 Reclamation 2010, 2012, 2013a, 2014a; Reclamation et al. 2011; USACE et al.  
19 2012). Therefore, the changes in reservoir elevations would not affect ITAs and  
20 are not analyzed in this EIS.

21 **20.4.1.2 Changes in Rivers Downstream of CVP and SWP Reservoirs**

22 There are no ITAs within the rivers downstream of CVP and SWP reservoirs  
23 (DWR 2005; Reclamation 2010, 2012, 2013a, 2014a; Reclamation et al. 2011;  
24 USACE et al. 2012). Therefore, changes in river flow patterns would not directly  
25 affect any ITAs. However, changes in river flow patterns in the Trinity River  
26 could indirectly affect several ITAs, including the Hoopa Valley Tribe, Resighini  
27 Rancheria Tribe, and Yurok Tribe of the Yurok Reservation. Changes in the river  
28 flow patterns could affect use of the Trinity River for boats, access to adjacent  
29 lands, and fish in the Trinity River that are important to the tribes.

30 As described in Chapter 5, Surface Water Resources and Water Supplies,  
31 implementation of Alternatives 1 through 5 as compared to the No Action  
32 Alternative and the Second Basis of Comparison, and the No Action Alternative  
33 as compared to the Second Basis of Comparison could affect change river flow  
34 patterns in the Trinity River.

35 **20.4.1.3 Changes due to CVP and SWP Water Deliveries**

36 There are no ITAs that directly receive CVP or SWP water. As described in  
37 Chapter 19, Socioeconomics, municipalities that use CVP or SWP water supplies,  
38 including agencies that serve ITAs, would continue to meet water demands in  
39 2030 if CVP and SWP water supplies are reduced through the increased use of  
40 non-CVP and SWP water supplies. Therefore, changes in CVP and SWP water



1 deliveries would not affect water supplies to ITAs and are not analyzed in this  
2 EIS.

3 **20.4.1.4 Effects Related to Cross Delta Water Transfers**

4 Cross Delta water transfers involving the CVP and SWP facilities or water  
5 supplies would be required to be implemented in accordance with all existing  
6 regulations and requirements, including not causing adverse impacts to other  
7 water users in accordance with the requirements of Reclamation, California  
8 Department of Water Resources (DWR), and the State Water Resources Control  
9 Board (SWRCB).

10 Reclamation recently prepared a long-term regional water transfer environmental  
11 document which evaluated potential changes in surface water conditions related to  
12 water transfer actions (Reclamation 2014d). Results from this analysis were used  
13 to inform the impact assessment of potential effects of water transfers under the  
14 alternatives as compared to the No Action Alternative and the Second Basis of  
15 Comparison.

16 The transfers could change flow patterns in rivers downstream of CVP and SWP  
17 reservoirs. Surface water elevations in CVP and SWP reservoirs due to transfer  
18 programs under the alternatives and Second Basis of Comparison could be  
19 affected for a short-time during a water year; however, because the transferred  
20 water would have been released for the seller's use, the end of September storage  
21 elevations would be similar with or without the transfer.

22 **20.4.2 Conditions in Year 2030 without Implementation of**  
23 **Alternatives 1 through 5**

24 The impact analysis in this EIS is based upon the comparison of the alternatives to  
25 the No Action Alternative and the Second Basis of Comparison in the Year 2030.  
26 Many of the changed conditions would occur in the same manner under both the  
27 No Action Alternative and the Second Basis of Comparison (e.g., climate change,  
28 sea-level rise, general plan development, and implementation of reasonable and  
29 foreseeable projects). Due to these changes, especially climate change and sea-  
30 level rise, it is anticipated that reservoir elevations at the end of September would  
31 be lower and flows patterns in the rivers downstream of the reservoirs would be  
32 different than under recent condition, as described in Chapter 5, Surface Water  
33 Resources and Water Supplies.

34 **20.4.3 Evaluation of Alternatives**

35 As described in Chapter 4, Approach to Environmental Analysis, Alternatives 1  
36 through 5 have been compared to the No Action Alternative, and the No Action  
37 Alternative and Alternatives 1 through 5 have been compared to the Second Basis  
38 of Comparison. The evaluation of alternatives is focused on the Trinity River  
39 Region because, as discussed above, potential changes that could affect ITAs are  
40 located along the Trinity River.

41 During review of the numerical modeling analyses used in this EIS, an error was  
42 determined in the CalSim II model assumptions related to the Stanislaus River

1 operation for the Second Basis of Comparison, Alternative 1, and Alternative 4  
 2 model runs. Appendix 5C includes a comparison of the CalSim II model run  
 3 results presented in this chapter and CalSim II model run results with the error  
 4 corrected. Appendix 5C also includes a discussion of changes in the comparison  
 5 of four alternative analyses:

- 6 • No Action Alternative compared to the Second Basis of Comparison
- 7 • Alternative 1 compared to the No Action Alternative
- 8 • Alternative 3 compared to the Second Basis of Comparison
- 9 • Alternative 5 compared to the Second Basis of Comparison

#### 10 **20.4.3.1 No Action Alternative**

11 As described in Chapter 4, Approach to Environmental Analysis, the No Action  
 12 Alternative is compared to the Second Basis of Comparison.

##### 13 **20.4.3.1.1 Potential Changes in Trinity River downstream of Lewiston Dam**

14 As described in Chapter 5, Surface Water Resources and Water Supplies, the  
 15 following changes would occur on the Trinity River under the No Action  
 16 Alternative as compared to the Second Basis of Comparison.

- 17 • Over long-term conditions (over the 82-year analysis period), flows would be  
 18 similar (within 5 percent) from March through November, and reduced from  
 19 December through February (up to 9.5 percent; 70 cubic feet per second  
 20 [cfs]).
- 21 • In wet years, flows would be similar from April through November, and  
 22 reduced from December through March (up to 11.2 percent; 160 cfs).
- 23 • In above normal years, flows would be similar from March through  
 24 November, and reduced in January and February (up to 19.9 percent; 74 cfs).
- 25 • In below normal years, flows would be similar from March through January,  
 26 and reduced in February (30.4 percent, 192 cfs).
- 27 • In dry and Critical dry years, flows would be similar all months.

28 The changes in river flows would occur in the winter months of wetter years when  
 29 potential use of the rivers would be less for transportation and ceremonies  
 30 (USFWS et al. 1999). As described in Chapter 9, Fish and Aquatic Resources,  
 31 these changes in river flows would result in similar conditions for salmonids using  
 32 Trinity River. Therefore, there would be no effect the ITAs.

##### 33 **20.4.3.1.2 Effects Related to Cross Delta Water Transfers**

34 As described in Chapter 5, Surface Water Resources and Water Supplies, and  
 35 Chapter 7, Groundwater Resources and Groundwater Quality, potential effects on  
 36 surface water resources could be similar to those identified in a recent  
 37 environmental analysis conducted by Reclamation for long-term water transfers  
 38 from the Sacramento Valley to San Joaquin Valley (Reclamation 2014d).  
 39 Potential effects were identified as reduced surface water storage in upstream  
 40 reservoirs; changes in flow patterns in rivers downstream of the reservoirs if water

1 was released from the reservoirs in patterns that were different than would have  
2 been used by the sellers; and groundwater elevation reductions if groundwater  
3 substitution was used to provide the water for the transfers. All water transfers  
4 would be required to avoid adverse impacts on other water users and biological  
5 resources; and water transfer programs would include groundwater mitigation and  
6 monitoring plans (see Section 3.A.6.3, Transfers). Therefore, water transfer  
7 programs would need to be implemented in a manner that would avoid impacts  
8 associated with changes in Trinity Lake storage, Trinity River flow patterns, and  
9 groundwater elevation reductions in the Central Valley that could affect ITAs.  
10 For the purposes of this EIS, it is anticipated that similar conditions would occur  
11 due to cross Delta water transfers under the No Action Alternative as compared to  
12 the Second Basis of Comparison, and there would be no effect on the ITAs due to  
13 cross Delta water transfers.

#### 14 **20.4.3.2 Alternative 1**

15 Alternative 1 is identical to the Second Basis of Comparison. Alternative 1 is  
16 compared to the No Action Alternative and the Second Basis of Comparison.  
17 However, because conditions under Alternative 1 are identical to conditions under  
18 the Second Basis of Comparison, Alternative 1 is only compared to the No Action  
19 Alternative.

#### 20 **20.4.3.2.1 Alternative 1 Compared to the No Action Alternative**

##### 21 *Potential Changes in Trinity River downstream of Lewiston Dam*

22 As described in Chapter 5, Surface Water Resources and Water Supplies, the  
23 following changes would occur on the Trinity River under Alternative 1 and the  
24 No Action Alternative.

- 25 • Over long-term conditions, flows would be similar from March through  
26 November, and increased from December through February (up to  
27 10.5 percent, 86 cfs).
- 28 • In wet years, flows would be similar from April through November, and  
29 increased from December through March (up to 12.6 percent, 160 cfs).
- 30 • In above normal years, flows would be similar from March through  
31 November, and increased in January and February (up to 24.8 percent; 74 cfs).
- 32 • In below normal years, flows would be similar from March through January,  
33 and increased in February (30.4 percent, 192 cfs).
- 34 • In dry and critical dry years, flows would be similar all months.

35 The changes in river flows would increase flows in the Trinity River under  
36 Alternative 1 as compared to the No Action Alternative. As described in  
37 Chapter 9, Fish and Aquatic Resources, these changes in river flows would result  
38 in similar conditions for salmonids using Trinity River. Therefore, there would be  
39 no effect on the ITAs.

1 *Effects Related to Cross Delta Water Transfers*  
 2 As described in Chapter 5, Surface Water Resources and Water Supplies, and  
 3 Chapter 7, Groundwater Resources and Groundwater Quality, potential effects on  
 4 surface water resources could be similar to those identified in a recent  
 5 environmental analysis conducted by Reclamation for long-term water transfers  
 6 from the Sacramento to San Joaquin valleys (Reclamation 2014d). Potential  
 7 effects were identified as reduced surface water storage in upstream reservoirs;  
 8 changes in flow patterns in rivers downstream of the reservoirs if water was  
 9 released from the reservoirs in patterns that were different than would have been  
 10 used by the seller; and groundwater elevation reductions if groundwater  
 11 substitution was used to provide the water for the transfers. All water transfers  
 12 would be required to avoid adverse impacts on other water users and biological  
 13 resources; and water transfer programs would include groundwater mitigation and  
 14 monitoring plans (see Section 3.A.6.3, Transfers). Therefore, water transfer  
 15 programs would need to be implemented in a manner that would avoid impacts  
 16 associated with changes in Trinity Lake storage, Trinity River flow patterns, and  
 17 groundwater elevation reductions in the Central Valley that could affect ITAs.  
 18 For the purposes of this EIS, it is anticipated that similar conditions would occur  
 19 due to cross Delta water transfers under Alternative 1 as compared to the No  
 20 Action Alternative, and there would be no effect on the ITAs due to cross Delta  
 21 water transfers.

#### 22 **20.4.3.2.2 Alternative 1 Compared to the Second Basis of Comparison**

23 Alternative 1 is identical to the Second Basis of Comparison.

#### 24 **20.4.3.3 Alternative 2**

25 The ITA conditions under Alternative 2 would be identical to the conditions under  
 26 the No Action Alternative; therefore, Alternative 2 is only compared to the  
 27 Second Basis of Comparison.

#### 28 **20.4.3.3.1 Alternative 2 Compared to the Second Basis of Comparison**

29 Changes to ITAs under Alternative 2 as compared to the Second Basis of  
 30 Comparison would be the same as the impacts described in Section 20.4.3.1,  
 31 No Action Alternative.

#### 32 **20.4.3.4 Alternative 3**

33 CVP and SWP operation under Alternative 3 are similar to the Second Basis of  
 34 Comparison with modified Old and Middle River flow criteria and New Melones  
 35 Reservoir operation.

36 Alternative 3 would include changed water demands for American River water  
 37 supplies as compared to the No Action Alternative and Second Basis of  
 38 Comparison. Alternative 3 would provide water supplies of up to 17 thousand  
 39 acre feet (TAF)/year under a Warren Act Contract for El Dorado Irrigation  
 40 District and 15 TAF/year under a CVP water service contract for El Dorado  
 41 County Water Agency. These demands are not included in the analysis presented

1 in this section of the EIS. A sensitivity analysis comparing the results of the  
2 analysis with and without these demands is presented in Appendix 5B of this EIS.

3 **20.4.3.4.1 Alternative 3 Compared to the No Action Alternative**

4 *Potential Changes in Trinity River downstream of Lewiston Dam*

5 As described in Chapter 5, Surface Water Resources and Water Supplies, the  
6 following changes would occur on the Trinity River under Alternative 3 as  
7 compared to the No Action Alternative.

- 8 • Over long-term conditions, flows would be similar from March through  
9 November, and increased from December through February (up to  
10 11.8 percent, 79 cfs).
- 11 • In wet years, flows would be similar from April through October, reduced in  
12 November (7.0 percent, 36 cfs), and increased from December through March  
13 (up to 15.0 percent, 193 cfs).
- 14 • In above normal years, flows would be similar from March through  
15 November, and increased in January and February (up to 24.8 percent; 74 cfs).
- 16 • In dry years, flows would be similar in all months.

17 However, as described in Chapter 9, Fish and Aquatic Resources, these changes  
18 in river flows would result in similar conditions for salmonids using Trinity River,  
19 and there would be no effect on the ITAs.

- 20 • In above normal years, flows would be similar from March through  
21 December, and increased in January and February (up to 22.5 percent; 67 cfs).
- 22 • In below normal years, flows would be similar from March through January,  
23 and increased in February (43.3 percent, 192 cfs).
- 24 • In dry years, flows would be similar all months.
- 25 • In Critical dry years, flows would be similar from December through October,  
26 and increased in November (20.0 percent, 50 cfs).

27 The changes in river flows would increase flows in the Trinity River under  
28 Alternative 3 as compared to the No Action Alternative. As described in  
29 Chapter 9, Fish and Aquatic Resources, these changes in river flows would result  
30 in similar conditions for salmonids using Trinity River. Therefore, there would be  
31 no effect on the ITAs.

32 *Effects Related to Cross Delta Water Transfers*

33 As described in Chapter 5, Surface Water Resources and Water Supplies, and  
34 Chapter 7, Groundwater Resources and Groundwater Quality, potential effects on  
35 surface water resources could be similar to those identified in a recent  
36 environmental analysis conducted by Reclamation for long-term water transfers  
37 from the Sacramento to San Joaquin valleys (Reclamation 2014d). Potential  
38 effects were identified as: reduced surface water storage in upstream reservoirs;  
39 changes in flow patterns in river downstream of the reservoirs if water was  
40 released from the reservoirs in patterns that were different than would have been

1 used by the sellers; and groundwater elevation reductions if groundwater  
 2 substitution was used to provide the water for the transfers. All water transfers  
 3 would be required to avoid adverse impacts on other water users and biological  
 4 resources; and water transfer programs would include groundwater mitigation and  
 5 monitoring plans (see Section 3.A.6.3, Transfers). Therefore, water transfer  
 6 programs would need to be implemented in a manner that would avoid impacts  
 7 associated with changes in Trinity Lake storage, Trinity River flow patterns, and  
 8 groundwater elevation reductions in the Central Valley that could affect ITAs.  
 9 For the purposes of this EIS, it is anticipated that similar conditions would occur  
 10 due to cross Delta water transfers under Alternative 3 as compared to the No  
 11 Action Alternative, and there would be no effect on the ITAs due to cross Delta  
 12 water transfers.

#### 13 **20.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison**

##### 14 *Potential Changes in Trinity River downstream of Lewiston Dam*

15 As described in Chapter 5, Surface Water Resources and Water Supplies, under  
 16 Alternative 3 as compared to the Second Basis of Comparison, flows would be  
 17 similar under long-term conditions and all water year types. As described in  
 18 Chapter 9, Fish and Aquatic Resources, there would be similar conditions for  
 19 salmonids using Trinity River. Therefore, there would be no effect on the ITAs.

##### 20 *Effects Related to Cross Delta Water Transfers*

21 As described in Chapter 5, Surface Water Resources and Water Supplies, and  
 22 Chapter 7, Groundwater Resources and Groundwater Quality, potential effects on  
 23 surface water resources could be similar to those identified in a recent  
 24 environmental analysis conducted by Reclamation for long-term water transfers  
 25 from the Sacramento to San Joaquin valleys (Reclamation 2014d). Potential  
 26 effects were identified as: reduced surface water storage in upstream reservoirs;  
 27 changes in flow patterns in river downstream of the reservoirs if water was  
 28 released from the reservoirs in patterns that were different than would have been  
 29 used by the sellers; and groundwater elevation reductions if groundwater  
 30 substitution was used to provide the water for the transfers. All water transfers  
 31 would be required to avoid adverse impacts on other water users and biological  
 32 resources; and water transfer programs would include groundwater mitigation and  
 33 monitoring plans (see Section 3.A.6.3, Transfers). Therefore, water transfer  
 34 programs would need to be implemented in a manner that would avoid impacts  
 35 associated with changes in Trinity Lake storage, Trinity River flow patterns, and  
 36 groundwater elevation reductions in the Central Valley that could affect ITAs.  
 37 For the purposes of this EIS, it is anticipated that similar conditions would occur  
 38 due to cross Delta water transfers under Alternative 3 as compared to the Second  
 39 Basis of Comparison, and there would be no effect on the ITAs due to cross Delta  
 40 water transfers.

#### 41 **20.4.3.5 Alternative 4**

42 The ITA conditions under Alternative 4 would be identical to the ITA conditions  
 43 under the Second Basis of Comparison; therefore, Alternative 4 is only compared  
 44 to the No Action Alternative.

1 **20.4.3.5.1 Alternative 4 Compared to the No Action Alternative**

2 Changes in ITA conditions under Alternative 4 as compared to the No Action  
3 Alternative would be the same as the impacts described in Section 20.4.3.2.1,  
4 Alternative 1 Compared to the No Action Alternative.

5 **20.4.3.6 Alternative 5**

6 The CVP and SWP operation under Alternative 5 are similar to the No Action  
7 Alternative with modified Old and Middle River flow criteria and New Melones  
8 Reservoir operation. Alternative 5 would include changed water demands for  
9 American River water supplies as compared to the No Action Alternative or  
10 Second Basis of Comparison. Alternative 5 would provide water supplies of up to  
11 17 TAF/year under a Warren Act Contract for El Dorado Irrigation District and  
12 15 TAF/year under a CVP water service contract for El Dorado County Water  
13 Agency. These demands are not included in the analysis presented in this section  
14 of the EIS. A sensitivity analysis comparing the results of the analysis with and  
15 without these demands is presented in Appendix 5B of this EIS.

16 **20.4.3.6.1 Alternative 5 Compared to the No Action Alternative**

17 *Potential Changes in Trinity River downstream of Lewiston Dam*

18 As described in Chapter 5, Surface Water Resources and Water Supplies, flows  
19 under Alternative 5 and the No Action Alternative would be similar under  
20 long-term conditions and all water year types. As described in Chapter 9, Fish  
21 and Aquatic Resources, there would be similar conditions for salmonids using  
22 Trinity River. Therefore, there would be no effect on the ITAs.

23 *Effects Related to Cross Delta Water Transfers*

24 As described in Chapter 5, Surface Water Resources and Water Supplies, and  
25 Chapter 7, Groundwater Resources and Groundwater Quality, potential effects on  
26 surface water resources could be similar to those identified in a recent  
27 environmental analysis conducted by Reclamation for long-term water transfers  
28 from the Sacramento to San Joaquin valleys (Reclamation 2014d). Potential  
29 effects were identified as: reduced surface water storage in upstream reservoirs;  
30 changes in flow patterns in river downstream of the reservoirs if water was  
31 released from the reservoirs in patterns that were different than would have been  
32 used by the sellers; and groundwater elevation reductions if groundwater  
33 substitution was used to provide the water for the transfers. All water transfers  
34 would be required to avoid adverse impacts on other water users and biological  
35 resources; and water transfer programs would include groundwater mitigation and  
36 monitoring plans (see Section 3.A.6.3, Transfers). Therefore, water transfer  
37 programs would need to be implemented in a manner that would avoid impacts  
38 associated with changes in Trinity Lake storage, Trinity River flow patterns, and  
39 groundwater elevation reductions in the Central Valley that could affect ITAs.  
40 For the purposes of this EIS, it is anticipated that similar conditions would occur  
41 due to cross Delta water transfers under Alternative 5 as compared to the No  
42 Action Alternative, and there would be no effect on the ITAs due to cross Delta  
43 water transfers.

1 **20.4.3.6.2 Alternative 5 Compared to the Second Basis of Comparison**

2 *Potential Changes in Trinity River downstream of Lewiston Dam*

3 As described in Chapter 5, Surface Water Resources and Water Supplies, the  
4 following changes would occur on the Trinity River flows under Alternative 5 and  
5 Second Basis of Comparison

- 6 • Over long-term conditions, flows would be similar from March through  
7 November and January, and reduced in December and February (up to  
8 9.6 percent, 200 cfs).
- 9 • In wet years, flows would be similar from April through November, and  
10 reduced in December through March (up to 13.9 percent).
- 11 • In above normal years, flows would be similar from April through December,  
12 and reduced in January and February (up to 19.9 percent, 74 cfs).
- 13 • In below normal years, flows would be similar from March through January,  
14 and reduced in February (up to 21.5 percent, 135 cfs).
- 15 • In dry and critical dry years, flows would be similar in all months.

16 However, as described in Chapter 9, Fish and Aquatic Resources, these changes  
17 in river flows would result in similar conditions for salmonids using Trinity River;  
18 and there would be no effect the ITAs.

19 *Effects Related to Cross Delta Water Transfers*

20 As described in Chapter 5, Surface Water Resources and Water Supplies, and  
21 Chapter 7, Groundwater Resources and Groundwater Quality, potential effects on  
22 surface water resources could be similar to those identified in a recent  
23 environmental analysis conducted by Reclamation for long-term water transfers  
24 from the Sacramento to San Joaquin valleys (Reclamation 2014d). Potential  
25 effects were identified as reduced surface water storage in upstream reservoirs  
26 and changes in flow patterns in river downstream of the reservoirs if water was  
27 released from the reservoirs in patterns that were different than would have been  
28 used by the water seller's; and groundwater elevation reductions if groundwater  
29 substitution was used to provide the water for the transfers. All water transfers  
30 would be required to avoid adverse impacts on other water users and biological  
31 resources; and water transfer programs would include groundwater mitigation and  
32 monitoring plans (see Section 3.A.6.3, Transfers). Therefore, water transfer  
33 programs would need to be implemented in a manner that would avoid impacts  
34 associated with changes in Trinity Lake storage, Trinity River flow patterns, and  
35 groundwater elevation reductions in the Central Valley that could affect ITAs.  
36 For the purposes of this EIS, it is anticipated that similar conditions would occur  
37 due to cross Delta water transfers under Alternative 5 as compared to the Second  
38 Basis of Comparison, and there would be no effect on the ITAs due to cross Delta  
39 water transfers.



1 **20.4.3.7 Summary of Impact Analysis**

2 The results of the impact analysis of implementation of Alternatives 1 through 5  
3 as compared to the No Action Alternative and the Second Basis of Comparison  
4 are presented in Tables 20.2 and 20.3.

5 **Table 20.2 Comparison of Alternatives 1 through 5 to No Action Alternative**

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	No effects to ITAs	None needed
Alternative 2	No effects to ITAs	None needed
Alternative 3	No effects to ITAs	None needed
Alternative 4	No effects to ITAs	None needed
Alternative 5	No effects to ITAs	None needed

6 **Table 20.3 Comparison of No Action Alternative and Alternatives 1 through 5 to**  
7 **Second Basis of Comparison**

Alternative	Potential Change	Consideration for Mitigation Measures
No Action Alternative	No effects to ITAs	None needed
Alternative 1	No effects to ITAs	None needed
Alternative 2	No effects to ITAs	None needed
Alternative 3	No effects to ITAs	None needed
Alternative 4	No effects to ITAs	None needed
Alternative 5	No effects to ITAs	None needed

8 **20.4.3.8 Potential Mitigation Measures**

9 Mitigation measures are presented in this section to avoid, minimize, rectify,  
10 reduce, eliminate, or compensate for adverse environmental effects of  
11 Alternatives 1 through 5 as compared to the No Action Alternative. Mitigation  
12 measures were not included to address adverse impacts under the alternatives as  
13 compared to the Second Basis of Comparison because this analysis was included  
14 in this EIS for information purposes only.

15 Changes under Alternatives 1 through 5 as compared to the No Action Alternative  
16 would result in similar or increased flows in the Trinity River, and  
17 implementation of cross Delta water transfers would not result in adverse impacts  
18 to ITAs. Therefore, there would be no adverse impacts to ITAs, and no  
19 mitigation measures are needed.

20 **20.4.3.9 Cumulative Effects Analysis**

21 As described in Chapter 3, the cumulative effects analysis considers projects,  
22 programs, and policies that are not speculative, and are based upon known or

1 reasonably foreseeable long-range plans, regulations, operating agreements, or  
 2 other information that establishes them as reasonably foreseeable.

3 The cumulative effects analysis for Alternatives 1 through 5 to Indian Trust  
 4 Assets are summarized in Table 20.4. As described in this chapter, potential  
 5 changes to Indian Trust Assets would be associated with changes in flows in the  
 6 Trinity River.

7 **Table 20.4 Summary of Cumulative Effects on Indian Trust Assets with**  
 8 **Implementation of Alternatives 1 through 5 as Compared to the No Action**  
 9 **Alternative**

Scenarios	Actions	Cumulative Effects of Actions
Past & Present, and Future Actions included in the No Action Alternative and All Alternatives in Year 2030	Consistent with Affected Environment conditions plus: Actions in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives), including climate change and sea level rise Actions not included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives): - Trinity River Restoration Program. - Central Valley Project Improvement Act programs	<u>These effects would be the same under all alternatives.</u> Climate change and sea level rise are anticipated to reduce carryover storage in reservoirs, including Trinity Lake, and changes in stream flow patterns, including Trinity River, in a manner that would change beneficial use of the Trinity River, including salmon fishing. Other ongoing actions, including Trinity River Restoration Program, would improve water quality and/or habitat along the Trinity River.
Future Actions considered as Cumulative Effects Actions in All Alternatives in Year 2030	Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives): - Bay-Delta Water Quality Control Plan Update - FERC Relicensing Projects - Bay Delta Conservation Plan (including the California WaterFix alternative) - Shasta Lake Water Resources, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations - El Dorado Water and Power Authority Supplemental Water Rights Project - Semitropic Water Storage District Delta Wetlands - North Bay Aqueduct Alternative Intake	<u>These effects would be the same under all alternatives.</u> Based upon environmental documents prepared for these programs, changes to the Trinity River flows are not anticipated due to implementation of these programs.

Scenarios	Actions	Cumulative Effects of Actions
No Action Alternative with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO	Implementation of No Action Alternative with reasonably foreseeable actions would result in changes Trinity Lake carryover storage and Trinity River flows which would result in changes to beneficial use opportunities for Indian Trust Assets as compared to historical conditions prior to the BOs.
Alternative 1 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternative 1 with reasonably foreseeable actions would result in similar conditions for Indian Trust Assets as for the No Action Alternative with the added actions.
Alternative 2 with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions  No implementation of structural improvements or other actions that require further study to develop a more detailed action description.	Implementation of Alternative 2 with reasonably foreseeable actions would result in similar conditions for Indian Trust Assets as for the No Action Alternative with the added actions.
Alternative 3 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)  Slight increase in positive Old and Middle River flows in the winter and spring months	Implementation of Alternative 3 with reasonably foreseeable actions would result in similar conditions for Indian Trust Assets as for the No Action Alternative with the added actions.
Alternative 4 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternative 4 with reasonably foreseeable actions would result in similar conditions for Indian Trust Assets as for the No Action Alternative with the added actions.
Alternative 5 with Associated Cumulative Effects Actions in Year 20530	Full implementation of the 2008 USFWS BO and 2009 NMFS BO  Positive Old and Middle River flows and increased Delta outflow in spring months	Implementation of Alternative 5 with reasonably foreseeable actions would result in similar conditions for Indian Trust Assets as for the No Action Alternative with the added actions.

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8 *Restoration Environmental Impact Statement/Report*. October.

## Chapter 21

# 1 Environmental Justice

## 2 21.1 Introduction

3 This chapter describes the presence of environmental justice populations in the  
 4 study area and potential changes that could have disproportionately high and  
 5 adverse human health or environmental effects on minority and/or low-income  
 6 populations as a result of implementing the alternatives evaluated in this  
 7 Environmental Impact Statement (EIS). Implementation of the alternatives could  
 8 affect conditions through potential changes in operation of the Central Valley  
 9 Project (CVP) and State Water Project (SWP) and ecosystem restoration.

## 10 21.2 Regulatory Environment and Compliance 11 Requirements

12 This chapter was prepared in compliance with Presidential Executive Order  
 13 12898, *Federal Actions to Address Environmental Justice in Minority Populations*  
 14 *and Low-Income Populations*, dated February 11, 1994 and Title VI of the Civil  
 15 Rights Act of 1964.

16 Potential actions that could be implemented under the alternatives evaluated in  
 17 this EIS could have disproportionately high and adverse human health or  
 18 environmental effects on minority and/or low-income populations. Actions  
 19 located on public agency lands; or implemented, funded, or approved by Federal  
 20 and state agencies would need to be compliant with appropriate Federal and state  
 21 agency policies and regulations, as summarized in Chapter 4, Approach to  
 22 Environmental Analyses.

## 23 21.3 Affected Environment

24 This section describes changes that could result in disproportionately high and  
 25 adverse human health or environmental effects on minority and/or low-income  
 26 populations due to changes in CVP and SWP operations. The conditions  
 27 described in this chapter are related to the distribution of minority populations and  
 28 populations below poverty levels.

### 29 21.3.1 Area of Analysis

30 A summary of conditions are described in this section of the EIS for the following  
 31 regions that could be affected by implementation of alternatives analyzed in this  
 32 EIS, as described in Chapter 4, Approach to Environmental Analysis.

- 33 • Trinity River Region
- 34 • Central Valley Region

- 1 • San Francisco Bay Area Region
- 2 • Central Coast Region
- 3 • Southern California Region

### 4 **21.3.2 Characterization of Conditions Considered in the** 5 **Environmental Justice Analysis**

6 Characterization of the conditions within the Study Area is based upon publically  
7 available data from government websites and other data sources. The data  
8 sources used include the 2010 U.S. Census Bureau data on minority populations  
9 and the 2010 American Community Survey (ACS) 5-year population estimates on  
10 populations below the poverty level.

#### 11 **21.3.2.1 Determination of Minority Populations**

12 The U.S. Census Bureau provides a total population value for each county, which  
13 are also used by the State Department of Finance, as presented in Chapter 14,  
14 Socioeconomics. The U.S. Census Bureau also provides a definition of minority  
15 and low income populations. Minority populations are defined by the  
16 U.S. Census as racial and ethnic minorities. Racial minorities, as defined by the  
17 U.S. Census, include people who identified themselves in the census as belonging  
18 to one of the following categories:

- 19 • Single Race
  - 20 – Black/African American
  - 21 – American Indian and Alaskan Native
  - 22 – Asian
  - 23 – Native Hawaiian and Other Pacific Islander
  - 24 – Some Other Race
- 25 • Two or More Races (inclusive the races listed above and White).

26 Ethnic minorities, as defined by the U.S. Census, include individuals who  
27 identified themselves as being of Hispanic or Latino origin by responding to one  
28 of the following categories in the census:

- 29 • Mexican
- 30 • Mexican American
- 31 • Chicano
- 32 • Puerto Rican
- 33 • Cuban
- 34 • Other Spanish/Hispanic/Latino

35 Individuals who identified themselves of Hispanic or Latino origin maybe of one  
36 or more races according to the U.S. Census.

#### 37 **21.3.2.2 Determination of Populations below the Poverty Level**

38 Populations below the Federal poverty level can be identified using several  
39 methodologies. The information presented in this chapter has been developed in  
40 ACS reports by the U.S. Census Bureau based upon 48 different sets of dollar

1 value thresholds related to family size and ages. The poverty level is assigned at  
 2 the family-level and affects every member of the family. The thresholds are  
 3 consistent throughout the United States and do not consider geographic  
 4 differentials. The thresholds are updated each year based on the Consumer Price  
 5 Index. For the five-year ACS reporting period used in this chapter, separate  
 6 thresholds are applied to each year in this continuous survey. Other federal  
 7 agencies rely upon different poverty statistics including the Current Population  
 8 Survey Annual Social and Economic Supplement and the U.S. Department of  
 9 Health and Human Services poverty guidelines.

10 The population for whom poverty level is estimated by ACS is smaller value than  
 11 the total population values presented in Chapter 14, Socioeconomics, for each  
 12 county and the equivalent population values used for the distribution of the  
 13 population by race and ethnicity. The population values to determine poverty  
 14 rates do not include institutionalized individuals (e.g., military personnel that live  
 15 in group quarters, students that live in college dormitories, and prison inmates.  
 16 The U.S. Census Bureau designates geographical areas with poverty rates at and  
 17 above 20 percent as “poverty areas.”

#### 18 **21.3.2.3 Social Services**

19 The need for and delivery of social services within each county is another  
 20 indication of social conditions, including Federal grants to the state and local  
 21 agencies for Medicaid, other health related activities, and nutrition and family  
 22 welfare; and Federal direct payments made to individuals under the CalFresh  
 23 (previously referred to as “Food Stamps”) and supplemental social security  
 24 income.

#### 25 **21.3.2.4 Limited English Proficiency**

26 Another consideration related to environmental justice is the ability of the Federal  
 27 government to provide access to federally conducted and assisted programs and  
 28 activities to all people who, as a result of their national origin, are limited in their  
 29 English proficiency (LEP). These individuals are not able to speak, read, write, or  
 30 understand the English language at a level that permits them to interact effectively  
 31 with Federal employees who provide Federal services. Therefore, these  
 32 individuals are often excluded from Federal programs, do not receive all available  
 33 Federal services, and/or experience delays when interacting with Federal  
 34 programs. The Executive Order 13166 became effective on August 11, 2000 to  
 35 ensure meaningful participation by individuals who have limited English  
 36 proficiency in federally conducted and federally assisted programs and activities.  
 37 This information is compiled and reported by the U.S. Census Bureau.

#### 38 **21.3.3 Trinity River Region**

39 The Trinity River Region includes the area in Trinity County along the Trinity  
 40 River from Trinity Lake to the confluence with the Klamath River; and in  
 41 Humboldt and Del Norte counties along the Lower Klamath River from the  
 42 confluence with the Trinity River to the Pacific Ocean. Tribal lands along the  
 43 Trinity or Lower Klamath River within the Trinity River Region include the



1 Hoopa Valley Indian Reservation, Yurok Indian Reservation, and Resighini  
2 Rancheria.

3 **21.3.3.1 Minority Populations**

4 As recorded in the 2010 Census, the Trinity River Region had a total population  
5 of 177,019 (U.S. Census 2014a). About 24.3 percent of this population identified  
6 themselves as a racial minority and/or of Hispanic or Latino origin, regardless of  
7 race, as presented in Table 21.1 (U.S. Census 2014a, 2014b, 2014c, 2014d).  
8 There are fewer minorities in the Trinity River Region than in the entire State of  
9 California.

10 **21.3.3.2 Poverty Levels**

11 Poverty levels presented in Table 21.2 are calculated on a subset of the total  
12 population of a county, as described above in section 21.3.2, Characterization of  
13 Conditions Considered in the Environmental Justice Analysis. Of the total  
14 population for whom poverty is determined in the Trinity River Region,  
15 167,987 individuals (or 18.2 percent) were below the poverty level based on the  
16 2006–2010 ACS 5-year dataset (U.S. Census 2014e). The U.S. Census Bureau  
17 defines geographical areas with more than 20 percent of the population below the  
18 poverty level as a “poverty areas.” Both Humboldt and Del Norte counties are  
19 defined as poverty areas.

20 Poverty rates based upon the 2000 census were reported as 40 percent for Indians  
21 on the Yurok Indian Reservation, 34 percent of the Indians on the Hoopa Valley  
22 Indian Reservation, and 54 percent of the Indians on and off Karuk Reservation  
23 trust lands (NMFS 2012a, 2012b, 2012c). The Yurok Tribe has reported an  
24 average poverty rate of 80 percent of the Indians on the Yurok Indian Reservation  
25 (Yurok Tribe 2014a). Average per capita income of residents on the Resighini  
26 Rancheria (not limited to Resighini Rancheria members) in 1999 was reported to  
27 be approximately 46 percent of the average per capita income in Del Norte  
28 County (NMFS 2012d).

29 **21.3.3.3 Social Services**

30 Federal grants to the state and local agencies for Medicaid, other health related  
31 activities, and nutrition and family welfare; and Federal direct payments made to  
32 individuals under the CalFresh (previously referred to as “Food Stamps”) and  
33 supplemental social security income within counties in the Trinity River Region  
34 are summarized in Table 21.3.

35 Social services to tribal members are funded by the tribe and/or the federal  
36 government (DOI and DFG 2012). The Hoopa Valley Tribe provides food  
37 distribution and other social services, including Temporary Assistance for Needy  
38 Families (TANF) which receives some assistance from Humboldt County social  
39 services to provide cash assistance, utility billing assistance, childcare,  
40 educational assistance, job development, substance abuse assistance, and family  
41 assistance (Hoopa Tribe 2014 a, 2014b). The Yurok Tribe provides a wide range  
42 of services, including general assistance, food distribution, Indian Child welfare,  
43 low income energy assistance, Yurok Youth Program, emergency and temporary

1 assistance, and Yurok Domestic Violence/Sexual Assault Project (Yurok  
2 Tribe 2014b).

3 **21.3.3.4 Limited English Proficiency**

4 The percent of the population that speaks English and other languages at home  
5 and the percent of the population that speak English “less than very well” based  
6 on the language they speak at home are presented in Tables 21.4 and 21.5.

7 **21.3.4 Central Valley Region**

8 The Central Valley Region includes the Sacramento Valley, San Joaquin Valley,  
9 and Delta and Suisun Marsh subregions.

10 **21.3.4.1 Sacramento Valley**

11 The Sacramento Valley includes the counties of Shasta, Plumas, Tehama, Glenn,  
12 Colusa, Butte, Sutter, Yuba, Nevada, Placer, and El Dorado counties.  
13 Sacramento, Yolo, and Solano counties also are located within the Sacramento  
14 Valley; however, these counties are discussed below as part of the Delta and  
15 Suisun Marsh subsection. Other counties in this region are not anticipated to be  
16 affected by changes in CVP and SWP operations, and are not discussed here,  
17 including: Alpine, Sierra, Lassen, and Amador counties.

18 **21.3.4.1.1 Minority Populations**

19 As recorded in the 2010 U.S. Census, the Sacramento Valley portion of the  
20 Central Valley Region had a total population of 1,325,380 in 2010. About  
21 25.8 percent of this population identified themselves as a racial minority and/or of  
22 Hispanic or Latino origin, regardless of race, as presented in Table 21.6. The  
23 table also shows the minority population distribution for the entire Central Valley  
24 Region and the State of California.

1 **Table 21.1 Minority Population Distribution in Trinity River Region in 2010**

Areas	Total Population	Races							Hispanic or Latino Origin	Total Minority <sup>a</sup>
		White	Black/ African American	American Indian and Native Alaskan	Asian	Native Hawaiian and Other Pacific Islander	Some Other Race	Two or More Races		
Trinity County	13,786	87.3%	0.4%	4.8%	0.7%	0.1%	1.6%	5.2%	7.0%	16.5%
Humboldt County	134,623	81.7%	1.1%	5.7%	2.2%	0.3%	3.7%	5.3%	9.8%	22.8%
Del Norte County	28,610	73.7%	3.5%	7.8%	3.4%	0.1%	6.9%	4.5%	17.8%	35.3%
Trinity River Region	177,019	80.8%	1.4%	6.0%	2.3%	0.2%	4.1%	5.2%	10.9%	24.3%
<b>STATE OF CALIFORNIA</b>	<b>37,253,956</b>	<b>57.6%</b>	<b>6.2%</b>	<b>1.0%</b>	<b>13.0%</b>	<b>0.4%</b>	<b>17.0%</b>	<b>4.9%</b>	<b>40.1%</b>	<b>59.9%</b>

2 Sources: U.S. Census 2014a, 2014b, 2014c, 2014d

3 Note:

4 a. Total Minority is an aggregation of all non-white racial groups and includes all individuals of Hispanic or Latino origin, regardless of race.

1 **Table 21.2 Population below Poverty Level in Trinity River Region, 2006–2010**

Areas	Total Population <sup>a</sup>	Population Below Poverty Level	Percent of Population Below Poverty Level
Trinity County	13,225	1,993	15.1%
Humboldt County	129,592	22,973	17.7%
Del Norte County	25,170	5,526	22.0%
Trinity River Region	167,987	30,492	18.2%
<b>STATE OF CALIFORNIA</b>	<b>35,877,036</b>	<b>4,919,945</b>	<b>13.7%</b>

2 Source: U.S. Census 2014e

3 Note: a. Population numbers are only those for whom poverty status was determined and exclude institutionalized individuals

4 **Table 21.3 Federal Funds Distributed for Social Programs in Trinity River Region in 2010**

Areas	Grants (millions of dollars)		Distributed to Individuals (millions of dollars)
	Medicaid and Other Health-Related Items	Nutrition and Family Welfare	CalFresh Benefits and Supplemental Security Income
Trinity County	\$12.5	\$4.9	\$6.6
Humboldt County	\$167.8	\$36.0	\$65.6
Del Norte County	\$28.8	\$10.1	\$19.1
Trinity River Region	\$209.1	\$51.0	\$91.3
<b>STATE OF CALIFORNIA</b>	<b>\$41,931.1</b>	<b>\$11,743.7</b>	<b>\$12,469.4</b>

5 Source: Gaquin and Ryan 2013

1 **Table 21.4 Top Five Non-English Languages Spoken at Home as a Proportion of the Total Population Five Years and Older in the Trinity**  
 2 **River Region, 2006–2010**

Areas	Only English	Spanish/ Spanish Creole	Portuguese/ Portuguese Creole	German	Tagalog	Hmong	Total Excluding English
Trinity County	93.9%	3.8%	0.0%	0.3%	0.1%	0.0%	4.2%
Humboldt County	90.8%	5.7%	0.4%	0.3%	0.3%	0.0%	6.8%
Del Norte County	83.3%	11.6%	0.1%	0.5%	0.5%	1.6%	14.2%
Trinity River Region	89.8%	6.5%	0.4%	0.3%	0.3%	0.3%	7.8%
<b>STATE OF CALIFORNIA</b>	<b>57.0%</b>	<b>28.5%</b>	<b>0.2%</b>	<b>0.3%</b>	<b>2.2%</b>	<b>0.2%</b>	<b>31.4%</b>

3 Source: U.S. Census 2014f

4 **Table 21.5 Percent of Population Speaking One of the Top Five Non-English Languages Spoken at Home in the Trinity River Region that**  
 5 **Speaks English “Less than Very Well” as a Proportion of the Total Population Five Years and Older, 2006–2010**

Areas	Spanish/ Spanish Creole	Portuguese/ Portuguese Creole	German	Tagalog	Hmong
Trinity County	1.4%	0.0%	0.0%	0.0%	0.0%
Humboldt County	2.3%	0.2%	0.1%	0.1%	0.0%
Del Norte County	3.1%	0.0%	0.1%	0.1%	0.6%
Trinity River Region	2.4%	0.1%	0.1%	0.1%	0.1%
<b>STATE OF CALIFORNIA</b>	<b>13.6%</b>	<b>0.1%</b>	<b>0.05%</b>	<b>0.7%</b>	<b>0.1%</b>

6 Source: U.S. Census 2014f

1 **Table 21.6 Minority Population Distribution in the Central Valley Region–Sacramento Valley in 2010**

Areas	Total Population	Races							Hispanic or Latino Origin	Total Minority <sup>a</sup>
		White	Black/ African American	American Indian and Native Alaskan	Asian	Native Hawaiian and Other Pacific Islander	Some Other Race	Two or More Races		
Shasta County	177,223	86.7%	0.9%	2.8%	2.5%	0.2%	2.5%	4.4%	8.4%	17.6%
Plumas County	20,007	89.0%	1.0%	2.7%	0.7%	0.1%	3.0%	3.6%	8.0%	15.0%
Tehama County	63,463	81.5%	0.6%	2.6%	1.0%	0.1%	9.9%	4.3%	21.9%	28.1%
Glenn County	28,122	71.1%	0.8%	2.2%	2.6%	0.1%	19.6%	3.6%	37.5%	44.1%
Colusa County	21,419	64.7%	0.9%	2.0%	1.3%	0.3%	27.3%	3.6%	55.1%	60.2%
Butte County	220,000	81.9%	1.6%	2.0%	4.1%	0.2%	5.5%	4.7%	14.1%	24.8%
Yuba County	72,155	68.4%	3.3%	2.3%	6.7%	0.4%	11.8%	7.1%	25.0%	41.2%
Nevada County	98,764	91.4%	0.4%	1.1%	1.2%	0.1%	2.7%	3.2%	8.5%	13.5%
Sutter County	94,737	61.0%	2.0%	1.4%	14.4%	0.3%	15.3%	5.6%	28.8%	49.6%
Placer County	348,432	83.5%	1.4%	0.9%	5.9%	0.2%	3.8%	4.3%	12.8%	23.9%
El Dorado County	181,058	86.6%	0.8%	1.1%	3.5%	0.2%	4.0%	3.8%	12.1%	20.1%
Sacramento Valley Subtotal	1,325,380	81.7%	1.3%	1.6%	4.7%	0.2%	6.1%	4.5%	23.1%	25.8%
Central Valley Region	8,379,045	61.4%	6.3%	1.3%	9.5%	0.4%	15.7%	5.4%	42.6%	53.5%
<b>STATE OF CALIFORNIA</b>	<b>37,253,956</b>	<b>57.6%</b>	<b>6.2%</b>	<b>1.0%</b>	<b>13.0%</b>	<b>0.4%</b>	<b>17.0%</b>	<b>4.9%</b>	<b>37.6%</b>	<b>59.9%</b>

2 Sources: U.S. Census 2014a, 2014g, 2014h, 2014i, 2014j, 2014k, 2014l, 2014m, 2014n, 2014o, 2014p, 2014q

3 Note:

4 a. Total Minority is an aggregation of all non-white racial groups and includes all individuals of Hispanic or Latino origin, regardless of race.

1    **21.3.4.1.2 Poverty Levels**

2    Poverty levels presented in Table 21.7 are calculated on a subset of the total  
3    population of a county, as described above in section 21.3.2, Characterization of  
4    Conditions Considered in the Environmental Justice Analysis. Of the total  
5    population for whom poverty status is determined within the Sacramento Valley  
6    portion of the Central Valley Region, 1,288,594 individuals, 12.6 percent were  
7    below the poverty level based on the 2006–2010 ACS 5-year dataset (U.S. Census  
8    2014e).

9    The U.S. Census Bureau defines geographical areas with more than 20 percent of  
10   the population below the poverty level as a “poverty areas.” There are no  
11   counties in this area defined as poverty areas; although, 20 percent of the  
12   populations in Tehama and Yuba counties are below the poverty level.

13   **21.3.4.1.3 Social Services**

14   Federal grants to the state and local agencies for Medicaid, other health related  
15   activities, and nutrition and family welfare; and Federal direct payments made to  
16   individuals under the CalFresh and supplemental social security income within  
17   counties in the Sacramento Valley portion of the Central Valley Region are  
18   summarized in Table 21.8.

19   **21.3.4.1.4 Limited English Proficiency**

20   The percent of the population that speaks English and other languages at home  
21   and the percent of the population that speak English “less than very well” based  
22   on the language they speak at home are presented in Tables 21.9 and 21.10.

23   **21.3.4.2 San Joaquin Valley**

24   The San Joaquin Valley includes the counties of Stanislaus, Merced, Madera,  
25   Fresno, Kings, Tulare, and Kern counties. San Joaquin County also is located  
26   within the San Joaquin Valley; however, this county is discussed below as part of  
27   the Delta and Suisun Marsh subsection. Other counties in this region are not  
28   anticipated to be affected by changes in CVP and SWP operations, and are not  
29   discussed here, including: Calaveras, Mariposa, and Tuolumne counties.

30   **21.3.4.2.1 Minority Populations**

31   As recorded in the 2010 U.S. Census, the San Joaquin Valley portion of the  
32   Central Valley Region had a total population of 3,286,353 in 2010. About  
33   63.3 percent of this population identified themselves as a racial minority and/or of  
34   Hispanic or Latino origin, regardless of race, as presented in Table 21.11. The  
35   table also shows the minority population distribution for the entire Central Valley  
36   Region and the State of California.

1 **Table 21.7 Population below Poverty Level in the Central Valley Region–**  
 2 **Sacramento Valley, 2006–2010**

Areas	Total Population <sup>a</sup>	Population Below Poverty Level	Percent of Population Below Poverty Level
Shasta County	174,180	28,772	16.5%
Plumas County	20,179	2,437	12.1%
Tehama County	61,201	12,397	20.3%
Glenn County	27,853	4,875	17.5%
Colusa County	20,768	3,107	15.0%
Butte County	213,501	39,290	18.4%
Yuba County	68,848	13,760	20.0%
Nevada County	97,209	8,740	9.0%
Sutter County	92,477	13,194	14.3%
Placer County	334,718	22,090	6.6%
El Dorado County	177,660	14,003	7.9%
Sacramento Valley Subtotal	1,288,594	162,665	12.6%
Central Valley Region	8,025,054	1,268,984	15.8%
<b>STATE OF CALIFORNIA</b>	<b>35,877,036</b>	<b>4,919,945</b>	<b>13.7%</b>

3 Source: U.S. Census 2014e

4 Note: a. Population numbers are only those for whom poverty status was determined and exclude  
 5 institutionalized individuals



1 **Table 21.8 Federal Funds Distributed for Social Programs in the Central Valley**  
 2 **Region – Sacramento Valley in 2010**

Areas	Grants (millions of dollars)		Distributed to Individuals (millions of dollars)
	Medicaid and Other Health- Related Items	Nutrition and Family Welfare	CalFresh Benefits and Supplemental Security Income
Shasta County	\$199.0	\$50.8	\$93.5
Plumas County	\$19.3	\$7.9	\$5.9
Tehama County	\$61.6	\$17.5	\$23.1
Glenn County	\$25.3	\$10.6	\$11.3
Colusa County	\$18.6	\$8.2	\$6.5
Butte County	\$263.4	\$44.7	\$104.9
Yuba County	\$125.0	\$21.8	\$45.2
Nevada County	\$53.8	\$15.4	\$16.1
Sutter County	\$76.4	\$20.1	\$28.8
Placer County	\$139.2	\$44.8	\$43.2
El Dorado County	\$62.5	\$32.4	\$29.0
Sacramento Valley Subtotal	\$1,044.1	\$274.2	\$407.5
Central Valley Region	\$8,759.9	\$4,308.9	\$3,179.8
<b>STATE OF CALIFORNIA</b>	<b>\$41,931.1</b>	<b>\$11,743.7</b>	<b>\$12,469.4</b>

3 Source: Gaquin and Ryan 2013

1 **Table 21.9 Top Five Non-English Languages Spoken at Home as a Proportion of the Total Population Five Years and Older in the Central**  
 2 **Valley Region – Sacramento Valley, 2006–2010**

Areas	Only English	Spanish/ Spanish Creole	Tagalog	German	Chinese	Hmong	Total Excluding English
Shasta County	91.5%	4.6%	0.3%	0.6%	0.3%	0.01%	5.7%
Plumas County	92.4%	5.9%	0.1%	0.4%	0.6%	0.0%	7.0%
Tehama County	80.4%	16.9%	0.1%	0.4%	0.2%	0.02%	17.7%
Glenn County	67.4%	29.6%	0.1%	0.2%	0.0%	0.0%	29.8%
Colusa County	54.3%	44.1%	0.4%	0.1%	0.3%	0.0%	44.8%
Butte County	85.4%	9.3%	0.3%	0.3%	0.5%	1.3%	11.7%
Yuba County	74.4%	17.8%	0.8%	0.4%	0.3%	3.1%	22.3%
Nevada County	93.4%	4.1%	0.1%	0.8%	0.1%	0.0%	5.1%
Sutter County	65.5%	20.5%	0.5%	0.4%	0.5%	0.1%	21.9%
Placer County	86.1%	6.3%	1.3%	0.4%	0.7%	0.1%	8.7%
El Dorado County	88.2%	7.3%	0.4%	0.6%	0.5%	0.02%	9.0%
Sacramento Valley Subtotal	84.4%	9.7%	0.6%	0.5%	0.5%	0.4%	11.6%
Central Valley Region	66.2%	23.1%	1.7%	0.3%	1.2%	0.8%	27.1%
<b>STATE OF CALIFORNIA</b>	<b>57.0%</b>	<b>28.5%</b>	<b>2.2%</b>	<b>0.3%</b>	<b>2.9%</b>	<b>0.2%</b>	<b>34.1%</b>

3 Source: U.S. Census 2014f

1 **Table 21.10 Percent of Population Speaking One of the Top Five Non-English Languages Spoken at Home in the Central Valley Region –**  
 2 **Sacramento Valley that Speaks English “Less than Very Well” as a Proportion of the Total Population Five Years and Older, 2006–2010**

Areas	Spanish/ Spanish Creole	Tagalog	German	Chinese	Hmong
Shasta County	1.4%	0.1%	0.05%	0.1%	0.01%
Plumas County	1.8%	0.0%	0.00%	0.6%	0.0%
Tehama County	8.0%	0.1%	0.04%	0.1%	0.0%
Glenn County	13.3%	0.0%	0.1%	0.0%	0.0%
Colusa County	24.7%	0.0%	0.02%	0.3%	0.0%
Butte County	3.8%	0.1%	0.04%	0.4%	0.8%
Yuba County	9.2%	0.2%	0.1%	0.2%	2.1%
Nevada County	2.1%	0.1%	0.1%	0.06%	0.0%
Sutter County	12.3%	0.1%	0.02%	0.2%	0.03%
Placer County	2.7%	0.4%	0.05%	0.3%	0.07%
El Dorado County	3.3%	0.1%	0.1%	0.2%	0.0%
Sacramento Valley Subtotal	4.6%	0.2%	0.06%	0.2%	0.3%
Central Valley Region	10.8%	0.5%	0.04%	0.06%	0.4%
<b>STATE OF CALIFORNIA</b>	<b>13.6%</b>	<b>0.7%</b>	<b>0.04%</b>	<b>1.6%</b>	<b>0.1%</b>

3 Source: U.S. Census 2014f

1 **Table 21.11 Minority Population Distribution in the Central Valley Region – San Joaquin Valley in 2010**

Areas	Total Population	Races							Hispanic or Latino Origin	Total Minority <sup>a</sup>
		White	Black/ African American	American Indian and Native Alaskan	Asian	Native Hawaiian and Other Pacific Islander	Some Other Race	Two or More Races		
Stanislaus County	514,453	65.6%	2.9%	1.1%	5.1%	0.7%	19.3%	5.4%	41.9%	53.3%
Madera County	150,865	62.6%	3.7%	2.7%	1.9%	0.1%	24.8%	4.2%	53.7%	62.0%
Merced County	255,793	58.0%	3.9%	1.4%	7.4%	0.2%	24.5%	4.7%	54.9%	68.1%
Fresno County	930,450	55.4%	5.3%	1.7%	9.6%	0.2%	23.3%	4.5%	50.3%	67.3%
Tulare County	442,179	60.1%	1.6%	1.6%	3.4%	0.1%	29.0%	4.2%	60.6%	67.4%
Kings County	152,982	54.3%	7.2%	1.7%	3.7%	0.2%	28.1%	4.9%	50.9%	64.8%
Kern County	839,631	59.5%	5.8%	1.5%	4.2%	0.1%	24.3%	4.5%	49.2%	61.4%
San Joaquin Valley Subtotal	3,286,353	59.1%	4.5%	1.6%	5.9%	0.2%	24.1%	4.6%	50.6%	63.3%
Central Valley Region	8,379,045	61.4%	6.3%	1.3%	9.5%	0.4%	15.7%	5.4%	42.6%	53.5%
STATE OF CALIFORNIA	37,253,956	57.6%	6.2%	1.0%	13.0%	0.4%	17.0%	4.9%	37.6%	59.9%

2 Sources: U.S. Census 2014a, 2014r, 2014s, 2014t, 2014u, 2014v, 2014w, 2014x

3 Note:

4 a. Total Minority is an aggregation of all non-white racial groups and includes all individuals of Hispanic or Latino origin, regardless of race.

1     **21.3.4.2.2 Poverty Levels**

2     Poverty levels presented in Table 21.12 are calculated on a subset of the total  
3     population of a county, as described above in section 21.3.2, Characterization of  
4     Conditions Considered in the Environmental Justice Analysis. Of the total  
5     population for whom poverty status is determined within the San Joaquin Valley  
6     portion of the Central Valley Region, 3,111,943 individuals, 20.8 percent, were  
7     below the poverty level based on the 2006–2010 ACS 5-year dataset (U.S. Census  
8     2014e). The U.S. Census Bureau defines geographical areas with more than  
9     20 percent of the population below the poverty level as a “poverty areas.”  
10    Merced, Fresno, Tulare, and Kern counties are defined as poverty areas because  
11    more than 20 percent of the populations in these counties are below the  
12    poverty level.

13    **21.3.4.2.3 Social Services**

14    Distribution of social services varies for each county. Federal grants to the state  
15    and local agencies for Medicaid, other health related activities, and nutrition and  
16    family welfare; and Federal direct payments made to individuals under the  
17    CalFresh and supplemental social security income within counties in the San  
18    Joaquin Valley portion of the Central Valley Region are summarized in  
19    Table 21.13.

20    **21.3.4.2.4 Limited English Proficiency**

21    The percent of the population that speaks English and other languages at home  
22    and the percent of the population that speak English “less than very well” based  
23    on the language they speak at home are presented in Tables 21.14 and 21.15.

24    **21.3.4.2.5 Effects of Recent Drought in Two San Joaquin Valley**  
25    **Communities**

26    The San Joaquin Valley portion of the Central Valley Region includes about  
27    8.8 percent of the state’s total population, 9.3 percent of the state’s population that  
28    identified themselves as a racial minority and/or of Hispanic or Latino origin, and  
29    about 13.1 percent of the state’s population below the poverty level. Merced,  
30    Fresno, and Tulare counties had the highest concentration of total minority  
31    populations and the highest concentration of individuals living below the poverty  
32    level. There are communities within these counties that have higher  
33    concentrations of minority populations and/or populations below the poverty  
34    level. These communities are mainly farming communities that have been  
35    impacted by loss in agricultural employment, as described in Chapter 12,  
36    Agricultural Resources, and Chapter 19, Socioeconomics. The impacts have  
37    increased recently during the current drought.

1 **Table 21.12 Population below Poverty Level in the Central Valley Region – San**  
 2 **Joaquin Valley, 2006–2010**

Areas	Total Population <sup>a</sup>	Population Below Poverty Level	Percent of Population Below Poverty Level
Stanislaus County	502,108	82,480	16.4%
Madera County	138,151	26,656	19.3%
Merced County	246,260	53,738	21.8%
Fresno County	890,694	200,288	22.5%
Tulare County	423,902	97,012	22.9%
Kings County	133,206	25,713	19.3%
Kern County	777,622	159,967	20.6%
San Joaquin Valley Subtotal	3,111,943	645,854	20.8%
Central Valley Region	8,025,054	1,268,984	15.8%
<b>STATE OF CALIFORNIA</b>	<b>35,877,036</b>	<b>4,919,945</b>	<b>13.7%</b>

3 Source: U.S. Census 2014e

4 Note:

5 a. Population numbers are only those for whom poverty status was determined and exclude  
 6 institutionalized individuals

7 **Table 21.13 Federal Funds Distributed for Social Programs in the Central Valley**  
 8 **Region – San Joaquin Valley in 2010**

Areas	Grants (millions of dollars)		Distributed to Individuals (millions of dollars)
	Medicaid and Other Health-Related Items	Nutrition and Family Welfare	CalFresh Benefits and Supplemental Security Income
Stanislaus County	\$535.9	\$145.3	\$198.7
Madera County	\$144.3	\$33.6	\$45.6
Merced County	\$260.0	\$73.7	\$126.0
Fresno County	\$992.0	\$274.8	\$468.5
Tulare County	\$569.1	\$116.0	\$196.5
Kings County	\$129.2	\$37.8	\$49.3
Kern County	\$712.0	\$203.4	\$328.6
San Joaquin Valley Subtotal	\$3,342.5	\$884.6	\$1,413.2
Central Valley Region	\$8,759.9	\$4,308.9	\$3,179.8
<b>STATE OF CALIFORNIA</b>	<b>\$41,931.1</b>	<b>\$11,743.7</b>	<b>\$12,469.4</b>

9 Source: Gaquin and Ryan 2013

1 **Table 21.14 Top Five Non-English Languages Spoken at Home as a Proportion of the Total Population Five Years and Older in the**  
 2 **Central Valley Region – San Joaquin Valley, 2006–2010**

Areas	Speaks Only English	Spanish and Spanish Creole	Tagalog	Chinese	Portuguese/ Portuguese Creole	Hmong	Total Excluding English
Stanislaus County	59.8%	30.6%	0.7%	0.4%	0.9%	0.1%	32.8%
Madera County	58.0%	38.6%	0.3%	0.1%	0.2%	0.3%	39.5%
Merced County	48.5%	41.5%	0.7%	0.5%	2.2%	2.5%	47.4%
Fresno County	57.4%	32.5%	0.7%	0.6%	0.1%	2.7%	36.6%
Tulare County	53.2%	42.5%	0.7%	0.2%	0.7%	0.2%	44.4%
Kings County	57.4%	37.9%	1.6%	0.4%	1.0%	0.0%	40.9%
Kern County	59.0%	36.4%	1.1%	0.3%	0.0%	0.0%	37.8%
San Joaquin Valley Subtotal	57.0%	35.8%	0.8%	0.4%	0.5%	1.0%	38.5%
Central Valley Region	66.2%	23.1%	1.7%	1.2%	0.3%	0.8%	27.1%
<b>STATE OF CALIFORNIA</b>	<b>57.0%</b>	<b>28.5%</b>	<b>2.2%</b>	<b>2.9%</b>	<b>0.2%</b>	<b>0.2%</b>	<b>34.0%</b>

3 Source: U.S. Census 2014f

1 **Table 21.15 Percent of Population Speaking One of the Top Five Non-English Languages Spoken at Home in the Central Valley Region –**  
 2 **San Joaquin Valley that Speaks English “Less than Very Well” as a Proportion of the Total Population Five Years and Older, 2006–2010**

Areas	Spanish and Spanish Creole	Tagalog	Chinese	Portuguese/ Portuguese Creole	Hmong
Stanislaus County	13.1%	0.2%	0.3%	0.4%	0.0%
Madera County	17.7%	0.1%	0.0%	0.1%	0.1%
Merced County	19.4%	0.2%	0.2%	0.9%	1.2%
Fresno County	14.7%	0.2%	0.3%	0.0%	1.3%
Tulare County	21.4%	0.3%	0.1%	0.3%	0.1%
Kings County	19.4%	0.6%	0.3%	0.3%	0.0%
Kern County	16.4%	0.4%	0.2%	0.0%	0.0%
San Joaquin Valley Subtotal	16.5%	0.3%	0.2%	0.2%	0.5%
Central Valley Region	10.8%	0.5%	0.6%	0.1%	0.4%
<b>STATE OF CALIFORNIA</b>	<b>13.6%</b>	<b>0.7%</b>	<b>1.6%</b>	<b>0.1%</b>	<b>0.1%</b>

3 Source: U.S. Census 2014f



1 Conditions in this geographic area have been the focus of recent newspaper  
2 articles describing conditions in these communities. According to AgAlert  
3 (2014), a weekly newspaper for California agriculture, increased levels of land  
4 fallowing on irrigated cropland in the San Joaquin Valley has resulted in  
5 significant economic losses in small farming communities. Higher than typical  
6 unemployment rates has resulted in increased food insecurity. As a result, food  
7 banks are facing increased demand. Another article in the Fresno Bee Newspaper  
8 (2014) described the food insecurity issue in the City of Mendota, a community in  
9 Fresno County.

10 Although there are emergency programs such as those administered through the  
11 U.S. Department of Agriculture (USDA), many of these programs are specific in  
12 their targets, require a long time to implement, or are of limited duration. For  
13 example, the 2014 Farm Bill includes \$100 million in livestock disaster  
14 assistance; \$15 million in assistance to farmers and ranchers to implement water  
15 conservation practices; and \$60 million for food banks in the State of California  
16 (USDA 2014a). The USDA February 14, 2014 news release announcing these  
17 programs acknowledges that previous implementation of assistance programs  
18 were hampered by long processing times and emphasizes that the USDA is  
19 committed to reduce the response times by more than 80 percent. The USDA also  
20 is working with California Department of Education to expand the number of  
21 Summer Food Service Program meal sites. The U.S. Department of Homeland  
22 Security also provides assistance with food and related expenses through the  
23 Emergency Food and Shelter National Board Program (USDHS 2014); however  
24 this assistance is limited to one month. There also are many California-based  
25 programs, including the California Department of Social Services that provided in  
26 2014 up to \$25 million in food assistance for counties affected by employment  
27 losses due to the drought that has reduced agriculturally-related jobs  
28 (CDSS 2014). This program is specifically targeted for counties where the  
29 unemployment rate in 2013 was higher than the statewide average, including  
30 Fresno, Merced, and Tulare counties. This aid includes pre-packaged food boxes  
31 to be delivered to local food banks. Families and individuals that expected to  
32 experience long-term impacts due to the drought also were provided assistance to  
33 apply for the CalFresh Program to supplement funding for the food budget.

#### 34 *Huron and Mendota*

35 The cities of Huron and Mendota are both located in Fresno County. Economic  
36 activities in both cities and surrounding communities are based on agriculture. Of  
37 the 25 major employers in Fresno County, only one, Stamoules Produce  
38 Company, is located in the City of Mendota (CEDD 2013). None of the 25 major  
39 employers in Fresno County are located in Huron. Another major employer in the  
40 City of Mendota is a medium security Federal prison for men (BOP 2014).

41 In 2010, the number of people that identified themselves as a racial minority  
42 and/or of Hispanic or Latino origin and the portion of the population below the  
43 poverty level in these two cities were significantly higher than the distribution of  
44 these populations in Fresno County and the State of California, as presented in  
45 Tables 21.16 and 21.17. Although the two communities became more racially

1 diverse in 2010 than they were in the 2000 Census, both communities became  
 2 poorer. While Huron and Mendota have experienced increases in poverty levels,  
 3 the proportion of the population below the poverty level has been relatively stable  
 4 in Fresno County.

5 **Table 21.16 Racial and Ethnic Minority Population in Huron and Mendota in 2010**

Areas	Total Population	Racial Minority	Hispanic or Latino Origin	Below Poverty Level
Huron City	6,754	65.9%	96.6%	54.5%
Mendota City	11,014	47.1%	96.6%	44.6%
Fresno County	930,450	44.6%	50.3%	22.5%
<b>State of California</b>	<b>37,253,956</b>	<b>42.4%</b>	<b>37.6%</b>	<b>13.7%</b>

6 Source: U.S. Census Bureau, 2013a, 2013b, 2014e, 2014u

7 **Table 21.17 Racial and Ethnic Minority Population in Huron and Mendota in 2000**

Areas	Total Population	Racial Minority	Hispanic or Latino Origin	Below Poverty Level
Huron City	6,306	79.6%	98.3%	39.4%
Mendota City	7,890	72.7%	94.7%	41.9%
Fresno County	799,407	45.7%	44.0%	22.9%
<b>State of California</b>	<b>33,871,648</b>	<b>40.5%</b>	<b>32.4%</b>	<b>14.2%</b>

8 Sources: U.S. Census Bureau, 2013c, 2013d, 2013e, 2013f

9 *Other Indicators of Economic Conditions*

10 Other indicators of economic struggles within these communities are the number  
 11 of individuals who are on poverty alleviation programs, including CalFresh, the  
 12 Federal Supplemental Nutrition Assistance Program administered by the State of  
 13 California, California Work Opportunity and Responsibility to Kids  
 14 (CalWORKs), and National School Lunch Program (NSLP).

15 Both CalFresh and CalWORKs are administered by the California Department of  
 16 Social Services. The CalFresh Program issues monthly electronic benefits that  
 17 can be used to buy most foods. The program's purpose is to help improve the  
 18 health and well-being of qualified households and individuals. CalWORKs is a  
 19 social welfare program that provides cash aid and services to eligible needy  
 20 California families. Figure 21.1 shows the trend in the average annual population  
 21 on public assistance (both the CalFresh Program and CalWORKs program)  
 22 between 2006 and 2012, the years for which electronic data were available for the  
 23 cities of Huron and Mendota. The populations in Huron and Mendota have higher  
 24 levels of participations in the two public assistance programs compared to the  
 25 levels in Fresno County and the state. Additionally, the rates of participation in

1 the two communities have been growing at a faster rate than growth in these  
2 programs in Fresno County and the state. Eligibility in the CalFresh Program is  
3 based upon several factors, including a poverty threshold requirement and  
4 citizenship/immigration status. Eligibility for CalWORKs is determined on the  
5 basis of citizenship, age, income, resources, assets and other factors  
6 (CDSS 2013j).

7 The NSLP program includes students that are eligible for assistance under  
8 CalFresh and other federal assistance programs, such as the Temporary  
9 Assistance for Needy Families and the Food Distribution Program on Indian  
10 Reservations; and students who are eligible under the Other Source Categorically  
11 Eligible Programs. A student is eligible under the Other Source Categorically  
12 Eligible Programs if that student is: (1) homeless, runaway or migrant; (2) a foster  
13 child; or (3) enrolled in a Federally-funded Head Start Program or a comparable  
14 State-funded Head Start Program or pre-kindergarten programs, or in an Even  
15 Start Program (USDA 2014b). Students enrolled in the NSLP are eligible for  
16 either free or reduced price meals (FRPM). Figure 21.2 shows the proportion of  
17 students enrolled in the FRPM program in the two communities, Fresno County,  
18 and the state. Participation on FRPM in Fresno County is higher than in the entire  
19 state; and lower than within Huron and Mendota.

20 Relatively large participation in the social services programs is related to low  
21 employment in Huron and Mendota. Annual unemployment rates in Huron and  
22 Mendota between 2006 and 2012 have consistently remained higher than for  
23 Fresno County and the state, as presented in Figure 21.3. The pattern of  
24 unemployment has been similar to unemployment patterns in Fresno County, and  
25 increased following the economic recession that started in 2007. The increase in  
26 unemployment also occurred at a time when both agricultural cultivated acreage  
27 and farm employment in the area declined; and included five consecutive years  
28 with reduced water availability, as described in Chapter 12, Agricultural  
29 Resources, and Chapter 19, Socioeconomics.

### 30 **21.3.4.3 Delta and Suisun Marsh**

31 The Delta and Suisun Marsh portion of the Central Valley Region includes  
32 Sacramento, Yolo, Solano, San Joaquin, and Contra Costa counties.

#### 33 **21.3.4.3.1 Minority Populations**

34 As recorded in the 2010 U.S. Census, the Delta and Suisun Marsh portion of the  
35 Central Valley Region had a total population of 2,718,287 in 2010. About  
36 54.8 percent of this population identified themselves as a racial minority and/or of  
37 Hispanic or Latino origin, regardless of race, as presented in Table 21.18. The  
38 table also shows the minority population distribution for the entire Central Valley  
39 Region and the State of California.

#### 40 **21.3.4.3.2 Poverty Levels**

41 Poverty levels presented in Table 21.19 are calculated on a subset of the total  
42 population of a county, as described above in section 21.3.2, Characterization of  
43 Conditions Considered in the Environmental Justice Analysis.

1 **Table 21.18 Minority Population Distribution in the Central Valley Region – Delta and Suisun Marsh in 2010**

Areas	Total Population	Races							Hispanic or Latino Origin	Total Minority <sup>a</sup>
		White	Black/ African American	American Indian and Native Alaskan	Asian	Native Hawaiian and Other Pacific Islander	Some Other Race	Two or More Races		
Sacramento County	1,418,788	57.5%	10.4%	1.0%	14.3%	1.0%	9.3%	6.6%	21.6%	51.6%
Yolo County	200,849	63.2%	2.6%	1.1%	13.0%	0.5%	13.9%	5.8%	30.3%	50.1%
Solano County	413,344	51.0%	14.7%	0.8%	14.6%	0.9%	10.5%	7.6%	24.0%	59.2%
San Joaquin County	685,306	51.0%	7.6%	1.1%	14.4%	0.5%	19.1%	6.4%	38.9%	64.1%
Contra Costa County	1,049,025	58.6%	9.3%	0.6%	14.4%	0.5%	10.7%	5.9%	24.4%	52.2%
Total Delta and Suisun Marsh Valley	3,767,312	56.2%	9.6%	0.9%	14.3%	0.7%	11.9%	6.4%	26.2%	54.8%
Central Valley Region	8,379,045	61.4%	6.3%	1.3%	9.5%	0.4%	15.7%	5.4%	42.6%	53.5%
STATE OF CALIFORNIA	37,253,956	57.6%	6.2%	1.0%	13.0%	0.4%	17.0%	4.9%	37.6%	59.9%

2 Sources: U.S. Census 2014a, 2014y, 2014z, 2014aa, 2014ab, 2014ac

3 Note:

4 a. Total Minority is an aggregation of all non-white racial groups and includes all individuals of Hispanic or Latino origin, regardless of race.

1 **Table 21.19 Population below Poverty Level in the Central Valley Region – Delta**  
 2 **and Suisun Marsh, 2006–2010**

Areas	Total Population <sup>a</sup>	Population Below Poverty Level	Percent of Population Below Poverty Level
Sacramento County	1,368,693	190,768	13.9%
Yolo County	186,800	31,895	17.1%
Solano County	397,576	41,158	10.4%
San Joaquin County	657,594	105,502	16.0%
Contra Costa County	1,013,854	91,142	9.0%
Total Delta and Suisun Marsh Valley	3,624,517	460,465	12.7%
Central Valley Region	8,025,054	1,268,984	15.8%
<b>STATE OF CALIFORNIA</b>	<b>35,877,036</b>	<b>4,919,945</b>	<b>13.7%</b>

3 Source: U.S. Census 2014e

4 Note:

5 a. Population numbers are only those for whom poverty status was determined and exclude  
 6 institutionalized individuals

7 Of the total population for whom poverty status is determined within the Delta  
 8 and Suisun Marsh portion of the Central Valley Region, 3,624,517 individuals,  
 9 12.7 percent were below the poverty level based on the 2006–2010 ACS 5-year  
 10 dataset (U.S. Census 2014e). The U.S. Census Bureau defines geographical areas  
 11 with more than 20 percent of the population below the poverty level as a “poverty  
 12 areas.” None of the counties in this area are defined as poverty areas.

### 13 **21.3.4.3.3 Social Services**

14 Distribution of social services varies for each county. Federal grants to the state  
 15 and local agencies for Medicaid, other health related activities, and nutrition and  
 16 family welfare; and Federal direct payments made to individuals under the  
 17 CalFresh and supplemental social security income within counties in the Delta  
 18 and Suisun Marsh portion of the Central Valley Region are summarized in  
 19 Table 21.20.

### 20 **21.3.4.3.4 Limited English Proficiency**

21 The percent of the population that speaks English and other languages at home  
 22 and the percent of the population that speak English “less than very well” based  
 23 on the language they speak at home are presented in Tables 21.21 and 21.22.

### 24 **21.3.5 San Francisco Bay Area Region**

25 The San Francisco Bay Area Region includes portions of Napa, Alameda, Santa  
 26 Clara, and San Benito counties that are within the CVP and SWP service areas.  
 27 Contra Costa County also is part of the San Francisco Bay Area Region.  
 28 However, for this chapter, Contra Costa County is discussed under  
 29 Section 14.3.4.3, Delta Suisun Marsh.

1 **21.3.5.1 Minority Populations**

2 As recorded in the 2010 U.S. Census, the San Francisco Bay Area Region had a  
 3 total population of 3,483,666 in 2010. About 64.4 percent of this population  
 4 identified themselves as a racial minority and/or of Hispanic or Latino origin,  
 5 regardless of race, as presented in Table 21.23. The table also shows the minority  
 6 population distribution for the State of California.

7 **21.3.5.2 Poverty Levels**

8 Poverty levels presented in Table 21.24 are calculated on a subset of the total  
 9 population of a county, as described above in section 21.3.2, Characterization of  
 10 Conditions Considered in the Environmental Justice Analysis. Of the total  
 11 population for whom poverty status is determined within the San Francisco Bay  
 12 Area Region, 3,344,994 individuals, 10.1 percent were below the poverty level  
 13 based on the 2006–2010 ACS 5-year dataset (U.S. Census 2014e). The  
 14 U.S. Census Bureau defines geographical areas with more than 20 percent of the  
 15 population below the poverty level as a “poverty areas.” None of the counties in  
 16 the San Francisco Bay Area Region are defined as poverty areas.

17 **Table 21.20 Federal Funds Distributed for Social Programs in the Central Valley**  
 18 **Region – Delta and Suisun Marsh in 2010**

Areas	Grants (millions of dollars)		Distributed to Individuals (millions of dollars)
	Medicaid and Other Health-Related Items	Nutrition and Family Welfare	CalFresh Benefits and Supplemental Security Income
Sacramento County	\$2,115.5	\$2,695.9	\$659.1
Yolo County	\$504.8	\$39.7	\$55.2
Solano County	\$264.2	\$71.7	\$118.6
San Joaquin County	\$739.1	\$153.5	\$287.4
Contra Costa County	\$749.7	\$189.3	\$238.8
Total Delta and Suisun Marsh Valley	\$4,373.3	\$3,150.1	\$1,359.1
Central Valley Region	\$8,759.9	\$4,308.9	\$3,179.8
<b>STATE OF CALIFORNIA</b>	<b>\$41,931.1</b>	<b>\$11,743.7</b>	<b>\$12,469.4</b>

19 Source: Gaquin and Ryan 2013

1 **Table 21.21 Top Five Non-English Languages Spoken at Home as a Proportion of the Total Population Five Years and Older in the**  
 2 **Central Valley Region – Delta and Suisun Marsh, 2006 – 2010**

Areas	Speaks Only English	Spanish and Spanish Creole	Chinese	Tagalog	Vietnamese	Russian	Total Excluding English
Sacramento County	69.8%	13.2%	2.2%	2.0%	1.5%	1.6%	20.5%
Yolo County	65.8%	20.2%	3.3%	0.8%	0.9%	1.6%	26.9%
Solano County	70.6%	15.9%	0.8%	6.8%	0.6%	0.1%	24.1%
San Joaquin County	0.0%	25.1%	1.0%	2.8%	1.0%	0.0%	29.9%
Contra Costa County	67.6%	17.3%	2.9%	2.8%	0.6%	0.6%	24.2%
Total Delta and Suisun Marsh Valley	56.5%	17.2%	2.1%	2.8%	1.0%	0.9%	24.0%
Central Valley Region	66.2%	23.1%	1.2%	1.7%	0.6%	0.5%	27.1%
<b>STATE OF CALIFORNIA</b>	<b>57.0%</b>	<b>28.5%</b>	<b>2.9%</b>	<b>2.2%</b>	<b>1.4%</b>	<b>0.4%</b>	<b>35.4%</b>

3 Source: U.S. Census 2014f

1 **Table 21.22 Percent of Population Speaking One of the Top Five Non-English Languages Spoken at Home in the Central Valley Region –**  
 2 **Delta and Suisun Marsh that Speaks English “Less than Very Well” as a Proportion of the Total Population Five Years and Older,**  
 3 **2006–2010**

Areas	Spanish and Spanish Creole	Chinese	Tagalog	Vietnamese	Russian
Sacramento County	6.0%	1.3%	0.7%	0.9%	0.9%
Yolo County	9.5%	1.5%	0.2%	0.3%	1.0%
Solano County	7.4%	0.4%	2.2%	0.3%	0.0%
San Joaquin County	12.3%	0.6%	1.0%	0.6%	0.0%
Contra Costa County	8.4%	1.3%	0.7%	0.3%	0.3%
Total Delta and Suisun Marsh Valley	8.1%	1.1%	0.9%	0.6%	0.5%
Central Valley Region	10.8%	0.6%	0.5%	0.3%	0.2%
<b>STATE OF CALIFORNIA</b>	<b>13.6%</b>	<b>1.6%</b>	<b>0.7%</b>	<b>0.9%</b>	<b>0.2%</b>

4 Source: U.S. Census 2014f



1 **Table 21.23 Minority Population Distribution in the San Francisco Bay Area Region in 2010**

Areas	Total Population	Races							Hispanic or Latino Origin	Total Minority <sup>a</sup>
		White	Black/ African American	American Indian and Native Alaskan	Asian	Native Hawaiian and Other Pacific Islander	Some Other Race	Two or More Races		
Alameda County	1,510,271	43.0%	12.6%	0.6%	26.1%	0.8%	10.8%	6.0%	22.5%	65.9%
Santa Clara County	1,781,642	47.0%	2.6%	0.7%	32.0%	0.4%	12.4%	4.9%	26.9%	64.8%
San Benito County	55,269	63.7%	0.9%	1.6%	2.6%	0.2%	26.2%	4.9%	56.4%	61.7%
Napa County	136,484	71.5%	2.0%	0.8%	6.8%	0.3%	14.7%	4.1%	32.2%	43.6%
San Francisco Bay Area Region	3,483,666	46.5%	6.9%	0.7%	28.0%	0.6%	12.0%	5.4%	25.7%	64.4%
<b>STATE OF CALIFORNIA</b>	<b>37,253,956</b>	<b>57.6%</b>	<b>6.2%</b>	<b>1.0%</b>	<b>13.0%</b>	<b>0.4%</b>	<b>17.0%</b>	<b>4.9%</b>	<b>37.6%</b>	<b>59.9%</b>

2 Sources: U.S. Census 2014a, 2014ad, 2014ae, 2014af, 2014ag

3 Note:

4 a. Total Minority is an aggregation of all non-white racial groups and includes all individuals of Hispanic or Latino origin, regardless of race.

1 **Table 21.24 Population below Poverty Level in the San Francisco Bay Area Region,**  
 2 **2006–2010**

Areas	Total Population <sup>a</sup>	Population Below Poverty Level	Percent of Population Below Poverty Level
Alameda County	1,450,546	165,417	11.4
Santa Clara County	1,710,231	152,066	8.9
San Benito County	54,160	6,323	11.7
Napa County	130,057	12,948	10.0
San Francisco Bay Area Region	3,344,994	336,754	10.1
<b>STATE OF CALIFORNIA</b>	<b>35,877,036</b>	<b>4,919,945</b>	<b>13.7%</b>

3 Source: U.S. Census 2014e

4 Note:

5 a. Population numbers are only those for whom poverty status was determined and exclude  
 6 institutionalized individuals

7 **21.3.5.3 Social Services**

8 Distribution of social services varies for each county. Federal grants to the state  
 9 and local agencies for Medicaid, other health related activities, and nutrition and  
 10 family welfare; and Federal direct payments made to individuals under the  
 11 CalFresh and supplemental social security income within counties in the San  
 12 Francisco Bay Area Region are summarized in Table 21.25.

13 **21.3.5.4 Limited English Proficiency**

14 The percent of the population that speaks English and other languages at home  
 15 and the percent of the population that speak English “less than very well” based  
 16 on the language they speak at home are presented in Tables 21.26 and 21.27.

17 **21.3.6 Central Coast Region**

18 The Central Coast Region includes portions of San Luis Obispo and Santa  
 19 Barbara counties served by the SWP. SWP water supplies are used directly by  
 20 municipal and industrial water users, and as part of groundwater replenishment  
 21 plans to meet municipal, industrial, and agricultural water demands.

22 **21.3.6.1 Minority Populations**

23 As recorded in the 2010 U.S. Census, the Central Coast Region had a total  
 24 population of 693,532 in 2010. About 43.1 percent of this population identified  
 25 themselves as a racial minority and/or of Hispanic or Latino origin, regardless of  
 26 race, as presented in Table 21.28. The table also shows the minority population  
 27 distribution for the State of California.

28 **21.3.6.2 Poverty Levels**

29 Poverty levels presented in Table 21.29 are calculated on a subset of the total  
 30 population of a county, as described above in section 21.3.2, Characterization of  
 31 Conditions Considered in the Environmental Justice Analysis. Of the total  
 32 population for whom poverty status is determined within the Central Coast

1 Region, 649,348 individuals, 13.8 percent were below the poverty level based on  
 2 the 2006–2010 ACS 5-year dataset (U.S. Census 2014e). The U.S. Census  
 3 Bureau defines geographical areas with more than 20 percent of the population  
 4 below the poverty level as a “poverty areas.” None of the counties in the Central  
 5 Coast Region are defined as poverty areas.

6 **21.3.6.3 Social Services**

7 Distribution of social services varies for each county. Federal grants to the state  
 8 and local agencies for Medicaid, other health related activities, and nutrition and  
 9 family welfare; and Federal direct payments made to individuals under the  
 10 CalFresh and supplemental social security income within counties in the Central  
 11 Coast Region are summarized in Table 21.30.

12 **Table 21.25 Federal Funds Distributed for Social Programs in the San Francisco**  
 13 **Bay Area Region in 2010**

Areas	Grants (millions of dollars)		Distributed to Individuals (millions of dollars)
	Medicaid and Other Health-Related Items	Nutrition and Family Welfare	CalFresh Benefits and Supplemental Security Income
Alameda County	\$2,556.4	\$318.6	\$529.6
Santa Clara County	\$2,000.2	\$334.3	\$466.3
San Benito County	\$27.1	\$12.5	\$8.2
Napa County	\$102.5	\$32.0	\$21.3
San Francisco Bay Area Region	\$4,686.2	\$697.4	\$1,025.4
<b>STATE OF CALIFORNIA</b>	<b>\$41,931.1</b>	<b>\$11,743.7</b>	<b>\$12,469.4</b>

14 Source: Gaquin and Ryan 2013

1 **Table 21.26 Top Five Non-English Languages Spoken at Home as a Proportion of the Total Population Five Years and Older in the San**  
 2 **Francisco Bay Area Region, 2006–2010**

Areas	Speaks Only English	Spanish and Spanish Creole	Chinese	Tagalog	Vietnamese	Hindi	Total Excluding English
Alameda County	57.4%	16.8%	8.2%	3.8%	1.8%	1.6%	32.2%
Santa Clara County	49.3%	19.1%	7.4%	3.3%	6.5%	1.5%	37.8%
San Benito County	60.1%	37.3%	0.1%	0.7%	0.2%	0.0%	38.3%
Napa County	66.5%	26.2%	0.4%	2.4%	0.2%	0.1%	29.3%
San Francisco Bay Area Region	53.7%	18.6%	7.3%	3.4%	4.1%	1.5%	35.0%
<b>STATE OF CALIFORNIA</b>	<b>57.0%</b>	<b>28.5%</b>	<b>2.9%</b>	<b>2.2%</b>	<b>1.4%</b>	<b>0.4%</b>	<b>35.4%</b>

3 Source: U.S. Census 2014f

1 **Table 21.27 Percent of Population Speaking One of the Top Five Non-English Languages Spoken at Home in the San Francisco Bay**  
 2 **Area Region that Speaks English “Less than Very Well” as a Proportion of the Total Population Five Years and Older, 2006–2010**

Areas	Spanish and Spanish Creole	Chinese	Tagalog	Vietnamese	Hindi
Alameda County	8.2%	4.8%	1.1%	1.1%	0.3%
Santa Clara County	8.9%	3.6%	1.1%	4.0%	0.2%
San Benito County	20.4%	0.1%	0.3%	0.2%	0.0%
Napa County	14.6%	0.2%	0.9%	0.2%	0.04%
San Francisco Bay Area Region	9.0%	3.9%	1.1%	2.5%	0.2%
<b>STATE OF CALIFORNIA</b>	<b>13.6%</b>	<b>1.6%</b>	<b>0.7%</b>	<b>0.9%</b>	<b>0.1%</b>

3 Source: U.S. Census 2014f

4 **Table 21.28 Minority Population Distribution in the Central Coast Region in 2010**

Areas	Total Population	Races							Hispanic or Latino Origin	Total Minority <sup>a</sup>
		White	Black/ African American	American Indian and Native Alaskan	Asian	Native Hawaiian and Other Pacific Islander	Some Other Race	Two or More Races		
San Luis Obispo County	269,637	82.6%	2.1%	0.9%	3.2%	0.1%	7.3%	3.8%	20.8%	28.9%
Santa Barbara County	423,895	69.6%	2.0%	1.3%	4.9%	0.2%	17.4%	4.6%	42.8%	52.1%
Central Coast Region	693,532	74.7%	2.0%	1.2%	4.2%	0.2%	13.5%	4.3%	34.3%	43.1%
<b>STATE OF CALIFORNIA</b>	<b>37,253,956</b>	<b>57.6%</b>	<b>6.2%</b>	<b>1.0%</b>	<b>13.0%</b>	<b>0.4%</b>	<b>17.0%</b>	<b>4.9%</b>	<b>37.6%</b>	<b>59.9%</b>

5 Sources: U.S. Census 2014a, 2014ah, 2014ai

6 Note:

7 a. Total Minority is an aggregation of all non-white racial groups and includes all individuals of Hispanic or Latino origin, regardless of race.

1 **Table 21.29 Population below Poverty Level in the Central Coast Region,**  
 2 **2006–2010**

Areas	Total Population <sup>a</sup>	Population Below Poverty Level	Percent of Population Below Poverty Level
San Luis Obispo County	248,764	32,183	12.9%
Santa Barbara County	400,584	57,463	14.3%
Central Coast Region	649,348	89,646	13.8%
<b>STATE OF CALIFORNIA</b>	<b>35,877,036</b>	<b>4,919,945</b>	<b>13.7%</b>

3 Source: U.S. Census 2014e

4 Note:

5 a. Population numbers are only those for whom poverty status was determined and exclude  
 6 institutionalized individuals

7 **Table 21.30 Federal Funds Distributed for Social Programs in the Central Coast**  
 8 **Region in 2010**

Areas	Grants (millions of dollars)		Distributed to Individuals (millions of dollars)
	Medicaid and Other Health-Related Items	Nutrition and Family Welfare	CalFresh Benefits and Supplemental Security Income
San Luis Obispo County	\$176.0	\$70.7	\$44.5
Santa Barbara County	\$332.1	\$93.3	\$91.6
Central Coast Region	\$508.1	\$164.0	\$136.1
STATE OF CALIFORNIA	\$41,931.1	\$11,743.7	\$12,469.4

9 Source: Gaquin and Ryan 2013

10 **21.3.6.4 Limited English Proficiency**

11 The percent of the population that speaks English and other languages at home  
 12 and the percent of the population that speak English “less than very well” based  
 13 on the language they speak at home are presented in Tables 21.31 and 21.32.

14 **21.3.7 Southern California Region**

15 The Southern California Region includes portions of Ventura, Los Angeles,  
 16 Orange, San Diego, Riverside, and San Bernardino counties served by the SWP.

17 **21.3.7.1 Minority Populations**

18 As recorded in the 2010 U.S. Census, the Southern California Region had a total  
 19 population of 20,972,319 in 2010. About 64.2 percent of this population  
 20 identified themselves as a racial minority and/or of Hispanic or Latino origin,  
 21 regardless of race, as presented in Table 21.33. The table also shows the minority  
 22 population distribution for the State of California.

1    **21.3.7.2    Poverty Levels**

2    Poverty levels presented in Table 21.34 are calculated on a subset of the total  
3    population of a county, as described above in section 21.3.2, Characterization of  
4    Conditions Considered in the Environmental Justice Analysis. Of the total  
5    population for whom poverty status is determined within the Southern California  
6    Region, 20,296,879 individuals, 13.8 percent, were below the poverty level based  
7    on the 2006–2010 ACS 5-year dataset (U.S. Census 2014e). The U.S. Census  
8    Bureau defines geographical areas with more than 20 percent of the population  
9    below the poverty level as a “poverty areas.” None of the counties in the  
10   Southern California Region are defined as poverty areas.

11   **21.3.7.3    Social Services**

12   Distribution of social services varies for each county. Federal grants to the state  
13   and local agencies for Medicaid, other health related activities, and nutrition and  
14   family welfare; and Federal direct payments made to individuals under the  
15   CalFresh and supplemental social security income within counties in the Southern  
16   California Region are summarized in Table 21.35.

17   **21.3.7.4    Limited English Proficiency**

18   The percent of the population that speaks English and other languages at home  
19   and the percent of the population that speak English “less than very well” based  
20   on the language they speak at home are presented in Tables 21.36 and 21.37.

1 **Table 21.31 Top Five Non-English Languages Spoken at Home as a Proportion of the Total Population Five Years and Older in the**  
 2 **Central Coast Region, 2006–2010**

Areas	Speaks Only English	Spanish and Spanish Creole	Chinese	Tagalog	French (including Patois and Cajun)	German	Total Excluding English
San Luis Obispo County	83.3%	13.1%	0.3%	0.5%	0.3%	0.4%	14.7%
Santa Barbara County	61.3%	31.9%	0.8%	0.9%	0.6%	0.6%	34.7%
Central Coast Region	70.0%	24.5%	0.6%	0.8%	0.5%	0.5%	26.8%
<b>STATE OF CALIFORNIA</b>	<b>57.0%</b>	<b>28.5%</b>	<b>2.9%</b>	<b>2.2%</b>	<b>0.4%</b>	<b>0.3%</b>	<b>34.3%</b>

3 Source: U.S. Census 2014f

4 **Table 21.32 Percent of Population Speaking One of the Top Five Non-English Languages Spoken at Home in the Central Coast Region**  
 5 **that Speaks English “Less than Very Well” as a Proportion of the Total Population Five Years and Older, 2006–2010**

Areas	Spanish and Spanish Creole	Chinese	Tagalog	French (including Patois and Cajun)	German
San Luis Obispo County	5.5%	0.1%	0.2%	0.04%	0.04%
Santa Barbara County	16.5%	0.4%	0.4%	0.1%	0.1%
Central Coast Region	12.2%	0.3%	0.4%	0.1%	0.1%
<b>STATE OF CALIFORNIA</b>	<b>13.6%</b>	<b>1.6%</b>	<b>0.7%</b>	<b>0.1%</b>	<b>0.04%</b>

6 Source: U.S. Census 2014f



1 **Table 21.33 Minority Population Distribution in the Southern California Region in 2010**

Areas	Total Population	Races							Hispanic or Latino Origin	Total Minority <sup>a</sup>
		White	Black/ African American	American Indian and Native Alaskan	Asian	Native Hawaiian and Other Pacific Islander	Some Other Race	Two or More Races		
Ventura County	823,318	68.7%	1.8%	1.0%	6.7%	0.2%	17.0%	4.5%	40.3%	51.3%
Los Angeles County	9,818,605	50.3%	8.7%	0.7%	13.7%	0.3%	21.8%	4.5%	47.7%	72.2%
Orange County	3,010,232	60.8%	1.7%	0.6%	17.9%	0.3%	14.5%	4.2%	33.7%	55.9%
San Diego County	3,095,313	64.0%	5.1%	0.9%	10.9%	0.5%	13.6%	5.1%	32.0%	51.5%
Riverside County	2,189,641	61.0%	6.4%	1.1%	6.0%	0.3%	20.5%	4.8%	45.5%	60.3%
San Bernardino County	2,035,210	56.7%	8.9%	1.1%	6.3%	0.3%	21.6%	5.0%	49.2%	66.7%
Southern California Region	20,972,319	56.3%	6.7%	0.8%	12.1%	0.3%	19.2%	4.6%	43.1%	64.2%
<b>STATE OF CALIFORNIA</b>	<b>37,253,956</b>	<b>57.6%</b>	<b>6.2%</b>	<b>1.0%</b>	<b>13.0%</b>	<b>0.4%</b>	<b>17.0%</b>	<b>4.9%</b>	<b>37.6%</b>	<b>59.9%</b>

2 Sources: U.S. Census 2014a, 2014aj, 2014ak, 2014al, 2014am, 2014an, 2014ao

3 Note:

4 a. Total Minority is an aggregation of all non-white racial groups and includes all individuals of Hispanic or Latino origin, regardless of race.

1 **Table 21.34 Population below Poverty Level in the Southern California Region,**  
 2 **2006–2010**

Areas	Total Population <sup>a</sup>	Population Below Poverty Level	Percent of Population Below Poverty Level
Ventura County	798,863	73,842	9.2%
Los Angeles County	9,604,871	1,508,618	15.7%
Orange County	2,925,244	296,846	10.1%
San Diego County	2,930,875	361,248	12.3%
Riverside County	2,075,782	278,358	13.4%
San Bernardino County	1,961,244	291,020	14.8%
Southern California Region	798,863	73,842	9.2%
<b>STATE OF CALIFORNIA</b>	<b>35,877,036</b>	<b>4,919,945</b>	<b>13.7%</b>

3 Source: U.S. Census 2014e

4 Note:

5 a. Population numbers are only those for whom poverty status was determined and exclude  
 6 institutionalized individuals

7 **Table 21.35 Federal Funds Distributed for Social Programs in the Southern**  
 8 **California Region in 2010**

Areas	Grants (millions of dollars)		Distributed to Individuals (millions of dollars)
	Medicaid and Other Health-Related Items	Nutrition and Family Welfare	CalFresh Benefits and Supplemental Security Income
Ventura County	\$445.3	\$153.9	\$147.1
Los Angeles County	\$13,950.6	\$2,840.6	\$4,259.6
Orange County	\$1,678.3	\$610.6	\$633.2
San Diego County	\$3,866.8	\$677.8	\$790.1
Riverside County	\$966.4	\$347.2	\$488.0
San Bernardino County	\$1,236.2	\$390.1	\$751.9
Southern California Region	\$22,143.6	\$5,020.2	\$7,069.9
<b>STATE OF CALIFORNIA</b>	<b>\$41,931.1</b>	<b>\$11,743.7</b>	<b>\$12,469.4</b>

9 Source: Gaquin and Ryan 2013

1 **Table 21.36 Top Five Non-English Languages Spoken at Home as a Proportion of the Total Population Five Years and Older in the**  
 2 **Southern California Region, 2006–2010**

Areas	Speaks Only English	Spanish and Spanish Creole	Chinese	Tagalog	Vietnamese	Korean	Total Excluding English
Ventura County	62.6%	29.5%	1.0%	1.7%	0.4%	0.4%	33.1%
Los Angeles County	43.6%	39.4%	3.6%	2.5%	0.8%	2.0%	48.3%
Orange County	55.6%	26.2%	2.2%	1.5%	5.4%	2.5%	37.8%
San Diego County	63.7%	24.4%	1.4%	3.1%	1.3%	0.5%	30.6%
Riverside County	60.5%	33.2%	0.5%	1.4%	0.6%	0.4%	36.2%
San Bernardino County	59.5%	33.6%	1.0%	1.4%	0.6%	0.5%	37.1%
Southern California Region	52.3%	33.7%	2.4%	2.2%	1.5%	1.5%	41.3%
<b>STATE OF CALIFORNIA</b>	<b>57.0%</b>	<b>28.5%</b>	<b>2.9%</b>	<b>2.2%</b>	<b>1.4%</b>	<b>1.1%</b>	<b>36.1%</b>

3 Source: U.S. Census 2014f

1 **Table 21.37 Percent of Population Speaking One of the Top Five Non-English Languages Spoken at Home in the Southern California**  
 2 **Region that Speaks English “Less than Very Well” as a Proportion of the Total Population Five Years and Older, 2006–2010**

<b>Areas</b>	<b>Spanish and Spanish Creole</b>	<b>Chinese</b>	<b>Tagalog</b>	<b>Vietnamese</b>	<b>Korean</b>
Ventura County	14.1%	0.5%	0.5%	0.2%	0.2%
Los Angeles County	19.0%	2.2%	0.8%	0.5%	1.3%
Orange County	13.4%	1.0%	0.4%	3.3%	1.5%
San Diego County	11.0%	0.7%	1.1%	0.8%	0.3%
Riverside County	14.5%	0.3%	0.4%	0.4%	0.2%
San Bernardino County	15.5%	0.5%	0.4%	0.4%	0.3%
Southern California Region	16.0%	1.4%	0.7%	0.9%	0.9%
<b>STATE OF CALIFORNIA</b>	<b>13.6%</b>	<b>1.6%</b>	<b>0.7%</b>	<b>0.9%</b>	<b>0.7%</b>

3 Source: U.S. Census 2014f

## 1 **21.4 Impact Analysis**

2 This section describes the potential mechanisms for change in conditions and  
3 analytical methods; results of impact analyses; potential mitigation measures; and  
4 cumulative effects.

### 5 **21.4.1 Potential Mechanisms for Change and Analytical Methods**

6 As described in Chapter 4, Approach to Environmental Analysis, the impact  
7 analysis considers changes in factors that affect environmental justice or minority  
8 and low-income populations specifically related to changes in CVP and SWP  
9 operations under the alternatives as compared to the No Action Alternative and  
10 Second Basis of Comparison.

11 The Council of Environmental Quality (CEQ) and U.S. Environmental Protection  
12 Agency (USEPA) established guidelines to assist federal agencies in the analysis  
13 of environmental justice defines minority and low-income areas summarized in  
14 Section 21.3, Affected Environment (CEQ, 1997). The following guidelines are  
15 used to determine if minority populations are present in a study area:

- 16 • The minority population of the affected area exceeds 50 percent, or
- 17 • The population percentage of the affected area is meaningfully greater than  
18 the minority population percentage in the general population or other  
19 appropriate unit of geographical analysis.

20 The CEQ guidelines do not specifically state the percentage considered  
21 meaningful in the case of low-income populations. For this analysis, the  
22 assumptions set forth in the CEQ guidelines for identifying and evaluating  
23 impacts on minority populations also are used to identify and evaluate impacts on  
24 low-income populations, including a determination that a low-income population  
25 is present if the project area if 50 percent or more of the population is living  
26 below the poverty level.

27 The alternatives considered in this EIS do not include project-specific  
28 construction activities. In most portions of the study area, the availability of CVP  
29 and SWP water supplies directly or indirectly affects most of the population  
30 within a county. Therefore, the entire population of each counties within the  
31 study area is considered to determine whether minority or low-income areas could  
32 be affected by implementation of the alternatives. In the study area, populations  
33 below the poverty level do not include 50 percent or more of the population. The  
34 highest proportion of populations below the poverty level occurs in Fresno and  
35 Tulare counties in which approximately 23 percent of the populations are below  
36 the poverty level. However, minority populations contribute more than  
37 50 percent of the total county populations in 24 of the 35 counties. The following  
38 counties have 50 percent or more of the total population as minority populations.

- 39 • Central Valley Region: Colusa, Sacramento, Solano, Sutter, Yolo, Fresno,  
40 Kern, Kings, Madera, Merced, San Joaquin, Stanislaus, and Tulare counties

- 1 • Central Coast Region; Santa Barbara.
- 2 • Southern California Region: Los Angeles, Orange, Riverside, San Bernardino,
- 3 San Diego, and Ventura.

4 Although, the majority of the populations in the Trinity River Region counties are  
5 not minority populations, these counties do include the Hoopa Valley Indian  
6 Reservation, Yurok Indian Reservation, and Resighini Rancheria. Therefore, the  
7 Trinity River Region counties are also included in the environmental justice  
8 analysis.

9 The CEQ guidance provides the following three factors to be considered for  
10 determination if disproportionately high and adverse impacts may accrue to  
11 minority or low-income populations.

12 The following criteria were used to evaluate the impacts to minority and  
13 low-income populations resulting from the operational changes following the  
14 implementation of each of the alternatives as compared to the No Action  
15 Alternative and the Second Basis of Comparison:

- 16 • Whether there is or would be an impact that results in a disproportionately  
17 high and adverse human health and environmental impact, including social  
18 and economic effects on environmental justice populations.
- 19 • Whether the environmental effects are significant and are, or may be, having  
20 an adverse impact on environmental justice populations that appreciably  
21 exceeds or is likely to appreciably exceed those on the general population or  
22 other appropriate comparison group.
- 23 • Whether the environmental effects occur or would occur in an environmental  
24 justice population affected by cumulative or multiple adverse exposures from  
25 environmental hazards.

26 To determine whether the operational changes resulting from implementation of  
27 each of the alternatives as compared to the No Action Alternative and the Second  
28 Basis of Comparison will have a “disproportionately high and adverse impact” on  
29 minority and low-income populations, various factors were considered, including  
30 potential adverse impacts, mitigation, and enhancement measures that will be  
31 incorporated into the alternatives; and offsetting benefits.

32 The environmental justice guidance documents do not specifically define  
33 conditions that would result in “high and adverse human health and  
34 environmental impact.” For this analysis, the potential changes in air quality,  
35 cultural resources, public health, and socioeconomics were considered within the  
36 counties that had a minority population of 50 percent or greater of the total  
37 population.

38 The changes were then determined if the impacts would be disproportionately high  
39 on the minority populations. Potential adverse impacts were evaluated with  
40 regard to air quality, public health, and socioeconomics.

1 Changes in CVP and SWP operations under the alternatives as compared to the  
2 No Action Alternative and Second Basis of Comparison could result in  
3 disproportionately high effects on minority or tribal populations related to changes  
4 in air quality, public health, and socioeconomics.

5 **21.4.1.1 Changes in Emissions of Criteria Air Pollutants and Precursors,**  
6 **and/or Exposure of Sensitive Receptors to Substantial**  
7 **Concentrations of Air Contaminants Related to Changes in**  
8 **Groundwater Pumping**

9 Changes in CVP and SWP operations under the alternatives could change the use  
10 of individual engines to operate groundwater wells. To evaluate the potential for  
11 changes in emissions of criteria air pollutants and precursors, and/or exposure of  
12 sensitive receptors to substantial concentrations of air contaminants, results from  
13 the CVHM model that indicate changes in groundwater withdrawals due to  
14 changes in CVP and SWP operations were analyzed. However, it is not known  
15 how many of the groundwater pumps use electricity and how many use diesel  
16 engines. The diesel engines have the potential to emit criteria air pollutants and  
17 precursors, and toxic air contaminants, as described in Chapter 16, Air Quality  
18 and Greenhouse Gas Emissions.

19 Most of the groundwater wells in the Central Valley use electrical pumps. As  
20 reported in a recent environmental assessment, approximately 14 to 15 percent of  
21 the pumps used diesel fuel in 2003 (Reclamation 2013a). It is assumed for this  
22 EIS, that the portion of groundwater pumps that use electricity would remain  
23 approximately at 85 percent. Therefore, it is assumed that increases or decreases  
24 in groundwater pumping would be indicative of an increase or decrease in the use  
25 of diesel engines in the Central Valley as well as in the San Francisco Bay Area,  
26 Central Coast, and Southern California regions. Changes in CVP and SWP  
27 operations would not result in changes in groundwater pumping in the Trinity  
28 River Region; therefore, this analysis does not address Trinity River Region.

29 **21.4.1.2 Changes in Public Health Related to Changes in Potential**  
30 **Exposure to Mercury in Fish Used in Human Consumption**

31 Changes in CVP and SWP operations under the alternatives could change public  
32 health factors related to mercury concentrations in fish used for human  
33 consumption as compared to the No Action Alternative and Second Basis of  
34 Comparison, as described in Chapter 18, Public Health.

35 **21.4.1.3 Changes in Socioeconomics**

36 Changes in CVP and SWP operations under the alternatives could change  
37 socioeconomic factors related to employment related to irrigated agriculture and  
38 municipal and industrial (M&I) water supplies and tribal salmon harvest in the  
39 Trinity River Region as compared to the No Action Alternative and Second Basis  
40 of Comparison, as described in Chapter 19, Socioeconomics. However, changes  
41 in employment related to irrigated agriculture and M&I water supplies would be  
42 similar. Therefore, these changes are not analyzed in this EIS.

#### 1 **21.4.1.4 Effects due to Cross Delta Water Transfers**

2 Historically water transfer programs have been developed on an annual basis.  
3 The demand for water transfers is dependent upon the availability of water  
4 supplies to meet water demands. Water transfer transactions have increased over  
5 time as CVP and SWP water supply availability has decreased, especially during  
6 drier water years.

7 Parties seeking water transfers generally acquire water from sellers who have  
8 available surface water who can make the water available through releasing  
9 previously stored water, pump groundwater instead of using surface water  
10 (groundwater substitution); idle crops; or substitute crops that uses less water in  
11 order to reduce normal consumptive use of surface water.

12 Water transfers using CVP and SWP Delta pumping plants and south of Delta  
13 canals generally occur when there is unused capacity in these facilities. These  
14 conditions generally occur during drier water year types when the flows from  
15 upstream reservoirs plus unregulated flows are adequate to meet the Sacramento  
16 Valley water demands and the CVP and SWP export allocations. In non-wet  
17 years, the CVP and SWP water allocations would be less than full contract  
18 amounts; therefore, capacity may be available in the CVP and SWP conveyance  
19 facilities to move water from other sources.

20 Projecting future environmental justice conditions related to water transfer  
21 activities is difficult because specific water transfer actions required to make the  
22 water available, convey the water, and/or use the water would change each year  
23 due to changing hydrological conditions, CVP and SWP water availability,  
24 specific local agency operations, and local cropping patterns. Reclamation  
25 recently prepared a long-term regional water transfer environmental document  
26 which evaluated potential changes in conditions related to water transfer actions  
27 (Reclamation 2014c). Results from this analysis were used to inform the impact  
28 assessment of potential effects of water transfers under the alternatives as  
29 compared to the No Action Alternative and the Second Basis of Comparison.

#### 30 **21.4.2 Conditions in Year 2030 without Implementation of** 31 **Alternatives 1 through 5**

32 This EIS includes two bases of comparison, as described in Chapter 3,  
33 Description of Alternatives: the No Action Alternative and the Second Basis of  
34 Comparison. Both of these bases are evaluated at 2030 conditions.

35 Changes that would occur over the next 15 years without implementation of the  
36 alternatives are not analyzed in this EIS. However, the changes to environmental  
37 justice factors that are assumed to occur by 2030 under the No Action Alternative  
38 and the Second Basis of Comparison are summarized in this section. Many of the  
39 changed conditions would occur in the same manner under both the No Action  
40 Alternative and the Second Basis of Comparison.



1 **21.4.2.1 Common Changes in Conditions under the No Action Alternative**  
2 **and Second Basis of Comparison**

3 Conditions in 2030 would be different than existing conditions due to:

- 4 • Climate change and sea level rise
- 5 • General plan development throughout California, including increased water  
6 demands in portions of Sacramento Valley
- 7 • Implementation of reasonable and foreseeable water resources management  
8 projects to provide water supplies

9 It is anticipated that climate change would result in more short-duration high-  
10 rainfall events and less snowpack in the winter and early spring months. The  
11 reservoirs would be full more frequently by the end of April or May by 2030 than  
12 in recent historical conditions. However, as the water is released in the spring,  
13 there would be less snowpack to refill the reservoirs. This condition would  
14 reduce reservoir storage and available water supplies to downstream uses in the  
15 summer. The reduced end of September storage also would reduce the ability to  
16 release stored water to downstream regional reservoirs. These conditions would  
17 occur for all reservoirs in the California foothills and mountains, including non-  
18 CVP and SWP reservoirs.

19 These changes would result in a decline of the long-term average CVP and SWP  
20 water supply deliveries by 2030 as compared to recent historical long-term  
21 average deliveries under the No Action Alternative and the Second Basis of  
22 Comparison. However, the CVP and SWP water deliveries would be less under  
23 the No Action Alternative as compared to the Second Basis of Comparison, as  
24 described in Chapter 5, Surface Water Resources and Water Supplies. Due to  
25 climate change and related lower snowfall, end of September low reservoir  
26 storage would be lower in critical dry years by 2030 as compared to recent  
27 historical conditions in Shasta Lake, Lake Oroville, Folsom Lake, New Melones  
28 Reservoir, and San Luis Reservoir. Therefore, the potential for reduced reservoir  
29 water supplies for wildland firefighting would be greater under the No Action  
30 Alternative and Second Basis of Comparison as compared to recent historical  
31 conditions.

32 Under the No Action Alternative and the Second Basis of Comparison, land uses  
33 in 2030 would occur in accordance with adopted general plans.

34 The No Action Alternative and the Second Basis of Comparison assumes  
35 completion of water resources management and environmental restoration  
36 projects that would have occurred without implementation of Alternatives 1  
37 through 5, including regional and local recycling projects, surface water and  
38 groundwater storage projects, conveyance improvement projects, and desalination  
39 projects, as described in Chapter 3, Description of Alternatives. The No Action  
40 Alternative and the Second Basis of Comparison also assumes implementation of  
41 actions included in the 2008 U.S. Fish and Wildlife Service (USFWS) Biological  
42 Opinion (BO) and 2009 National Marine Fisheries Service (NMFS) BO that

1 would have been implemented without the BOs by 2030, as described in  
2 Chapter 3, Description of Alternatives.

3 Under the No Action Alternative and Second Basis of Comparison, it is  
4 anticipated that mercury concentrations in fish tissue within the Delta will be  
5 either similar or greater than recent historical conditions. Phase 1 of the Delta  
6 Mercury Program mandated by the Central Valley Regional Water Quality  
7 Control Board (RWQCB) is currently being completed to protect people eating  
8 one meal per week of larger fish from the Delta, including Largemouth Bass.  
9 Phase 1 is focused on studies and pilot projects to develop and evaluate  
10 management practices to control methylmercury from mercury sources in the  
11 Delta and Yolo Bypass; and to reduce total mercury loading to the San Francisco  
12 Bay. Following completion of Phase 1 in 2019, Phase 2 will be implemented  
13 through 2030. Phase 2 will focus on methylmercury control programs and  
14 reduction programs for total inorganic mercury. Due to the extent of these  
15 studies, it is not anticipated that changes in methylmercury or total mercury  
16 concentrations in fish tissue will be reduced by 2030. Future mercury reduction  
17 and control programs will reduce mercury sources and related fish tissue  
18 concentrations; however, that will occur after 2030.

### 19 **21.4.3 Evaluation of Alternatives**

20 Alternatives 1 through 5 have been compared to the No Action Alternative; and  
21 the No Action Alternative and Alternatives 1 through 5 have been compared to  
22 the Second Basis of Comparison.

23 During review of the numerical modeling analyses used in this EIS, an error was  
24 determined in the CalSim II model assumptions related to the Stanislaus River  
25 operations for the Second Basis of Comparison, Alternative 1, and Alternative 4  
26 model runs. Appendix 5C includes a comparison of the CalSim II model run  
27 results presented in this chapter and CalSim II model run results with the error  
28 corrected. Appendix 5C also includes a discussion of changes in the comparison  
29 of groundwater conditions for the following alternative analyses.

- 30 • No Action Alternative compared to the Second Basis of Comparison
- 31 • Alternative 1 compared to the No Action Alternative
- 32 • Alternative 3 compared to the Second Basis of Comparison
- 33 • Alternative 5 compared to the Second Basis of Comparison.

#### 34 **21.4.3.1 No Action Alternative**

35 The No Action Alternative is compared to the Second Basis of Comparison.

##### 36 **21.4.3.1.1 Central Valley Region**

37 *Changes in Emissions of Criteria Air Pollutants and Precursors, and/or Exposure*  
38 *of Sensitive Receptors to Substantial Concentrations of Air Contaminants Related*  
39 *to Changes in Groundwater Pumping*

40 Groundwater pumping in the San Joaquin Valley portion of the Central Valley  
41 Region would increase by 8 percent under the No Action Alternative as compared  
42 to the Second Basis of Comparison. It is not known if the additional groundwater

1 pumping would rely upon electricity or diesel to drive the pump engines. Under  
2 the worst case analysis, it is assumed that the increased use of diesel engines  
3 would be proportional to the increased use of groundwater. Therefore, under the  
4 No Action Alternative, there would be a potential increase in emissions of criteria  
5 air pollutants and precursors, and/or exposure of sensitive receptors to substantial  
6 concentrations of air contaminants as compared to the Second Basis of  
7 Comparison.

8 *Changes in Public Health Factors Related to Mercury in Fish used for Human*  
9 *Consumption*

10 Mercury concentrations in Largemouth Bass would be similar (within 5 percent  
11 change) in most locations in the Delta, except for Rock Slough, San Joaquin River  
12 near Antioch, and Montezuma Slough in Suisun Marsh. In these areas, the  
13 mercury concentrations would increase by 7 percent over long-term conditions  
14 under the No Action Alternative as compared to the Second Basis of Comparison.  
15 Under dry and critical dry years, mercury concentrations would increase by 7 to  
16 8 percent at Rock Slough, intakes of the Banks and Jones pumping plants, and  
17 Victoria Canal. All values exceed the threshold of 0.24 mg/kg ww for mercury.

18 *Effects Related to Cross Delta Water Transfers*

19 Potential effects to environmental justice factors could be similar to those  
20 identified in a recent environmental analysis conducted by Reclamation for long-  
21 term water transfers from the Sacramento to San Joaquin valleys (Reclamation  
22 2014c). Potential effects to environmental justice were identified as loss of  
23 employment in the seller's service area if crop idling was used to provide transfer  
24 water. The analysis indicated that the proportion of crop idled acreage would be  
25 small as compared to the overall regional irrigated acreage, and that this change  
26 would not result in in disproportionately high or adverse effects. In addition,  
27 beneficial effects could occur in the purchaser's service area if more acreage was  
28 cultivated with the water transfer program than without the water transfer  
29 program.

30 Under the No Action Alternative, the timing of cross Delta water transfers would  
31 be limited to July through September and include annual volumetric limits, in  
32 accordance with the 2008 USFWS BO and 2009 NMFS BO. Under the Second  
33 Basis of Comparison, water could be transferred throughout the year without an  
34 annual volumetric limit. Overall, the potential for cross Delta water transfers  
35 would be less under the No Action Alternative than under the Second Basis of  
36 Comparison.

37 **21.4.3.1.2 San Francisco Bay Area, Central Coast, and Southern**  
38 **California Regions**

39 *Changes in Emissions of Criteria Air Pollutants and Precursors, and/or Exposure*  
40 *of Sensitive Receptors to Substantial Concentrations of Air Contaminants Related*  
41 *to Changes in Groundwater Pumping*

42 It is anticipated that CVP and SWP water supplies would be decreased by  
43 10 percent and 18 percent, respectively, in the San Francisco Bay Area, Central

1 Coast, and Southern California regions under No Action Alternative as compared  
 2 to the Second Basis of Comparison. The decrease in surface water supplies could  
 3 result in additional use of groundwater pumps and emissions of air pollutants and  
 4 contaminants if the use of diesel engines is also increased.

#### 5 **21.4.3.2 Alternative 1**

6 As described in Chapter 3, Description of Alternatives, Alternative 1 is identical  
 7 to the Second Basis of Comparison. As described in Chapter 4, Approach to  
 8 Environmental Analysis, Alternative 1 is compared to the No Action Alternative  
 9 and the Second Basis of Comparison. However, because CVP and SWP  
 10 operations under Alternative 1 are identical to conditions under the Second Basis  
 11 of Comparison; Alternative 1 is only compared to the No Action Alternative.

#### 12 **21.4.3.2.1 Alternative 1 Compared to the No Action Alternative**

##### 13 *Central Valley Region*

##### 14 *Changes in Emissions of Criteria Air Pollutants and Precursors, and/or* 15 *Exposure of Sensitive Receptors to Substantial Concentrations of Air* 16 *Contaminants Related to Changes in Groundwater Pumping*

17 Groundwater pumping in the San Joaquin Valley portion of the Central Valley  
 18 Region would decrease by 8 percent under Alternative 1 as compared to the No  
 19 Action Alternative. It is not known if the reduction in groundwater pumping  
 20 would result in a reduction of the use of electricity or diesel to drive the pump  
 21 engines. For this analysis, it is assumed that the decreased use of diesel engines  
 22 would be proportional to the decreased use of groundwater. Therefore, under  
 23 Alternative 1, there would be a potential decrease in emissions of criteria air  
 24 pollutants and precursors, and/or exposure of sensitive receptors to substantial  
 25 concentrations of air contaminants as compared to the No Action Alternative.

##### 26 *Changes in Public Health Factors Related to Mercury in Fish used for Human* 27 *Consumption*

28 Mercury concentrations in Largemouth Bass would be similar in most locations in  
 29 the Delta, except for Rock Slough, San Joaquin River near Antioch, and  
 30 Montezuma Slough in Suisun Marsh. In these areas, the mercury concentrations  
 31 would decrease by 6 percent over the long-term conditions under Alternative 1 as  
 32 compared to the No Action Alternative. Under dry and critical dry years, mercury  
 33 concentrations would decrease by 6 to 8 percent at Rock Slough, intakes of the  
 34 Banks and Jones pumping plants, and Victoria Canal. All values exceed the  
 35 threshold of 0.24 mg/kg ww for mercury.

##### 36 *Effects Related to Cross Delta Water Transfers*

37 Potential effects to environmental justice conditions could be similar to those  
 38 identified in a recent environmental analysis conducted by Reclamation for long-  
 39 term water transfers from the Sacramento to San Joaquin valleys (Reclamation  
 40 2014c) as described above under the No Action Alternative compared to the  
 41 Second Basis of Comparison. For the purposes of this EIS, it is anticipated that  
 42 similar conditions would occur during implementation of cross Delta water  
 43 transfers under Alternative 1 and the No Action Alternative, and that impacts on

1 environmental justice factors would not be substantial due to implementation  
2 requirements of the transfer programs.

3 Under Alternative 1, water could be transferred throughout the year without an  
4 annual volumetric limit. Under the No Action Alternative, the timing of cross  
5 Delta water transfers would be limited to July through September and include  
6 annual volumetric limits, in accordance with the 2008 USFWS BO and 2009  
7 NMFS BO. Overall, the potential for cross Delta water transfers would be  
8 increased under Alternative 1 as compared to the No Action Alternative.

9 *San Francisco Bay Area, Central Coast, and Southern California Regions*  
10 *Changes in Emissions of Criteria Air Pollutants and Precursors, and/or*  
11 *Exposure of Sensitive Receptors to Substantial Concentrations of Air*  
12 *Contaminants Related to Changes in Groundwater Pumping*

13 It is anticipated that CVP and SWP water supplies would be increased by  
14 11 percent and 21 percent, respectively, in the San Francisco Bay Area, Central  
15 Coast, and Southern California regions under Alternative 1 as compared to the No  
16 Action Alternative. The increase in surface water supplies could result in the  
17 reduction in use of groundwater pumps and emissions of air pollutants and  
18 contaminants if the use of diesel engines is also decreased.

19 **21.4.3.2 Alternative 1 Compared to the Second Basis of Comparison**

20 Alternative 1 is identical to the Second Basis of Comparison.

21 **21.4.3.3 Alternative 2**

22 The CVP and SWP operations under Alternative 2 are identical to the CVP and  
23 SWP operations under the No Action Alternative, as described in Chapter 3,  
24 Description of Alternatives; therefore Alternative 2 is only compared to the  
25 Second Basis of Comparison.

26 **21.4.3.3.1 Alternative 2 Compared to the Second Basis of Comparison**

27 The CVP and SWP operations under Alternative 2 are identical to the CVP and  
28 SWP operations under the No Action Alternative. Therefore, changes to  
29 environmental justice factors under Alternatives 2 as compared to the Second  
30 Basis of Comparison would be the same as the impacts described in  
31 Section 18.4.3.1, No Action Alternative.

32 **21.4.3.4 Alternative 3**

33 As described in Chapter 3, Description of Alternatives, CVP and SWP operations  
34 under Alternative 3 are similar to the Second Basis of Comparison with modified  
35 Old and Middle River flow criteria and New Melones Reservoir operations. As  
36 described in Chapter 4, Approach to Environmental Analysis, Alternative 3 is  
37 compared to the No Action Alternative and the Second Basis of Comparison.

1 **21.4.3.4.1 Alternative 3 Compared to the No Action Alternative**

2 *Central Valley Region*

3 *Changes in Emissions of Criteria Air Pollutants and Precursors, and/or*  
 4 *Exposure of Sensitive Receptors to Substantial Concentrations of Air*  
 5 *Contaminants Related to Changes in Groundwater Pumping*

6 Groundwater pumping in the San Joaquin Valley portion of the Central Valley  
 7 Region would decrease by 6 percent under Alternative 3 as compared to the No  
 8 Action Alternative. It is not known if the reduction in groundwater pumping  
 9 would result in a reduction of the use of electricity or diesel to drive the pump  
 10 engines. For this analysis, it is assumed that the decreased use of diesel engines  
 11 would be proportional to the decreased use of groundwater. Therefore, under  
 12 Alternative 3, there would be a potential decrease in emissions of criteria air  
 13 pollutants and precursors, and/or exposure of sensitive receptors to substantial  
 14 concentrations of air contaminants as compared to the No Action Alternative.

15 *Changes in Public Health Factors Related to Mercury in Fish used for Human*  
 16 *Consumption*

17 Mercury concentrations in Largemouth Bass would be similar (within 5 percent  
 18 change) in most locations in the Delta, except for San Joaquin River near Antioch  
 19 and Montezuma Slough in Suisun Marsh. In these areas, the mercury  
 20 concentrations would decrease by 6 percent over the long-term conditions under  
 21 Alternative 3 as compared to the No Action Alternative. Mercury concentrations  
 22 under the dry and critical dry years would be similar throughout the Delta. All  
 23 values exceed the threshold of 0.24 mg/kg ww for mercury.

24 *Effects Related to Cross Delta Water Transfers*

25 Potential effects to environmental justice factors could be similar to those  
 26 identified in a recent environmental analysis conducted by Reclamation for long-  
 27 term water transfers from the Sacramento to San Joaquin valleys (Reclamation  
 28 2014c) as described above under the No Action Alternative compared to the  
 29 Second Basis of Comparison. For the purposes of this EIS, it is anticipated that  
 30 similar conditions would occur during implementation of cross Delta water  
 31 transfers under Alternative 3 and the No Action Alternative, and that impacts on  
 32 environmental justice factors would not be substantial due to implementation  
 33 requirements of the transfer programs.

34 Under Alternative 3, water could be transferred throughout the year without an  
 35 annual volumetric limit. Under the No Action Alternative, the timing of cross  
 36 Delta water transfers would be limited to July through September and include  
 37 annual volumetric limits, in accordance with the 2008 USFWS BO and 2009  
 38 NMFS BO. Overall, the potential for cross Delta water transfers would be  
 39 increased under Alternative 3 as compared to the No Action Alternative.

1 *San Francisco Bay Area, Central Coast, and Southern California Regions*  
2 *Changes in Emissions of Criteria Air Pollutants and Precursors, and/or*  
3 *Exposure of Sensitive Receptors to Substantial Concentrations of Air*  
4 *Contaminants Related to Changes in Groundwater Pumping*

5 It is anticipated that CVP and SWP water supplies would be increased by  
6 9 percent and 17 percent, respectively, in the San Francisco Bay Area, Central  
7 Coast, and Southern California regions under Alternative 3 as compared to the No  
8 Action Alternative. The increase in surface water supplies could result in the  
9 reduction in use of groundwater pumps and emissions of air pollutants and  
10 contaminants if the use of diesel engines is also decreased.

11 **21.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison**

12 *Central Valley Region*

13 *Changes in Emissions of Criteria Air Pollutants and Precursors, and/or*  
14 *Exposure of Sensitive Receptors to Substantial Concentrations of Air*  
15 *Contaminants Related to Changes in Groundwater Pumping*

16 Groundwater pumping in the San Joaquin Valley portion of the Central Valley  
17 Region would be similar (within a 5 percent change) under Alternative 3 as  
18 compared to the Second Basis of Comparison. Therefore, the emissions of  
19 criteria air pollutants and precursors, and/or exposure of sensitive receptors to  
20 substantial concentrations of air contaminants would be similar under  
21 Alternative 3 as compared to the Second Basis of Comparison.

22 *Changes in Public Health Factors Related to Mercury in Fish Used for*  
23 *Human Consumption*

24 Mercury concentrations in Largemouth Bass would be similar throughout the  
25 Delta under Alternative 3 as compared to the Second Basis of Comparison, as  
26 summarized in Chapter 6, Surface Water Quality. All values exceed the threshold  
27 of 0.24 mg/kg ww for mercury.

28 *Effects Related to Cross Delta Water Transfers*

29 Potential effects to environmental justice factors could be similar to those  
30 identified in a recent environmental analysis conducted by Reclamation for  
31 long-term water transfers from the Sacramento to San Joaquin valleys  
32 (Reclamation 2014c) as described above under the No Action Alternative  
33 compared to the Second Basis of Comparison. For the purposes of this EIS, it is  
34 anticipated that similar conditions would occur during implementation of cross  
35 Delta water transfers under Alternative 3 and the Second Basis of Comparison,  
36 and that impacts on environmental justice factors would not be substantial in the  
37 seller's service area due to implementation requirements of the transfer programs.

38 Under Alternative 3 and the Second Basis of Comparison, water could be  
39 transferred throughout the year without an annual volumetric limit. Overall, the  
40 potential for cross Delta water transfers would be similar under Alternative 3 and  
41 the Second Basis of Comparison.

1 *San Francisco Bay Area, Central Coast, and Southern California Regions*  
 2 *Changes in Emissions of Criteria Air Pollutants and Precursors, and/or*  
 3 *Exposure of Sensitive Receptors to Substantial Concentrations of Air*  
 4 *Contaminants Related to Changes in Groundwater Pumping*

5 It is anticipated that CVP and SWP water supplies and emissions from diesel  
 6 engines used for groundwater pumping would be similar in the San Francisco Bay  
 7 Area, Central Coast, and Southern California regions under Alternative 3 as  
 8 compared to the Second Basis of Comparison.

9 **21.4.3.5 Alternative 4**

10 The environmental justice conditions under Alternative 4 would be identical to  
 11 the conditions under the Second Basis of Comparison; therefore, Alternative 4 is  
 12 only compared to the No Action Alternative.

13 **21.4.3.5.1 Alternative 4 Compared to the No Action Alternative**

14 The CVP and SWP operations under Alternative 4 are identical to the CVP and  
 15 SWP operations under the Second Basis of Comparison and Alternative 1.  
 16 Therefore, changes in environmental justice conditions under Alternative 4 as  
 17 compared to the No Action Alternative would be the same as the impacts  
 18 described in Section 12.4.3.2.1, Alternative 1 Compared to the No Action  
 19 Alternative.

20 **21.4.3.6 Alternative 5**

21 As described in Chapter 3, Description of Alternatives, CVP and SWP operations  
 22 under Alternative 5 are similar to the No Action Alternative with modified Old  
 23 and Middle River flow criteria and New Melones Reservoir operations. As  
 24 described in Chapter 4, Approach to Environmental Analysis, Alternative 5 is  
 25 compared to the No Action Alternative and the Second Basis of Comparison.

26 **21.4.3.6.1 Alternative 5 Compared to the No Action Alternative**

27 *Central Valley Region*

28 *Changes in Emissions of Criteria Air Pollutants and Precursors, and/or*  
 29 *Exposure of Sensitive Receptors to Substantial Concentrations of Air*  
 30 *Contaminants Related to Changes in Groundwater Pumping*

31 Groundwater pumping in the San Joaquin Valley portion of the Central Valley  
 32 Region would be similar under Alternative 5 as compared to the No Action  
 33 Alternative. Therefore, the emissions of criteria air pollutants and precursors,  
 34 and/or exposure of sensitive receptors to substantial concentrations of air  
 35 contaminants would be similar under Alternative 5 as compared to the No Action  
 36 Alternative.



1        *Changes in Public Health Factors Related to Mercury in Fish used for Human*  
2        *Consumption*

3 Mercury concentrations in Largemouth Bass would be similar throughout the  
4 Delta under Alternative 5 as compared to the No Action Alternative, as  
5 summarized in Chapter 6, Surface Water Quality. All values exceed the threshold  
6 of 0.24 mg/kg ww for mercury.

7        *Effects Related to Cross Delta Water Transfers*

8 Potential effects to environmental justice factors could be similar to those  
9 identified in a recent environmental analysis conducted by Reclamation for long-  
10 term water transfers from the Sacramento to San Joaquin valleys (Reclamation  
11 2014c) as described above under the No Action Alternative compared to the  
12 Second Basis of Comparison. For the purposes of this EIS, it is anticipated that  
13 similar conditions would occur during implementation of cross Delta water  
14 transfers under Alternative 5 and the No Action Alternative, and that impacts on  
15 environmental justice factors would not be substantial in the seller's service area  
16 due to implementation requirements of the transfer programs.

17 Under Alternative 5 and the No Action Alternative, the timing of cross Delta  
18 water transfers would be limited to July through September and include annual  
19 volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO.  
20 Overall, the potential for cross Delta water transfers would be similar under  
21 Alternative 5 and the No Action Alternative.

22 *San Francisco Bay Area, Central Coast, and Southern California Regions*  
23        *Changes in Emissions of Criteria Air Pollutants and Precursors, and/or*  
24        *Exposure of Sensitive Receptors to Substantial Concentrations of Air*  
25        *Contaminants Related to Changes in Groundwater Pumping*

26 It is anticipated that CVP and SWP water supplies and emissions from diesel  
27 engines used for groundwater pumping would be similar in the San Francisco Bay  
28 Area, Central Coast, and Southern California regions under Alternative 5 as  
29 compared to the No Action Alternative.

30 **21.4.3.6.2 Alternative 5 Compared to the Second Basis of Comparison**

31 *Central Valley Region*

32        *Changes in Emissions of Criteria Air Pollutants and Precursors, and/or*  
33        *Exposure of Sensitive Receptors to Substantial Concentrations of Air*  
34        *Contaminants Related to Changes in Groundwater Pumping*

35 Groundwater pumping in the San Joaquin Valley portion of the Central Valley  
36 Region would increase by 8 percent under Alternative 5 as compared to the  
37 Second Basis of Comparison. It is not known if the additional groundwater  
38 pumping would rely upon electricity or diesel to drive the pump engines. Under  
39 the worst case analysis, it is assumed that the increased use of diesel engines  
40 would be proportional to the increased use of groundwater. Therefore, under  
41 Alternative 5, there would be a potential increase in emissions of criteria air  
42 pollutants and precursors, and/or exposure of sensitive receptors to substantial

1 concentrations of air contaminants as compared to the Second Basis of  
2 Comparison.

3 *Changes in Public Health Factors Related to Mercury in Fish used for Human*  
4 *Consumption*

5 Mercury concentrations in Largemouth Bass would be similar in most locations in  
6 the Delta, except for Rock Slough, San Joaquin River near Antioch, and  
7 Montezuma Slough in Suisun Marsh. In these areas, the mercury concentrations  
8 would increase by 7 to 8 percent over long-term conditions under Alternative 5 as  
9 compared to the Second Basis of Comparison. During dry and critical dry years,  
10 mercury concentrations also would increase by 7 percent at intakes to Banks  
11 Pumping Plant and Jones Pumping Plant; and 13 percent at Rock Slough. All  
12 values exceed the threshold of 0.24 mg/kg ww for mercury.

13 *Effects Related to Cross Delta Water Transfers*

14 Potential effects to environmental justice factors could be similar to those  
15 identified in a recent environmental analysis conducted by Reclamation for long-  
16 term water transfers from the Sacramento to San Joaquin valleys (Reclamation  
17 2014c) as described above under the No Action Alternative compared to the  
18 Second Basis of Comparison. For the purposes of this EIS, it is anticipated that  
19 similar conditions would occur during implementation of cross Delta water  
20 transfers under Alternative 5 and the Second Basis of Comparison, and that  
21 impacts on environmental justice factors would not be substantial in the seller's  
22 service area due to implementation requirements of the transfer programs.

23 Under Alternative 5, the timing of cross Delta water transfers would be limited to  
24 July through September and include annual volumetric limits, in accordance with  
25 the 2008 USFWS BO and 2009 NMFS BO. Under the Second Basis of  
26 Comparison, water could be transferred throughout the year without an annual  
27 volumetric limit. Overall, the potential for cross Delta water transfers would be  
28 reduced under Alternative 5 as compared to the Second Basis of Comparison.

29 *San Francisco Bay Area, Central Coast, and Southern California Regions*

30 *Changes in Emissions of Criteria Air Pollutants and Precursors, and/or*  
31 *Exposure of Sensitive Receptors to Substantial Concentrations of Air*  
32 *Contaminants Related to Changes in Groundwater Pumping*

33 It is anticipated that CVP and SWP water supplies would be decreased by  
34 10 percent and 18 percent, respectively, in the San Francisco Bay Area, Central  
35 Coast, and Southern California regions under Alternative 5 as compared to the  
36 Second Basis of Comparison. The decrease in surface water supplies could result  
37 in increased use of groundwater pumps and emissions of air pollutants and  
38 contaminants if the use of diesel engines is also increased.

39 **21.4.3.7 Summary of Environmental Consequences**

40 The results of the environmental consequences of implementation of  
41 Alternatives 1 through 5 as compared to the No Action Alternative and the  
42 Second Basis of Comparison are presented in Tables 21.38 and 21.39.

1 **Table 21.38 Comparison of Alternatives 1 through 5 to No Action Alternative**

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	Decrease potential for emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants by 8 percent in the Central Valley, 11 to 21 percent in the San Francisco Bay Area Region, and by 21 percent in the Central Coast and Southern California regions.  Similar mercury concentrations in Largemouth Bass in the most of the Delta; and a 6 percent decrease near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough over the long-term conditions.	None needed
Alternative 2	No effects on environmental justice factors.	None needed
Alternative 3	Decrease potential for emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants by 6 percent in the Central Valley, 9 to 17 percent in the San Francisco Bay Area Region, and by 17 percent in the Central Coast and Southern California regions.  Similar mercury concentrations in Largemouth Bass in the most of the Delta; and a 6 percent decrease near San Joaquin River at Antioch and Montezuma Slough over the long-term conditions.	None needed
Alternative 4	Same effects as described for Alternative 1 compared to the No Action Alternative.	None needed
Alternative 5	Similar potential for emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants in the Central Valley, San Francisco Bay Area, Central Coast, and Southern California regions.  Similar mercury concentrations in Largemouth Bass throughout the Delta.	None needed

2 Note: Due to the limitations and uncertainty in the CalSim II monthly model and other analytical  
 3 tools, incremental differences of 5 percent or less between alternatives and the Second Basis of  
 4 Comparison are considered to be “similar.”

5 **Table 21.39 Comparison of Alternatives 1 through 5 to Second Basis of**  
 6 **Comparison**

Alternative	Potential Change	Consideration for Mitigation Measures
No Action Alternative	Increase potential for emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants by 8 percent in the Central Valley, 10 to 18 percent in the San Francisco Bay Area Region, and by 18 percent in the Central Coast and Southern California regions.  Similar mercury concentrations in Largemouth Bass in the most of the Delta; and a 7 percent increase near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough over the long-term conditions.	Not considered for this comparison.
Alternative 1	No effects on environmental justice factors.	Not considered for this comparison.

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 2	Same effects as described for No Action Alternative as compared to the Second Basis of Comparison.	Not considered for this comparison.
Alternative 3	Similar potential for emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants in the Central Valley, San Francisco Bay Area, Central Coast, and Southern California regions.  Similar mercury concentrations in Largemouth Bass throughout the Delta.	Not considered for this comparison.
Alternative 4	No effects on environmental justice factors.	Not considered for this comparison.
Alternative 5	Increase potential for emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors to substantial concentrations of air contaminants by 8 percent in the Central Valley, 10 to 18 percent in the San Francisco Bay Area Region, and by 18 percent in the Central Coast and Southern California regions.  Similar mercury concentrations in Largemouth Bass in the most of the Delta; and a 7 percent increase near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough over the long-term conditions.	Not considered for this comparison.

1 Note: Due to the limitations and uncertainty in the CalSim II monthly model and other analytical  
2 tools, incremental differences of 5 percent or less between alternatives and the Second Basis of  
3 Comparison are considered to be "similar."

#### 4 **21.4.3.8 Potential Mitigation Measures**

5 Mitigation measures are presented in this section to avoid, minimize, rectify,  
6 reduce, eliminate, or compensate for adverse environmental effects of  
7 Alternatives 1 through 5 as compared to the No Action Alternative. Mitigation  
8 measures were not included to address adverse impacts under the alternatives as  
9 compared to the Second Basis of Comparison because this analysis was included  
10 in this EIS for information purposes only.

11 Changes in CVP and SWP operations under Alternatives 1 through 5 as compared  
12 to the No Action Alternative would not result in changes in air quality or public  
13 health that are related to environmental justice factors. Therefore, there would be  
14 no disproportionately high or adverse environmental justice effects; and no  
15 mitigation measures are required.

#### 16 **21.4.3.9 Cumulative Effects Analysis**

17 As described in Chapter 3, the cumulative effects analysis considers projects,  
18 programs, and policies that are not speculative; and are based upon known or  
19 reasonably foreseeable long-range plans, regulations, operating agreements, or  
20 other information that establishes them as reasonably foreseeable.

21 The cumulative effects analysis Alternatives 1 through 5 for Environmental  
22 Justice are summarized in Table 21.40.

1  
2

**Table 21.4 Summary of Cumulative Effects on Environmental Justice of Alternatives 1 through 5 as Compared to the No Action Alternative**

Scenarios	Actions	Cumulative Effects of Actions
<p>Past &amp; Present, and Future Actions included in the No Action Alternative and in all Alternatives in Year 2030</p>	<p>Consistent with Affected Environment conditions plus:</p> <p>Actions in the 2008 USFWS BO and 2009 NMFS BO that Would Have Occurred without Implementation of the Biological Opinions, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives), including climate change and sea level rise</p> <p>Actions not included in the 2008 USFWS BO and 2009 NMFS BO that Would Have Occurred without Implementation of the Biological Opinions, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives):</p> <ul style="list-style-type: none"> <li>• Implementation of Federal and state policies and programs, including Clean Water Act (e.g., Total Maximum Daily Loads); Safe Drinking Water Act; Clean Air Act; and flood management programs</li> <li>• General plans for 2030.</li> <li>• Trinity River Restoration Program.</li> <li>• Central Valley Project Improvement Act programs</li> <li>• Folsom Dam Water Control Manual Update</li> <li>• FERC Relicensing for the Middle Fork of the American River Project</li> <li>• Lower Mokelumne River Spawning Habitat Improvement Project</li> <li>• Dutch Slough Tidal Marsh Restoration</li> <li>• Suisun Marsh Habitat Management, Preservation, and Restoration Plan Implementation</li> <li>• Tidal Wetland Restoration: Yolo Ranch, Northern Liberty Island Fish Restoration Project, Prospect Island Restoration Project, and Calhoun Cut/Lindsey Slough Tidal Habitat Restoration Project</li> <li>• San Joaquin River Restoration Program</li> <li>• Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects with completed environmental documents)</li> </ul>	<p><u>These effects would be the same in all alternatives.</u></p> <p>Climate change and sea level rise, development under the general plans, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce the availability of surface water, including CVP and SWP water supplies. This could result in increased groundwater withdrawals; and a portion of those groundwater pumps would rely upon diesel engines. Therefore, there would be an increased potential for emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors that could cause a disproportionately high and adverse impact on minority and low-income populations.</p> <p>Mercury concentrations in fish tissue within the Delta will be either similar or greater than recent historical conditions because Phases 1 and 2 of the Delta Mercury Program would be completed by 2030, as mandated by the Central Valley RWQCB, including methylmercury control programs and reduction programs for total inorganic mercury. Due to the extent of these programs, it is anticipated that the programs would be initiated; however, future reductions in mercury sources and related reductions of mercury and methylmercury concentrations in fish tissue would actually occur after 2030.</p>

Scenarios	Actions	Cumulative Effects of Actions
<p>Future Actions considered as Cumulative Effects Actions in with all Alternatives in Year 2030</p>	<p>Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives):</p> <ul style="list-style-type: none"> <li>• Bay-Delta Water Quality Control Plan Update</li> <li>• FERC Relicensing Projects</li> <li>• Bay Delta Conservation Plan (including the California WaterFix alternative)</li> <li>• Shasta Lake Water Resources, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations</li> <li>• El Dorado Water and Power Authority Supplemental Water Rights Project</li> <li>• Sacramento River Water Reliability Project</li> <li>• Semitropic Water Storage District Delta Wetlands</li> <li>• North Bay Aqueduct Alternative Intake</li> <li>• San Luis Reservoir Low Point Improvement Project</li> <li>• Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects that did not have completed environmental documents during preparation of the EIS)</li> </ul>	<p><u>These effects would be the same in all alternatives.</u></p> <p>Future reasonably foreseeable storage and water supply projects would improve surface water reliability. These actions would reduce the potential for increased groundwater withdrawals; and reduce the potential for emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors that could cause a disproportionately high and adverse impact on minority and low-income populations.</p>
<p>No Action Alternative with Associated Cumulative Effects Actions in Year 2030</p>	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO</p>	<p>Climate change and sea level rise, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce the availability of surface water, including CVP and SWP water supplies. This could result in increased groundwater withdrawals; and a portion of those groundwater pumps would rely upon diesel engines. Therefore, there would be an increased potential for emissions of criteria air pollutants and precursors, and/or exposure of sensitive receptors that could cause a disproportionately high and adverse impact on minority and low-income populations.</p> <p>Mercury concentrations in fish tissue within the Delta will be</p>

Scenarios	Actions	Cumulative Effects of Actions
		<p>either similar or greater than recent historical conditions because Phases 1 and 2 of the Delta Mercury Program would be completed by 2030, as mandated by the Central Valley RWQCB, including methylmercury control programs and reduction programs for total inorganic mercury. Due to the extent of these programs, it is anticipated that the programs would be initiated; however, future reductions in mercury sources and related reductions of mercury and methylmercury concentrations in fish tissue would actually occur after 2030.</p>
<p>Alternative 1 with Associated Cumulative Effects Actions in Year 2030</p>	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)</p>	<p>Implementation of Alternative 1 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with these added actions.</p>
<p>Alternative 2 with Associated Cumulative Effects Actions in Year 2030</p>	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions No implementation of structural improvements or other actions that require further study to develop a more detailed action description.</p>	<p>Implementation of Alternative 2 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with these added actions.</p>
<p>Alternative 3 with Associated Cumulative Effects Actions in Year 2030</p>	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant) Slight increase in positive Old and Middle River flows in the winter and spring months</p>	<p>Implementation of Alternative 3 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with these added actions.</p>
<p>Alternative 4 with Associated Cumulative Effects Actions in Year 2030</p>	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)</p>	<p>Implementation of Alternative 4 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with these added actions.</p>
<p>Alternative 5 with Associated Cumulative Effects Actions in Year 2030</p>	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO Positive Old and Middle River flows and increased Delta outflow in spring months</p>	<p>Implementation of Alternative 5 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with these added actions.</p>

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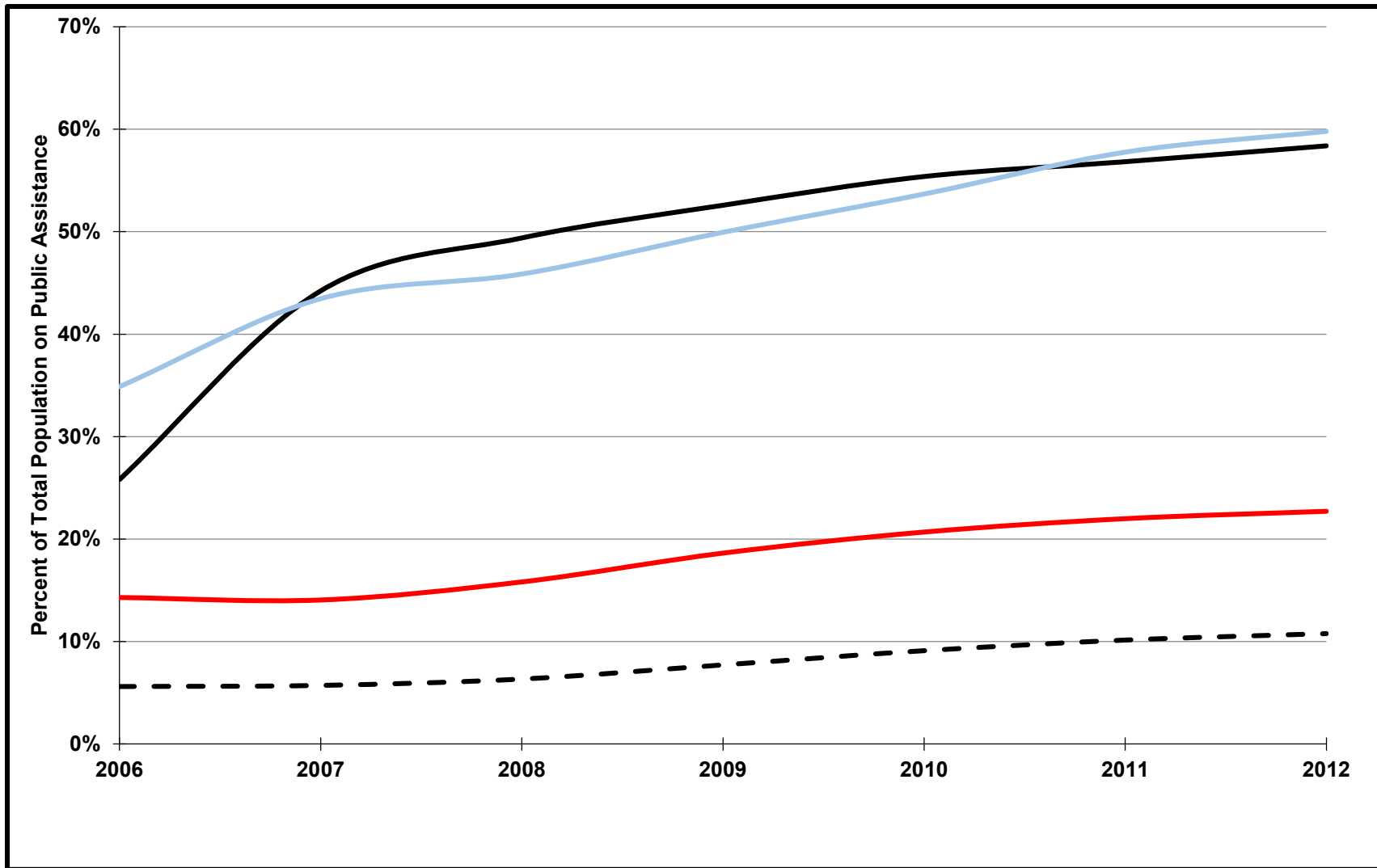


Figure 21.1 Population on CalFresh Program and CalWORKs Program in Huron and Mendota in 2006 through 2012

Source: CDSS 2008a –2008y, 2009a – 2009n, 2012a -2012a, 2013a – 2013i; Fresno County 2013



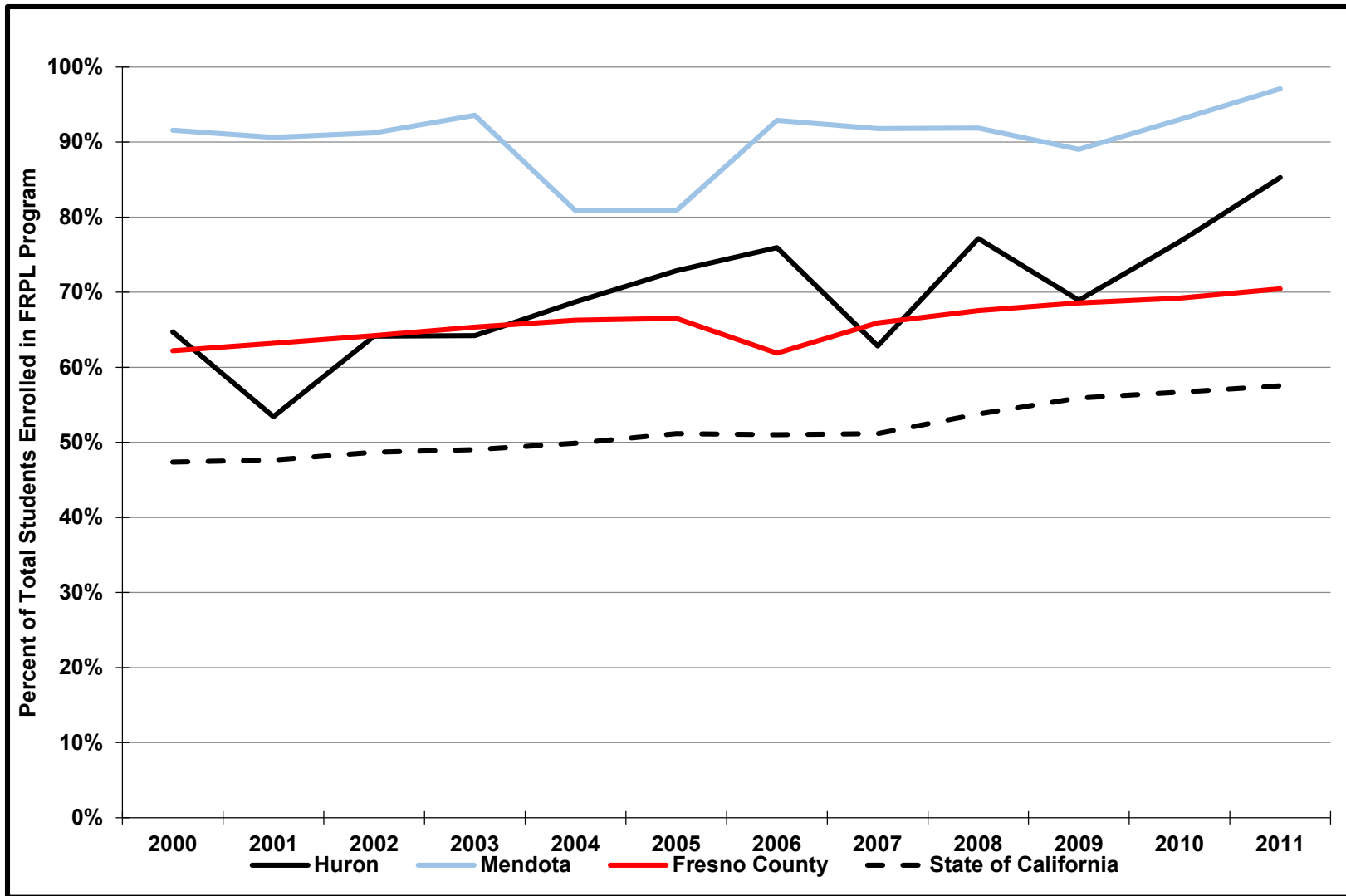


Figure 21.2 Enrollment in Free or Reduced Price Meals Program in Huron and Mendota in 2000 through 2011

Source: CDE 2013

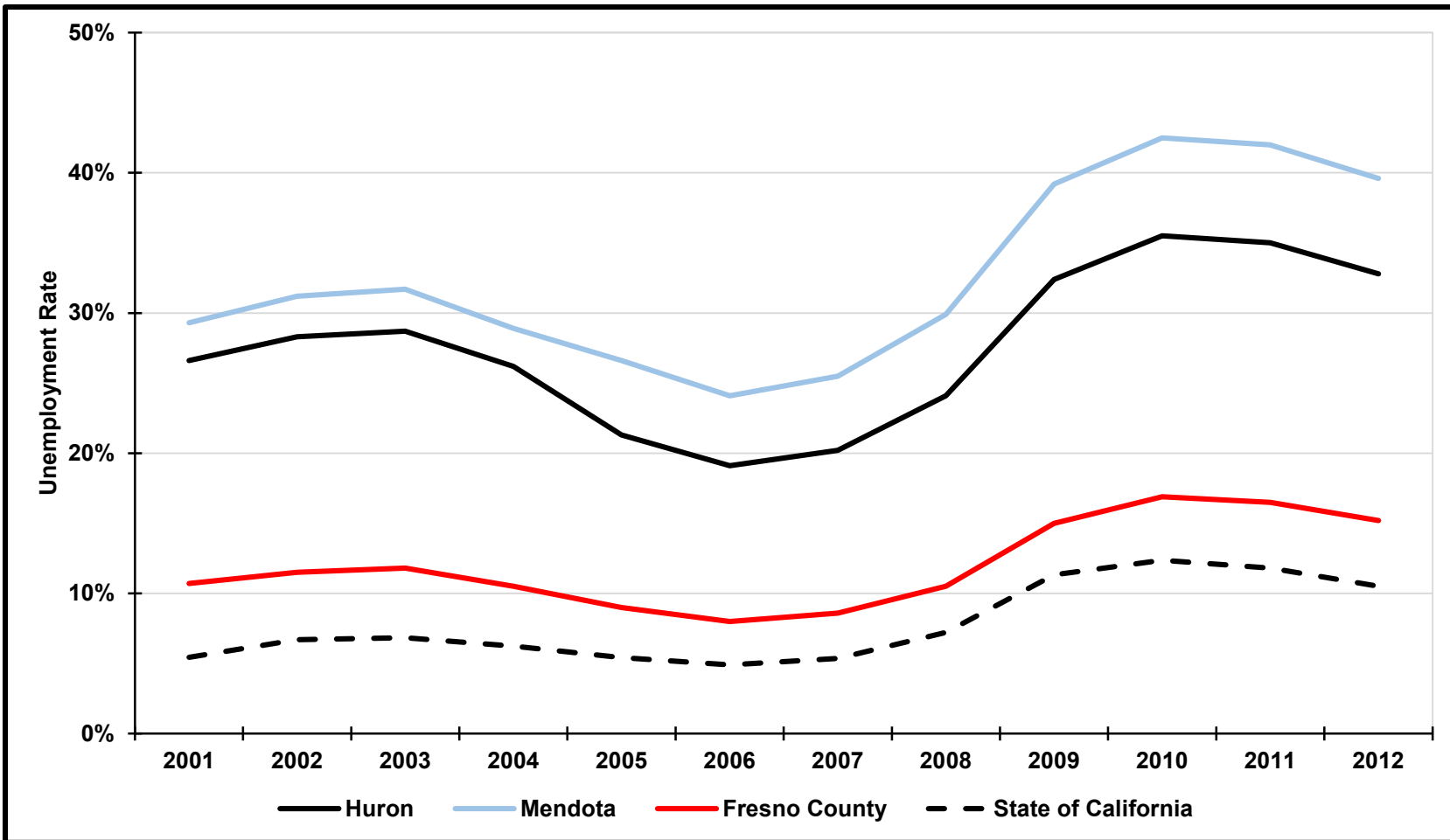


Figure 21.3 Unemployment in Huron and Mendota in 2001 through 2012

Source: BLS 2014; CEDD 2014

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**Chapter 22****1 Other NEPA Requirements****2 22.1 Introduction**

3 In addition to the factors described in Chapters 5 through 21, the National  
4 Environmental Policy Act (NEPA) requires consideration of the relationship of  
5 short-term uses and long-term productivity, consideration of irreversible and  
6 irretrievable commitments of resources, and growth-inducing impacts as  
7 compared to the No Action Alternative (40 Code of Federal Regulations  
8 [CFR] 1508.8). These considerations are described in the following sections of  
9 this chapter.

**10 22.2 Relationship between Short-term Uses and**  
**11 Long-term Productivity**

12 NEPA requires that an Environmental Impact Statement (EIS) prepared by  
13 Federal agencies disclose "...the relationship between short-term uses of man's  
14 environment and the maintenance and enhancement of long-term productivity..."  
15 (40 CFR 1502.16). As discussed in Chapter 1, Introduction, this EIS evaluates  
16 long-term potential direct, indirect, and cumulative impacts on the environment  
17 that could result from implementation of alternatives for the continued long-term  
18 operation of the Central Valley Project (CVP) and State Water Project (SWP) and  
19 implementation of ecosystem restoration. This EIS does not evaluate short-term  
20 impacts related to implementing project-specific actions, such as impacts during  
21 construction and/or start-up periods for actions that are not fully defined at this  
22 time and that may be implemented by Reclamation or other agencies as part of the  
23 alternatives. It is recognized that numerous projects would be planned, designed,  
24 and constructed under the No Action Alternative and the Second Basis of  
25 Comparison, including tidal wetlands and floodplain restoration, as described in  
26 Chapter 3, Description of Alternatives. It also recognized that facilities to  
27 implement fish passage at CVP reservoirs would be implemented under the No  
28 Action Alternative and Alternative 5; and facilities to implement a trap and haul  
29 program for steelhead from the San Joaquin River under Alternative 4.  
30 Project-specific construction impacts would be addressed in project-specific  
31 environmental documents prepared at the time the projects are proposed for  
32 approval. At this time, however, the need for, and the nature, magnitude, and  
33 extent of specific impacts are not known.

34 Potential long-term effects (beneficial and adverse) of implementation of  
35 Alternatives 1 through 5 as compared to the No Action Alternative with respect to  
36 each environmental resource are summarized in Table 22.1.

- 1 There would be no long-term effects related to geology and soils resources,  
 2 agricultural resources, land use, cultural resources, and Indian Trust Assets  
 3 because the conditions under Alternatives 1 through 5 would be similar to  
 4 conditions under the No Action Alternative and to the Second Basis of  
 5 Comparison.  
 6 A complete listing of the effects of implementation of Alternatives 1 through 5 as  
 7 compared to the No Action Alternative and to the Second Basis of Comparison  
 8 are included Chapter 3, Description of Alternatives.

9 **Table 22.1 Long-term Effects of Implementation of the No Action Alternative and**  
 10 **Alternatives 1 through 5**

Environmental Resources	Comparison of Alternatives 1 through 5 and the No Action Alternative
<b>Surface Water</b>	
Trinity Lake	Water surface elevations similar in Alternatives 1 through 5 and the No Action Alternative. Storage under Alternatives 1, 3, and 4 is higher than under Alternatives 2 and 5 and the No Action Alternative.
Trinity River at Lewiston Dam	Flows similar or higher in November-December under Alternatives 1, 3, and 4 than under Alternatives 2 and 5 and the No Action Alternative. Similar flows in other months.
Shasta Lake	Water surface elevations similar in Alternatives 1 through 5 and the No Action Alternative. Storage under Alternatives 1, 3, and 4 is higher than under Alternatives 2 and 5 and the No Action Alternative.
Sacramento River at Keswick Dam	Flows similar or higher in December-August under Alternatives 1, 3, and 4 than under Alternatives 2 and 5 and the No Action Alternative. Flows higher in September-November under Alternatives 2 and 5 and the No Action Alternative than under Alternatives 1, 3, and 4.
Sacramento River at Freeport	Flows similar or higher under Alternatives 1 and 4 than under Alternative 3; and flows higher under Alternative 3 than under Alternatives 2 and 5 and the No Action Alternative in May-June. Flows higher in July-December under Alternatives 2 and 5 and the No Action Alternative than under Alternative 3; and flows higher under Alternative 3 than under Alternatives 1 and 4.
Clear Creek near Igo	Flows are similar under Alternatives 1 through 5 and the No Action Alternative in June-April. Flows under Alternatives 2 and 5 and the No Action Alternative are higher in May than under Alternatives 1, 3, and 4.
Lake Oroville	Water surface elevations similar in Alternatives 1 through 5 and the No Action Alternative. Storage under Alternatives 1, 3, and 4 is higher than under Alternatives 2 and 5 and the No Action Alternative.
Feather River downstream of Thermalito Complex	Flows under Alternatives 1, 3, and 4 similar or higher than under Alternatives 2 and 5 and the No Action Alternative.

<b>Environmental Resources</b>	<b>Comparison of Alternatives 1 through 5 and the No Action Alternative</b>
Folsom Lake	<p>Water surface elevations similar in Alternatives 1 through 5 and the No Action Alternative.</p> <p>Storage under Alternatives 1, 3, and 4 is higher in October-January than under Alternatives 2 and 5 and the No Action Alternative.</p> <p>Storage under Alternatives 2 and 5 and the No Action Alternative are higher in August-September than under Alternatives 1, 3, and 4.</p> <p>Storage similar under February-July in Alternatives 1 through 5 and the No Action Alternative.</p>
American River at Nimbus Dam	<p>Flows under Alternatives 1, 3, and 4 similar or higher than under Alternatives 2 and 5 and the No Action Alternative.</p>
New Melones Reservoir	<p>Water surface elevations similar in Alternatives 1 through 5 and the No Action Alternative.</p> <p>Storage under Alternative 3 is higher than under Alternatives 1 and 4; and storage under Alternatives 1 and 4 are higher than under Alternatives 2 and 5 and the No Action Alternative.</p>
Stanislaus River at Goodwin Dam	<p>Flows higher under Alternatives 1 and 4 than under Alternative 3; and flows under Alternative 3 are higher than under Alternative 5 and the No Action Alternative.</p> <p>Flows under Alternative 5 higher than under the No Action Alternative in April-May.</p>
San Joaquin River at Vernalis	<p>Flows higher in October under the Alternatives 2 and 5 and the No Action Alternative than under Alternatives 1, 3, and 4.</p> <p>Flows higher in April under Alternative 5 than under all other alternatives.</p> <p>Flows higher in May under Alternatives 1 and 4 than under Alternatives 3 and 5 and the No Action Alternative.</p> <p>Flows similar during other months.</p>
San Luis Reservoir	<p>Water surface elevations similar in Alternatives 1 through 5 and the No Action Alternative.</p> <p>Storage under Alternatives 1 and 4 higher than under Alternative 3; and storage under Alternatives 2 and 5 and the No Action Alternative.</p> <p>Storage under Alternatives 2 and the No Action Alternative higher than under Alternative 5 in dry and critical dry years.</p>
Flows into Yolo Bypass	<p>Flows entering the Yolo Bypass at Fremont Weir higher under Alternatives 1, 3, and 4 than under Alternatives 2 and 5 and the No Action Alternative.</p>
Delta Outflow	<p>Delta outflow higher under Alternatives 2 and 5 and the No Action Alternative than under Alternatives 1, 3, and 4.</p>
Reverse Flows in Old and Middle Rivers	<p>Old and Middle River flows in April-May more positive under Alternative 5 than under Alternative 2 and the No Action Alternative.</p> <p>Old and Middle River flows in July more positive under Alternatives 1 and 4 than under Alternative 3; and under Alternative 3 than under Alternatives 2 and 5 and the No Action Alternative.</p> <p>Old and Middle River flows in other months higher under Alternatives 2 and 5 and the No Action Alternative than Alternative 3; and higher under Alternative 3 than under Alternatives 1 and 4.</p>
<b>Water Supplies</b>	
Non-CVP and Non-SWP Deliveries	<p>Water deliveries under Alternatives 1 through 5 and the No Action Alternative.</p>
CVP Water Deliveries	<p>Water deliveries higher under Alternatives 1 and 4 than under Alternative 3; and higher under Alternative 3 than under Alternatives 2 and 5 and the No Action Alternative.</p>

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<b>Environmental Resources</b>	<b>Comparison of Alternatives 1 through 5 and the No Action Alternative</b>
SWP Water Deliveries	Water deliveries higher under Alternatives 1 and 4 than under Alternative 3; and higher under Alternative 3 than under Alternatives 2 and 5 and the No Action Alternative.
<b>Surface Water Quality</b>	
Salinity in Northern Delta (near Emmaton)	Salinity in September-January under Alternatives 1, 3, and 4 than under Alternatives 2 and 5 and the No Action Alternative. Salinity in February-August under Alternatives 2 and 5 and the No Action Alternative higher than under Alternatives 1, 3, and 4.
Salinity in Western Delta (near Port Chicago)	Salinity in September-January under Alternatives 1, 3, and 4 than under Alternatives 2 and 5 and the No Action Alternative. Salinity in February-August under Alternatives 2 and 5 and the No Action Alternative higher than under Alternatives 1, 3, and 4.
Salinity in Western Central Delta (near Antioch)	Salinity in September-January under Alternatives 1, 3, and 4 than under Alternatives 2 and 5 and the No Action Alternative. Salinity in February-August under Alternatives 2 and 5 and the No Action Alternative higher than under Alternatives 1, 3, and 4.
Salinity in Western Central Delta (near Contra Costa Water District Intakes)	Salinity in September-January under Alternatives 1, 3, and 4 than under Alternatives 2 and 5 and the No Action Alternative. Salinity in February-August under Alternatives 2 and 5 and the No Action Alternative higher than under Alternatives 1, 3, and 4.
Salinity in Southern Delta (near CVP and SWP intakes)	Salinity under Alternatives 1 and 4 higher than under Alternative 3; and salinity under Alternative 3 higher than under Alternatives 2 and 5 and the No Action Alternative.
Mercury in Delta Fish	<p>Mercury concentrations in fish tissue of large fish in the Delta used for human consumption would exceed guidelines established by the State of California under Alternatives 1 through 5 and the No Action Alternative.</p> <p>In the interior Delta along the San Joaquin River and at the CVP Contra Costa Canal Pumping Plant, mercury concentrations in the tissue of large fish used for human consumption would be the higher under Alternative 5 than under Alternative 3. Mercury under Alternative 3 would be higher than under Alternative 2 and the No Action Alternative. Mercury under Alternative 2 and the No Action Alternative would be higher than under Alternatives 1 and 4.</p> <p>Near Suisun Marsh and Cache Slough, mercury concentrations would be higher under Alternative 2 and the No Action Alternative than under Alternatives 1 and 4. Mercury under Alternatives 1 and 4 would be higher than under Alternative 5; and concentrations under Alternative 5 would be higher than under Alternative 3.</p> <p>Along Old River near Clifton Court, mercury concentrations in the tissue of large fish used for human consumption would be higher under Alternative 2 and the No Action Alternative than under Alternative 5. Mercury under Alternative 5 would be higher than under Alternative 3. Mercury under Alternative 3 would be higher than under Alternatives 1 and 4.</p> <p>Near the CVP Jones Pumping Plant intake, mercury concentrations in the tissue of large fish used for human consumption would be higher under Alternative 2 and the No Action Alternative than under Alternative 3. Mercury under Alternative 3 would be higher than under Alternatives 1 and 4. Mercury under Alternatives 1 and 4 would be higher than under Alternative 5.</p>
Selenium in Delta and Delta Fish	Selenium concentrations similar under Alternatives 1 through 5 and the No Action Alternative.

<b>Environmental Resources</b>	<b>Comparison of Alternatives 1 through 5 and the No Action Alternative</b>
<b>Groundwater Resources</b>	
Trinity River Region	Similar groundwater conditions under Alternatives 1 through 5 and the No Action Alternative.
Central Valley Region: Sacramento Valley	Similar groundwater conditions under Alternatives 1 through 5 and the No Action Alternative.
Central Valley Region: San Joaquin Valley	Groundwater pumping would be higher under Alternative 5 than under Alternative 2 and the No Action Alternative. Pumping would be higher under Alternative 2 and the No Action Alternative than under Alternative 3. Pumping would be higher under Alternative 3 than under Alternatives 1 and 4. Increased groundwater pumping would result in lower groundwater elevations and increased subsidence potential.
San Francisco Bay Area, Central Coast, and Southern California Region	Groundwater pumping would be higher under Alternative 5 than under Alternative 2 and the No Action Alternative. Pumping would be higher under Alternative 2 and the No Action Alternative than under Alternative 3. Pumping would be higher under Alternative 3 than under Alternatives 1 and 4. Increased groundwater pumping would result in lower groundwater elevations and increased subsidence potential.
<b>CVP and SWP Energy Resources</b>	
Energy Generated and Used by CVP and SWP Water Users	<p>CVP net energy generation would be higher under Alternative 2 and the No Action Alternative than under Alternatives 1 and 4. Net energy generation would be higher under Alternatives 1 and 4 than under Alternative 3. Net energy generation would be higher under Alternative 3 than under Alternative 5.</p> <p>SWP net energy generation would be higher under Alternative 2 and the No Action Alternative than under Alternative 5. Net energy generation would be higher under Alternative 5 than under Alternative 3. Net energy generation would be higher under Alternative 3 than under Alternatives 1 and 4.</p> <p>Energy use by CVP and SWP water users for alternative water supplies would be higher under Alternative 5 than under Alternative 2 and the No Action Alternative. Energy use would be higher under Alternative 2 and the No Action Alternative than under Alternative 3. Energy use would be higher under Alternative 3 than under Alternatives 1 and 4.</p>
<b>Aquatic Resources</b>	
Trinity River: Coho Salmon	Habitat conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Trinity River: Spring-run Chinook Salmon	Habitat conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Trinity River: Fall-run Chinook Salmon	Habitat conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Trinity River: Steelhead	Habitat conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Trinity River: Green Sturgeon	Habitat conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Trinity Lake and Lewiston Reservoir: Reservoir Fish	Habitat conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Trinity River: Pacific Lamprey	Habitat conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Trinity River: Eulachon	Habitat conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.



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<b>Environmental Resources</b>	<b>Comparison of Alternatives 1 through 5 and the No Action Alternative</b>
Sacramento River System: Winter-run Chinook Salmon	Habitat conditions would be better under Alternative 5 and the No Action Alternative than under Alternative 2. Conditions under Alternative 2 would be better than under Alternatives 3 and 4. Conditions under Alternative 3 and 4 would be better than under Alternative 1.
Sacramento River System: Spring-run Chinook Salmon	Habitat conditions would be better under Alternative 5 and the No Action Alternative than under Alternative 2. Conditions under Alternative 2 would be better than under Alternatives 3 and 4. Conditions under Alternative 3 and 4 would be better than under Alternative 1.
Sacramento River System: Fall-run Chinook Salmon	Habitat conditions under Alternatives 1, 3, 4, and 5 and the No Action Alternative would be better than under Alternative 2.
Sacramento River System: Late Fall-run Chinook Salmon	Habitat conditions under Alternatives 1, 3, 4, and 5 and the No Action Alternative would be better than under Alternative 2.
Sacramento River System: Steelhead	Habitat conditions would be better under Alternative 5 and the No Action Alternative than under Alternative 2. Conditions under Alternative 2 would be better than under Alternatives 3 and 4. Conditions under Alternative 3 and 4 would be better than under Alternative 1.
Sacramento River System: Green Sturgeon and White Sturgeon	Habitat conditions would be better under Alternative 3 than under Alternatives 1 and 4. Conditions under Alternative 4 would be better than under Alternatives 2 and 5 and the No Action Alternative.
Delta: Delta Smelt	Habitat conditions would better under Alternatives 2 and 5 and the No Action Alternative than under Alternatives 1, 3, and 4.
Delta: Longfin Smelt	Habitat conditions would better under Alternatives 2 and 5 and the No Action Alternative than under Alternatives 1, 3, and 4.
Delta: Sacramento Splittail	Habitat conditions would better under Alternatives 2 and 5 and the No Action Alternative than under Alternatives 1, 3, and 4.
Sacramento River System: Reservoir Fish	Habitat conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Sacramento River System: Pacific Lamprey	Habitat conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Sacramento River System: Striped Bass, American Shad, and Hardhead	Habitat conditions for Hardhead and American Shad would be similar under Alternatives 1 through 5 and the No Action Alternative. Habitat conditions for Striped Bass would better under Alternatives 1, 2, and 5 and the No Action Alternative than under Alternatives 3 and 4 due to increased harvest limits.
Stanislaus River: Fall-run Chinook Salmon	Habitat conditions better under Alternatives 3 and 4 than under Alternatives 1, 2, and 5 and the No Action Alternative.
Stanislaus River: Steelhead	Habitat conditions better under Alternative 5 and the No Action Alternative than under Alternatives 3 and 4. Conditions under Alternatives 3 and 4 are better than under Alternatives 1 and 2.
Stanislaus River: White Sturgeon	Habitat conditions better under Alternatives 2 and 5 and the No Action Alternative than under Alternatives 1, 3, and 4.
New Melones Reservoir; Reservoir Fish	Habitat conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Stanislaus River: Other Fish	Habitat conditions for Hardhead and American Shad would be similar under Alternatives 1 through 5 and the No Action Alternative. Habitat conditions for Striped Bass would better under Alternatives 1, 2, and 5 and the No Action Alternative than under Alternatives 3 and 4 due to increased harvest limits.

<b>Environmental Resources</b>	<b>Comparison of Alternatives 1 through 5 and the No Action Alternative</b>
Pacific Ocean: Killer Whale	Habitat conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
<b>Terrestrial Resources</b>	
Terrestrial Resources along Shoreline of CVP and SWP Reservoirs	Habitat conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Terrestrial Resources along Rivers Downstream of CVP and SWP Reservoirs	Habitat conditions along Trinity, Sacramento, American, and Feather rivers would be similar under Alternatives 1 through 5 and the No Action Alternative. Habitat conditions along the Stanislaus River would be better under Alternatives 2 and 5 and the No Action Alternative than under Alternatives 1, 3, and 4.
Terrestrial Resources in Yolo Bypass	Habitat conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Terrestrial Resources in Western Delta	Freshwater habitat in the western Delta would be better under Alternatives 2 and 5 and the No Action Alternative than under Alternatives 1, 3, and 4.
<b>Geology and Soils Resources</b>	
Geology and Soils Resources	Geology and soils conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
<b>Agricultural Resources</b>	
Agricultural Production and Employment	Agricultural production and employment conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
<b>Land Use</b>	
Municipal and Industrial Land Use	Municipal and industrial land use conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
<b>Visual Resources</b>	
Visual Resources of Land Irrigated with CVP and SWP Water	Visual resource conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Visual Resources at Reservoirs that Store CVP and SWP Water	Visual resource conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
<b>Recreation Resources</b>	
Recreation Resources at Reservoirs that Store CVP and SWP Water	Recreational resource conditions at the reservoirs would be similar under Alternatives 1 through 5 and the No Action Alternative.
Recreation Resources in Rivers downstream of CVP and SWP Reservoirs	Recreational resource conditions at the along the rivers would be similar under Alternatives 1 through 5 and the No Action Alternative. Recreational resource conditions related to Striped Bass fishing and sport ocean salmon fishing would be better under Alternatives 1, 2, and 5 and the No Action Alternative than under Alternatives 3 and 4 due to increased harvest limitations.

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<b>Environmental Resources</b>	<b>Comparison of Alternatives 1 through 5 and the No Action Alternative</b>
<b>Air Quality and Greenhouse Gas Emissions</b>	
Emissions of Criteria Air Pollutants and Precursors and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants from Diesel Engines at Groundwater Wells	In the San Joaquin Valley and the San Francisco Bay Area, Central Coast, and Southern California regions, potential emissions from diesel engines used for groundwater pumping would be higher under Alternative 5 than under Alternative 2 and the No Action Alternative. Emissions would be higher under Alternative 2 and the No Action Alternative than under Alternative 3. Emissions would be higher under Alternative 3 than under Alternatives 1 and 4.
Increased Greenhouse Gas Emissions (GHG) due to Changes in Energy Resources Related to CVP and SWP Water Use	Overall changes are not known at this time due to complexity of energy demands associated with alternative water supplies. However, GHG emissions could increase due to energy use related to alternative water supplies. Energy use by CVP and SWP water users for alternative water supplies would be higher under Alternative 5 than under Alternative 2 and the No Action Alternative. Energy use would be higher under Alternative 2 and the No Action Alternative than under Alternative 3. Energy use would be higher under Alternative 3 than under Alternatives 1 and 4.
<b>Cultural Resources</b>	
Potential for Disturbance of Cultural Resources	Cultural resource conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
<b>Public Health</b>	
Water Supply Availability for Wildland Firefighting	Water supply conditions for fighting wildland firefighting would be similar under Alternatives 1 through 5 and the No Action Alternative.
Potential Exposure to Mercury in Fish in Delta	<p>Mercury concentrations in fish tissue of large fish in the Delta used for human consumption would exceed guidelines established by the State of California under Alternatives 1 through 5 and the No Action Alternative.</p> <p>In the interior Delta along the San Joaquin River and at the CVP Contra Costa Canal Pumping Plant, mercury concentrations in the tissue of large fish used for human consumption would be the higher under Alternative 5 than under Alternative 3. Mercury under Alternative 3 would be higher than under Alternative 2 and the No Action Alternative. Mercury under Alternative 2 and the No Action Alternative would be higher than under Alternatives 1 and 4.</p> <p>Near Suisun Marsh and Cache Slough, mercury concentrations would be higher under Alternative 2 and the No Action Alternative than under Alternatives 1 and 4. Mercury under Alternatives 1 and 4 would be higher than under Alternative 5; and concentrations under Alternative 5 would be higher than under Alternative 3.</p> <p>Along Old River near Clifton Court, mercury concentrations in the tissue of large fish used for human consumption would be higher under Alternative 2 and the No Action Alternative than under Alternative 5. Mercury under Alternative 5 would be higher than under Alternative 3. Mercury under Alternative 3 would be higher than under Alternatives 1 and 4.</p> <p>Near the CVP Jones Pumping Plant intake, mercury concentrations in the tissue of large fish used for human consumption would be higher under Alternative 2 and the No Action Alternative than under Alternative 3. Mercury under Alternative 3 would be higher than under Alternatives 1 and 4. Mercury under Alternatives 1 and 4 would be higher than under Alternative 5.</p>
<b>Socioeconomics</b>	
Agricultural and Municipal and Industrial Employment	Agricultural, municipal, and industrial employment would be similar under Alternatives 1 through 5 and the No Action Alternative.

<b>Environmental Resources</b>	<b>Comparison of Alternatives 1 through 5 and the No Action Alternative</b>
Municipal and Industrial Water Supply Operating Expenses	Municipal and industrial water supply operating expenses would be similar under Alternatives 1 through 5 and the No Action Alternative.
Recreational Economics CVP and SWP Reservoirs	Recreational economic conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
Recreational Economics Related to Striped Bass Fishing in Delta	Recreational economic conditions related to Striped Bass fishing would be better under Alternatives 1, 2, and 5 and the No Action Alternative than under Alternatives 3 and 4 due to changes in harvest limitations.
Commercial and Sport Ocean Salmon Fishing	Recreational economic conditions related to commercial and sport ocean salmon fishing would be better under Alternatives 1, 2, and 5 and the No Action Alternative than under Alternatives 3 and 4 due to changes in harvest limitations.
<b>Indian Trust Assets</b>	
Potential for Disturbance of Indian Trust Assets	Indian Trust Asset conditions would be similar under Alternatives 1 through 5 and the No Action Alternative.
<b>Environmental Justice</b>	
Emissions of Criteria Air Pollutants and Precursors and/or Exposure of Sensitive Receptors to Substantial Concentrations of Air Contaminants from Diesel Engines at Groundwater Wells	In the San Joaquin Valley, potential emissions from diesel engines used for groundwater pumping would be higher under Alternative 5 than under Alternative 2 and the No Action Alternative. Emissions would be higher under Alternative 2 and the No Action Alternative than under Alternative 3. Emissions would be higher under Alternative 3 than under Alternatives 1 and 4.
Potential Exposure to Mercury in Fish in Delta	<p>Mercury concentrations in fish tissue of large fish in the Delta used for human consumption would exceed guidelines established by the State of California under Alternatives 1 through 5 and the No Action Alternative.</p> <p>In the interior Delta along the San Joaquin River and at the CVP Contra Costa Canal Pumping Plant, mercury concentrations in the tissue of large fish used for human consumption would be the higher under Alternative 5 than under Alternative 3. Mercury under Alternative 3 would be higher than under Alternative 2 and the No Action Alternative. Mercury under Alternative 2 and the No Action Alternative would be higher than under Alternatives 1 and 4.</p> <p>Near Suisun Marsh and Cache Slough, mercury concentrations would be higher under Alternative 2 and the No Action Alternative than under Alternatives 1 and 4. Mercury under Alternatives 1 and 4 would be higher than under Alternative 5; and concentrations under Alternative 5 would be higher than under Alternative 3.</p> <p>Along Old River near Clifton Court, mercury concentrations in the tissue of large fish used for human consumption would be higher under Alternative 2 and the No Action Alternative than under Alternative 5. Mercury under Alternative 5 would be higher than under Alternative 3. Mercury under Alternative 3 would be higher than under Alternatives 1 and 4.</p> <p>Near the CVP Jones Pumping Plant intake, mercury concentrations in the tissue of large fish used for human consumption would be higher under Alternative 2 and the No Action Alternative than under Alternative 3. Mercury under Alternative 3 would be higher than under Alternatives 1 and 4. Mercury under Alternatives 1 and 4 would be higher than under Alternative 5.</p>

1 **22.3 Irreversible and Irretrievable Commitments**  
2 **of Resources**

3 NEPA requires that an EIS prepared by Federal agencies disclose "...any  
4 irreversible and irretrievable commitments of resources which would be involved  
5 in the proposed action should it be implemented..." (40 CFR 1502.16). An  
6 irreversible and irretrievable commitment of resources includes use of natural or  
7 depletable resources, including consumption of construction materials and  
8 nonrenewable energy sources, and permanent conversion of land uses or habitat.

9 As described in Chapter 3, Description of Alternatives, there are several ongoing  
10 projects that are assumed to be implemented by 2030, such as Grasslands Bypass  
11 Project which is currently under construction. It is assumed that these projects  
12 would be included in the No Action Alternative, all other alternatives, and Second  
13 Basis of Comparison. The 2030 conditions assume the projected long-term  
14 conditions for each ongoing project as described in their respective environmental  
15 documents. This analysis does not address the construction activities of each  
16 ongoing project because those impacts were addressed in separate environmental  
17 documents for each project.

18 The alternatives include several future actions that would require construction,  
19 such as implementation of tidal wetlands and floodplains, fish passage facilities,  
20 or temperature control devices at CVP dams. Specific details for location and  
21 construction of these future projects are not identified at this time and are not  
22 addressed in this EIS. Future environmental documents would be prepared to  
23 analyze potential environmental consequences related to specific construction and  
24 operations. This EIS analyzes implementation of the alternatives with the  
25 assumption that these projects would be implemented by 2030; however, this EIS  
26 does not address irreversible and irretrievable commitment of resources  
27 associated with consumption of construction materials and permanent conversion  
28 of land uses or habitat.

29 Changes in nonrenewable energy resources would occur through implementation  
30 of the No Action Alternative and Alternatives 1 through 5. Under the  
31 alternatives, energy would be generated by CVP and SWP operations and used to  
32 convey water in CVP and SWP facilities. As discussed in Chapter 8, Energy,  
33 changes in CVP and SWP energy generation and use would result in the ability to  
34 provide additional energy for use by others or the need to purchase additional  
35 energy from others to operate the CVP and SWP facilities. Under both long-term  
36 average conditions and dry/critical dry water years, Alternative 5 would result in  
37 the least demand for electrical generation by others which would generally be  
38 produced using fossil fuels. The No Action Alternative and Alternative 2 would  
39 require more electrical generation by non-CVP and SWP facilities than  
40 Alternative 5; and less electrical generation than under Alternatives 1, 3, and 4.  
41 Alternative 1 would require the most electrical generation as compared to other  
42 alternatives.

## 22.4 Growth-Inducing Impacts

NEPA requires that an EIS prepared by Federal agencies evaluate indirect growth-inducing effects (40 CFR 1508.8). A project could result in growth-inducing impacts through several measures, including the removal of obstacles to population growth, or actions that encourage and facilitate other activities beyond those proposed by the project. The availability of adequate water supplies, employment opportunities, and improved cultural amenities are examples of actions that could be growth-inducing impacts. Growth inducement may or may not be detrimental, beneficial, or significant. However, if the induced growth impacted the environment, or the ability of agencies to provide public services to an extent not envisioned due to the project actions, the impacts would be considered to be adverse.

As described in Chapter 13, Land Use, and Chapter 19, Socioeconomics, land use and growth projections are not anticipated to change under Alternatives 1 through 5 as compared to the No Action Alternative and the Second Basis of Comparison. Municipal and industrial water users that use CVP and SWP water have prepared Urban Water Management Plans (UWMPs) that project water demand and future water supplies to meet the demands by 2030, including water conservation measures. Projects that had undergone environmental review, were under design, or under construction were considered to exist in 2030 water supply assumptions in the No Action Alternative, Alternatives 1 through 5, and the Second Basis of Comparison. Future projects described in the UWMPs that are under evaluation are considered as options to increase fixed-yield supplies, including additional groundwater pumping, water transfers, recycling water treatment, and desalination water treatment. Existing and future water supplies considered for municipalities by 2030 are presented in Appendix 5B, Future Municipal Water Supplies for CVP and SWP Water Users. For smaller water users that are not addressed in a UWMP, information was obtained from water master plans and integrated regional water management plans. The analysis presented in Chapter 19, indicated that use of the existing and planned future projects would be adequate to meet the water demands in 2030 with or without the CVP and SWP water supply availability under the alternatives considered in this EIS.

Alternatives 1, 3, and 4 would result in higher CVP and SWP water deliveries than the No Action Alternative and Alternatives 2 and 5. However, the additional water supplies under Alternatives 1, 3, and 4 would result in less groundwater pumping and less water transfers which could result in less potential for groundwater overdraft and soil subsidence, and less potential impacts in the service area of the seller for the transfer water. None of the alternatives considered in this EIS would increase the total water supplies to meet 2030 water demands; and therefore, none of the alternatives considered in this EIS are considered to be growth inducing.

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## Chapter 23

# 1 Consultation and Coordination

## 2 23.1 Introduction

3 This chapter summarizes completed, ongoing, and anticipated public outreach and  
4 agency involvement efforts related to preparation of the Environmental Impact  
5 Statement (EIS) for the coordinated long-term operation of the Central Valley  
6 Project (CVP) and State Water Project (SWP).

## 7 23.2 Consultation with the Public and Interested 8 Parties

9 Consultation activities were initiated in 2012 with the scoping process and  
10 continued through the preparation of the Final EIS. In this section, the term  
11 “interested parties” includes representatives from agencies, utilities, agencies,  
12 organizations, and other entities.

### 13 23.2.1 Scoping Process

14 As described in Chapters 1 and 3, the scoping process was initiated on  
15 March 28, 2012, with the publication of the Notice of Intent (NOI) in the Federal  
16 Register and continued through June 28, 2012. Initially the public scoping  
17 process was to be completed on May 29, 2012. During the public scoping  
18 process, other agencies and interested persons requested an extension of the  
19 public scoping process to allow additional opportunities to provide scoping  
20 comments. In response to these requests, U.S. Department of the Interior, Bureau  
21 of Reclamation (Reclamation) published a notice on May 25, 2012, to extend the  
22 public scoping period through June 28, 2012.

23 Scoping meetings were held to inform the public and interested stakeholders  
24 about the project, and to solicit comments and input on the EIS. The scoping  
25 meetings were held in the following locations and resulted in the following level  
26 of public participation:

- 27 • Madera, California on April 25, 2012 (6 participants)
- 28 • Diamond Bar, California on April 26, 2012 (3 participants)
- 29 • Sacramento, California on May 2, 2012 (15 participants)
- 30 • Marysville, California on May 3, 2012 (2 participants)
- 31 • Los Banos, California on May 22, 2012 (230 participants)

32 Reclamation posted the scoping notices in the Federal Register, on its website,  
33 and in newspapers that served areas where the scoping meetings were held.  
34 Reclamation also published press releases to news organizations and others that  
35 have requested notifications for all press releases.



1 Each participant in the scoping meetings was invited to sign an attendance sheet  
2 and provided with an agenda, fact sheet, comment card, and speaker card. The  
3 agenda, fact sheet, and comment card were available in both English and Spanish.

4 Each scoping meeting began with a presentation by Reclamation. The  
5 presentation described the purpose of the meeting and the public scoping process,  
6 an overview of the reasons that Reclamation was preparing the EIS, description of  
7 the process and schedule that Reclamation will use to complete the EIS, and  
8 methods to provide comments at the scoping meeting and subsequently until the  
9 end of the public scoping period. The participants were encouraged to submit  
10 written comments by mail, email, or fax until the close of the public scoping  
11 comment period. During the presentation, Reclamation responded to questions as  
12 they arose from the meeting participants. Following the presentation,  
13 Reclamation heard testimony from those who presented oral comments. Oral  
14 comments were recorded by a transcriber. Reclamation offered to provide  
15 Spanish translation of the presentation and oral comments at each scoping  
16 meeting; however, the translation service was only requested and provided at the  
17 scoping meeting in Los Banos, California.

18 The scoping comments included suggestions related to:

- 19 • Purpose and need for the action.
- 20 • Geographical extent of the Project Area.
- 21 • Definition and assumptions of the No Action Alternative.
- 22 • Definition and assumptions of the action alternatives.
- 23 • Important considerations either for description of the affected environment or  
24 for the methods of analyses for the following resources:
  - 25 – Water resources.
  - 26 – Biological resources.
  - 27 – Land use and socioeconomics.
  - 28 – Air quality.
  - 29 – Recreation and visual resources.

30 Scoping comments were used in the development of a reasonable range of  
31 alternatives and identification of key issues that would require analysis in the  
32 Environmental Consequences sections of this EIS, as described in Chapters 3.

33 Scoping comments also were used in development of the level of detail and  
34 methods of analyses for water resources, biological resources, land use,  
35 socioeconomics, recreation, air quality, and visual resources. These resources are  
36 discussed in Chapters 5 through 10, 12 through 17, and 19 through 21.

37 Reclamation also posted on its website an initial range of alternatives discussed at  
38 the meeting on October 19, 2012 of invited stakeholders. As described in  
39 Chapter 3, Description of Alternatives, comments received during that process  
40 were used to refine the description of the alternatives.

1 Project status meetings were held with cooperating agencies and other  
 2 stakeholders during preparation of the Draft EIS, including meetings in  
 3 Sacramento, California on January 16, May 29, and November 5, 2014;  
 4 February 20, 2015; and June 24, 2015.

5 The scoping report is included in Appendix 23A, Scoping Report.

### 6 **23.2.2 Other Activities**

7 Reclamation established a website which includes the background material related  
 8 to the purpose and need for the action, materials used in the scoping process,  
 9 scoping comments, and information related to meetings with invited stakeholders  
 10 and interest groups to discuss assumptions to be considered in the development of  
 11 the No Action Alternative and action alternatives. As described in Chapter 3,  
 12 comments received on the information posted on Reclamation's website during  
 13 that process were used to refine the description of the alternatives.

### 14 **23.2.3 Stakeholder and Public Involvement during Preparation of** 15 **the Final EIS**

16 The Draft EIS was published for public review in July 2015. The Notice of  
 17 Availability was published by Reclamation in the Federal Register on  
 18 July 31, 2015 (Federal Register, Vol 80, No. 147, 45681). A copy of the Notice  
 19 of Availability is included in Appendix 23B, Public Review of Draft  
 20 Environmental Impact Statement.

21 Newspaper advertisements providing the dates and locations of the public  
 22 meetings for the Draft EIS were published in the following newspapers on the  
 23 specified dates.

- 24 • Sacramento Bee, Sacramento, California – August 26, 2015
- 25 • Oakland Tribune, Oakland, California – August 26, 2015
- 26 • San Jose Mercury, San Jose, California – August 26, 2015
- 27 • Contra Costa Times, Walnut Creek, California – August 26, 2015
- 28 • Record Searchlight, Redding, California – August 27, 2015
- 29 • Los Banos Enterprise, Los Banos, California – August 28, 2015
- 30 • Fresno Bee, Fresno, California – September 1, 2015
- 31 • Los Angeles Times, California – September 3, 2015

32 The distribution list for the Draft EIS is included in Chapter 24, Environmental  
 33 Impact Statement Distribution List. Reclamation posted notification of the  
 34 availability of the Draft EIS and the location and timing of public meetings on its  
 35 website and through press releases.

1 Four public meetings were held during the public review period for the Draft EIS  
2 in the following locations, with the following level of public participation:

- 3 • Sacramento, California on September 9, 2015 (9 participants)
- 4 • Red Bluff, California on September 10, 2015 (9 participants)
- 5 • Los Banos, California on Tuesday, September 15, 2015 (9 participants)
- 6 • Irvine, California on September 17, 2015 (2 participants)

7 The public meetings included an open house preceding a presentation by  
8 Reclamation. The open house portion of the meetings included several project  
9 information stations staffed by project team members available to respond to  
10 attendee's questions. The open house stations included:

- 11 • Welcome Station with display boards that described the public meeting format
- 12 • Purpose and Need of the Project
- 13 • Surface Water and Groundwater Resources
- 14 • Aquatic, Wildlife, and Botanical Resources
- 15 • Socioeconomics
- 16 • Comments with a court reporter to record verbal comments

17 Fact sheets were provided at each of the open house stations.

18 Following the open house portion of the public meeting, Reclamation staff led a  
19 brief presentation. The open house portion of the public meeting was resumed  
20 after the presentation.

21 Copies of the display boards, fact sheets, and the presentation are included in  
22 Appendix 23B, Public Review of Draft Environmental Impact Statement.

23 Only attendees at the meeting in Red Bluff chose to provide verbal comments to  
24 the court reporter. The transcript of those comments also is included in  
25 Appendix 23B. Responses to those comments are included in Appendix 1E.

26 Approximately 860 written and verbal comments were received on the Draft EIS.  
27 All of the comments received on the Draft EIS were considered in preparation of  
28 the Final EIS. Written responses to all substantial comments received are  
29 included in Appendices 1A through 1E of the Final EIS.

### 30 **23.3 Consultation with U.S. Fish and Wildlife Service** 31 **and National Marine Fisheries Service**

32 As described in Chapter 1, federal agencies also have an obligation pursuant to  
33 the Endangered Species Act (ESA) to "...ensure that any discretionary action  
34 authorized, funded, or carried out by such an agency is not likely to jeopardize the  
35 continued existence of any endangered or threatened species or result in the  
36 destruction or adverse modification..." of such species' designated "critical  
37 habitat," "...unless such agency has been granted an exemption for such  
38 action..." by the Endangered Species Committee which the ESA creates  
39 (16 United States Code (U.S.C.) section 1536 (a)(2). A discretionary agency

1 action jeopardizes the continued existence of a listed species if it “reasonably  
2 would be expected, directly or indirectly, to reduce appreciably the likelihood of  
3 both the survival and recovery of a listed species in the wild by reducing the  
4 reproduction, numbers, or distribution of that species” (50 Code of Federal  
5 Regulations [CFR] section 402.02). Such action results in the destruction or  
6 adverse modification of designated critical habitat if there is “... a direct or  
7 indirect alteration that appreciably diminishes the value of critical habitat for both  
8 the survival and recovery of a listed species” (50 CFR section 402.02).

9 In carrying out its obligations, Reclamation must consult with the appropriate  
10 regulatory agency or agencies (e.g., U.S. Fish and Wildlife Service [USFWS] and  
11 National Marine Fisheries Service [NMFS]). At the conclusion of this  
12 consultation process, those agencies render written statements (known as  
13 biological opinions) setting forth their opinion as to how an action being proposed  
14 by Reclamation would affect a listed species and its designated critical habitat. If  
15 these agencies conclude that an action will jeopardize the continued existence of a  
16 listed species or result in the destruction or adverse modification of their  
17 designated critical habitat, then they must suggest a reasonable and prudent  
18 alternative to the action being proposed by Reclamation.

19 Pursuant to ESA Section 7(a)(1), Reclamation also considers which it could take  
20 under its existing authorities to benefit listed species. However, Section 7(a)(1)  
21 does not give Reclamation additional authority to undertake any particular action,  
22 regardless of its potential benefit for threatened and endangered species.

23 The Fish and Wildlife Coordination Act requires that Reclamation consult with  
24 fish and wildlife agencies (federal and state) on all water development projects  
25 that could affect biological resources. As part of this project, Reclamation has  
26 been in continuous consultation with USFWS and NMFS. This continuous  
27 consultation also satisfies any applicable requirements of the Fish and Wildlife  
28 Coordination Act.

## 29 **23.4 Consultation with Cooperating Agencies and** 30 **Other Entities**

31 In accordance with requirements of the National Environmental Policy Act  
32 (NEPA), Reclamation invited eligible governmental agencies to participate as a  
33 cooperating agency. The federal cooperating agencies include the USFWS,  
34 NMFS, U.S. Environmental Protection Agency (USEPA), U.S. Army Corps of  
35 Engineers (USACE), and Bureau of Indian Affairs (BIA).

36 Reclamation also provided non-federal agencies with the opportunity to  
37 participate in the NEPA process if they qualified under NEPA (as described  
38 above) as a cooperating agency. In August of 2012, Reclamation mailed  
39 invitations to 747 non-federal entities to be cooperating agencies for this EIS,  
40 including:

- 41 • California Department of Water Resources

- 1 • State Water Resources Control Board
- 2 • California Department of Fish and Wildlife
- 3 • Agencies that have contracts with the CVP or SWP for water delivery, water
- 4 service repayment, exchange or settlement, or use of CVP or SWP facilities
- 5 for conveyance
- 6 • State and Federal Contractors Water Agency
- 7 • Cities and counties within the CVP and SWP service areas
- 8 • Federally-recognized tribes within the CVP and SWP service area or areas
- 9 affected by CVP or SWP operations
- 10 Non-federal entities that meet the specified criteria for cooperating agencies are
- 11 required to enter into a Memorandum of Understanding (MOU) with Reclamation
- 12 to memorialize their participation as a cooperating agency.
- 13 Reclamation has signed cooperating agency MOUs with the following entities:
- 14 • Anderson-Cottonwood Irrigation District
- 15 • California Department of Water Resources
- 16 • California Valley Miwok Tribe
- 17 • City of Hesperia
- 18 • Contra Costa Water District
- 19 • Friant Water Authority
- 20 • Glenn-Colusa Irrigation District
- 21 • Metropolitan Water District of Southern California
- 22 • Oakdale Irrigation District
- 23 • Reclamation District 108
- 24 • San Diego County Water Authority
- 25 • San Juan Water District
- 26 • San Luis & Delta-Mendota Water Authority
- 27 • Stockton East Water District
- 28 • Sutter Mutual Water District
- 29 • Tehama Colusa Canal Authority
- 30 • Zone 7 Water Agency
- 31 These agencies have participated in preliminary review of written materials that
- 32 were used to prepare this Draft EIS.
- 33 Reclamation also received a request from an interested party to include the
- 34 Federal Emergency Management Agency (FEMA) as a cooperating agency.
- 35 However, Reclamation concluded that FEMA does not have special expertise
- 36 related to environmental issue that would not be addressed by other cooperating
- 37 federal agencies.
- 38 Reclamation also received a request from the State Water Contractors, a non-
- 39 profit association of 27 public agencies from northern, central, and southern
- 40 California that purchase water under contract from the SWP (SWC 2015).

1 However, Reclamation concluded that the State Water Contractors was not a  
 2 public agency; and therefore, could not be cooperating agency. However, this  
 3 group and several other non-profit groups (including the Natural Resources  
 4 Defense Council and The Bay Institute) have participated in preliminary review  
 5 of written materials that were used to prepare this Draft EIS.

## 6 **23.5 Consultation with Other Federal, State, and** 7 **Local Agencies**

8 This EIS was prepared in accordance with policies and regulations adopted by  
 9 federal and state agencies. Brief discussions of relevant policies and regulations  
 10 for each resource are included in Appendix 4A, Federal and State Policies and  
 11 Regulations. Reclamation considered the requirements of these policies and  
 12 regulations during preparation of the EIS and consultation with the related  
 13 agencies, including the major regulations summarized below.

### 14 **23.5.1 Federal Water Pollution Control Act Amendments of 1972** 15 **(Clean Water Act)**

16 The Federal Water Pollution Control Act Amendments of 1972, also known as the  
 17 Clean Water Act (CWA), established the institutional structure for the  
 18 U.S. Environmental Protection Agency (USEPA) to regulate discharges of  
 19 pollutants into the waters of the United States, establish water quality standards,  
 20 conduct planning studies, and provide funding for specific grant projects. The  
 21 Clean Water Act was further amended through the Clean Water Act of 1977 and  
 22 the Water Quality Act of 1987. The California State Water Resources Control  
 23 Board (SWRCB) has been designated by the USEPA along with the nine  
 24 Regional Water Quality Control Boards (RWQCBs) to develop and enforce water  
 25 quality objectives and implementation plans in California. The provisions of the  
 26 Clean Water Act which affect water resources in the project area are described  
 27 below.

- 28 • Section 401 of the Clean Water Act requires water discharges into navigable  
 29 waters of the United States to apply for a Federal license or permit and to  
 30 certify that the discharge will be in compliance with specified provisions of  
 31 the Clean Water Act. Federal permits that are issued related to disturbance of  
 32 waters of the United States (such as streams and wetlands) also require a  
 33 Water Quality Certification in accordance with Clean Water Act section 401.
- 34 • Section 402 established the National Pollutant Discharge Elimination System  
 35 (NPDES) permit program to regulate point source and non-point source  
 36 discharges of pollutants into waters of the United States. An NPDES permit  
 37 sets specific discharge limits for point and non-point sources discharging  
 38 pollutants into waters of the United States and establishes monitoring and  
 39 reporting requirements. The NPDES permits are issued for long-term  
 40 discharges, including discharges from treatment plants, and temporary

1 discharges, such as discharges during construction activities (e.g., General  
2 Permit for Storm Water Discharges Associated with Construction Activities).

- 3 • Section 404 requires the U.S. Army Corps of Engineers (USACE) to issue  
4 permits for discharge of dredge or fill material into navigable waters, their  
5 tributaries, and associated wetlands. Activities regulated by 404 permits  
6 include, but are not limited to, dredging, bridge construction, flood control  
7 actions, and some fishing operations.
- 8 • Section 303 requires preparation of basins plans. The SWRCB has approved  
9 water quality control plans (basin plans) for each watershed basin in the State.  
10 The basin plans designate the beneficial uses of waters within each watershed  
11 basin, and water quality objectives designed to protect those uses pursuant to  
12 Section 303 of the Clean Water Act. The beneficial uses together with the  
13 water quality objectives that are contained in the basin plans constitute State  
14 water quality standards.
- 15 • Under the CWA section 303(d), the SWRCB and USEPA identifies and ranks  
16 water bodies for which existing pollution controls are insufficient to attain or  
17 maintain water quality standards based upon information prepared by all  
18 states, territories, and authorized Indian tribes. Each state must establish  
19 priority rankings and develop Total Maximum Daily Loads (TMDLs) for all  
20 impaired waters. TMDLs calculate the greatest pollutant load that a  
21 waterbody can receive and still meet water quality standards and designated  
22 beneficial uses.

### 23 **23.5.2 Rivers and Harbors Act**

24 The navigable waters of the United States in the Study Area, including the major  
25 rivers in Sacramento and San Joaquin rivers watersheds and waterways in these  
26 watersheds affected by tidal action, are subject to the requirements of the Rivers  
27 and Harbors Act. “Navigable waters of the United States” are defined as those  
28 waters subject to the ebb and flow of the tide shoreward to the mean high-water  
29 mark or those that are used, have been used in the past, or may be susceptible to  
30 use in interstate or foreign commerce. Sections 9 and 10 of the River and Harbors  
31 Act are applicable to the coordinated long-term operation of the CVP and SWP.

32 Under the reauthorization of the Rivers and Harbor Act of 1937, Reclamation  
33 took responsibility for the operation of the CVP.

#### 34 **23.5.2.1 Section 9 of the Rivers and Harbors Act**

35 Section 9 of the Rivers and Harbors Act prohibits construction of any dike or dam  
36 across any navigable waters without approvals from the Chief of Engineers and  
37 the Secretary of the Army.

#### 38 **23.5.2.2 Section 10 of the Rivers and Harbors Act**

39 Section 10 of the Rivers and Harbors Act of 1899 prohibits alterations of any  
40 navigable waters, including construction of structures in, over, or under;  
41 excavation of material from; and deposition of material into navigable waters of  
42 the United States without permission from the USACE. The approval process

1 generally is completed simultaneously with the approval process under the Clean  
2 Water Act Section 404.

### 3 **23.5.3 Federal Safe Drinking Water Act**

4 The Safe Drinking Water Act (SDWA) protects public health by regulating the  
5 nation's public drinking water supply. The SDWA authorizes USEPA to set  
6 national health-based standards for drinking water to protect against both  
7 naturally occurring and human-made contaminants that may be found in drinking  
8 water and its sources, including rivers, lakes, reservoirs, springs, and  
9 groundwater wells.

### 10 **23.5.4 Wild and Scenic Rivers Act**

11 Congress created the National Wild and Scenic Rivers Act in 1968 (Public  
12 Law 90-542; USC 1271 et seq.) to preserve rivers and outstanding natural,  
13 cultural, or recreational features in a free-flowing condition. High priority is  
14 place on visual resource management of these rivers to preserve or restore their  
15 scenic characteristics. Under this act, a Federal agency may not assist the  
16 construction of a water resources project that would have a direct and adverse  
17 effect on the free-flowing, scenic, and natural values of a wild or scenic river. If  
18 the project would affect the free-flowing characteristics of a designated river or  
19 unreasonably diminish the scenic, recreational, and fish and wildlife values  
20 present in the area, such activities should be undertaken in a manner that would  
21 minimize adverse impacts and should be developed in consultation with the  
22 National Park Service.

23 Within the study area, the following portions of the rivers have been designated as  
24 Wild and Scenic Rivers.

- 25 • The Klamath River from the confluence with the Trinity River to the Pacific  
26 Ocean was designated to be part of the National Wild and Scenic Rivers  
27 System on January 19, 1981.
- 28 • The Middle Fork Feather River (from Beckwourth downstream of Lake Davis  
29 to Lake Oroville) was designated to be part of the National Wild and Scenic  
30 Rivers System on October 2, 1968.
- 31 • The American River between Nimbus Dam and the confluence with the  
32 Sacramento River was designated to be part of the National Wild and Scenic  
33 Rivers System on January 19, 1981.

### 34 **23.5.5 Fish and Wildlife Coordination Act (16 USC Section 651** 35 **et seq.)**

36 The Fish and Wildlife Coordination Act, as amended in 1964, was enacted to  
37 protect fish and wildlife when federal actions result in the control or modification  
38 of a natural stream or body of water. The statute requires federal agencies to take  
39 into consideration the effect that water-related projects would have on fish and  
40 wildlife resources. Consultation and coordination with USFWS and State fish and  
41 game agencies are required to address ways to prevent loss of and damage to fish  
42 and wildlife resources and to further develop and improve these resources.



1     **23.5.6     Marine Mammal Protection Act (16 USC 1361-1421h)**

2     The Marine Mammal Protection Act (MMPA) was enacted in 1972. All marine  
3     mammals are protected under the MMPA. The MMPA prohibits, with certain  
4     exceptions, the “take” of marine mammals in U.S. waters and by U.S. citizens on  
5     the high seas, and the importation of marine mammals and marine mammal  
6     products into the United States. It defines “take” to mean “to hunt harass,  
7     capture, or kill” any marine mammal or attempt to do so. Exceptions to the  
8     moratorium can be made through permitting actions for take incidental to  
9     commercial fishing and other nonfishing activities; for scientific research; and for  
10    public display at licensed institutions such as aquaria and science centers.

11    **23.5.7     Migratory Bird Treaty Act**

12    The Migratory Bird Treaty Act (MBTA) implements a series of international  
13    treaties that provide migratory bird protection. The MBTA authorizes the  
14    Secretary of the Interior to regulate the taking of migratory birds, and the act  
15    provides that it shall be unlawful, except as permitted by regulations, “to pursue,  
16    take, or kill any migratory bird, or any part, nest or egg of any such bird” (16 USC  
17    section 703). This prohibition includes both direct and indirect acts, although  
18    harassment and habitat modification are not included unless they result in direct  
19    loss of birds, nests, or eggs. The current list of species protected by the MBTA  
20    was published in the March 10, 2010 *Federal Register* (*Federal Register*,  
21    Volume 75, page 9282 [75 FR 9282]).

22    **23.5.8     Executive Order 13186: Responsibilities of Federal**  
23    **Agencies to Protect Migratory Birds**

24    Executive Order 13186 (January 10, 2001) directs federal agencies that have, or  
25    are likely to have, a measurable negative effect on migratory bird populations to  
26    develop and implement a Memorandum of Understanding with USFWS to  
27    promote the conservation of migratory bird populations. The Memorandum of  
28    Understanding should include implementation actions and reporting procedures  
29    that would be followed through each agency’s formal planning process, such as  
30    resource management plans and fisheries management plans.

31    **23.5.9     Executive Order 11990: Protection of Wetlands**

32    Executive Order 11990 (May 24, 1977) established the protection of wetlands and  
33    riparian systems as the official policy of the federal government. It requires all  
34    federal agencies to consider wetland protection as an important part of their  
35    policies and take action to minimize the destruction, loss, or degradation of  
36    wetlands and to preserve and enhance the natural and beneficial values  
37    of wetlands.

38    **23.5.10    Federal Clean Air Act**

39    National air quality policies are regulated through the Federal Clean Air Act  
40    (FCAA) of 1970 and its 1977 and 1990 amendments. Basic elements of the  
41    FCAA include national ambient air quality standards for criteria air pollutants,  
42    hazardous air pollutants standards, state attainment plans, motor vehicle emissions

1 standards, stationary source emissions standards and permits, acid rain control  
2 measures, stratospheric ozone protection, and enforcement provisions.

### 3 **23.5.11 National Historic Preservation Act of 1966**

4 Section 106 of the NHPA and its implementing regulations (36 Code of Federal  
5 Regulations (CFR) Part 800) require Federal agencies to consider the effects of  
6 their undertakings on cultural resources that are, or that may be, eligible for listing  
7 in the National Register of Historic Places (NRHP) and to afford the Advisory  
8 Council on Historic Preservation an opportunity to comment. NRHP-eligible  
9 resources are considered to be “significant.” The criteria used to evaluate  
10 eligibility for listing on the NRHP are further discussed in the next subsection.

11 The Section 106 process that is typically associated with NEPA compliance  
12 requires consultation of the federal lead agency with other federal, state, and local  
13 agencies, the Advisory Council on Historic Preservation, the State Historic  
14 Preservation Officer (SHPO), Indian tribes, and interested members of the public,  
15 such as historical societies. Throughout the Section 106 process, the federal lead  
16 agency and consulting parties work together to identify adverse impacts on sites  
17 of cultural significance or historic properties, and seek ways to avoid, minimize,  
18 or mitigate the adverse effects. A Memorandum of Agreement or Programmatic  
19 Agreement is issued by the participating parties that includes the measures agreed  
20 upon to avoid or reduce (i.e., mitigate) adverse effects. For large or complex  
21 undertakings, a Programmatic Agreement may also be negotiated to develop a  
22 phased approach to historic properties management or alternative Section 106  
23 processes through consultations. Thus, impacts to cultural resources that are  
24 identified in a NEPA document are addressed through Section 106.

25 Section 110 of the NHPA sets out the broad responsibilities of Federal agencies  
26 for identifying and protecting historic properties under their jurisdiction, and for  
27 avoiding unnecessary damage to them. It is intended to ensure that an historic  
28 preservation program is fully integrated into the ongoing program of each Federal  
29 agency. Section 110 allows the costs of preservation activities as eligible project  
30 costs in all undertakings conducted or assisted by a Federal agency. Federal  
31 agencies are directed to withhold grants, licenses, approvals, or other assistance to  
32 applicants who intentionally damage or adversely affect historic properties in an  
33 effort to avoid the Section 106 process.

### 34 **23.5.12 American Indian Religious Freedom Act**

35 The American Indian Religious Freedom Act of 1978 protects the rights of Native  
36 Americans to freedom of expression of traditional religions (24 U.S. Code  
37 section 1996). This act established “the policy of the United States to protect and  
38 preserve for American Indians their inherent right of freedom to believe, express,  
39 and exercise the traditional religions...including but not limited to access to sites,  
40 use and possession of sacred objects, and the freedom to worship through  
41 ceremonials and traditional rites.”

1    **23.5.13 Indian Sacred Sites on Federal Land**

2    Executive Order 13007 provides that in managing Federal lands, each Federal  
3    agency with statutory or administrative responsibility for management of Federal  
4    lands shall, to the extent practicable and as permitted by law, accommodate access  
5    to and ceremonial use of Indian sacred sites by Indian religious practitioners, and  
6    avoid adversely affecting the physical integrity of such sacred sites.

7    **23.6 Consultation with Tribal Governments**

8    Consistent with President Clinton’s April 29, 1994 Memorandum and President  
9    Obama’s November 5, 2009 Memorandum, Reclamation contacted federally-  
10    recognized tribal governments to participate in preparation of this EIS.  
11    Reclamation met with the California Valley Miwok Tribe in 2012 and the Miwok  
12    Maidu United Auburn Indian Community of the Auburn Rancheria in 2013.

13    Reclamation will continue to consult with each tribe on a government-to-  
14    government basis before taking any action that could affect a tribal government.  
15    Under the Federal Trust responsibility, Reclamation will provide full disclosure of  
16    the beneficial and adverse impacts of a project to the tribal government in a  
17    manner that provides adequate time for review and response. Reclamation will  
18    review comments received and consult with the tribal government prior to  
19    decisions related to a project.

20    Tribes and Indian Trust Assets were considered during preparation of this EIS, in  
21    accordance with environmental justice considerations identified in Executive  
22    Order 12898 (February 11, 1994), as summarized in Chapter 20, Indian Trust  
23    Assets, and Chapter 21, Environmental Justice.

24    **23.7 References**

25    SWC (State Water Contractors). 2015. “State Water Contractors – About Us.”  
26    Site accessed June 23, 2015. <http://www.swc.org/about-us>

**Chapter 24**

1

2

# **Environmental Impact Statement Distribution List**

3

4

This chapter provides locations where the Draft and Final Environmental Impact Statement (EIS) are available for review and a list of governmental entities, organizations, and interested parties that received copies of this EIS.

5

6

7

## **24.1 Document Availability**

8

The public distribution of this Draft and Final EIS emphasizes the use of electronic media to ensure cost-effective, broad availability to the public and interested parties. The Draft and Final EIS are available on the Internet at Reclamation's website.

9

10

11

12

Printed copies of the Draft and Final EIS are available for review at the following locations.

13

14

U.S. Department of the Interior, Bureau of Reclamation Library

15

2800 Cottage Way

16

Sacramento, CA 95825

17

U.S. Department of the Interior, Bureau of Reclamation, Bay-Delta Office

18

801 I Street, Suite 140

19

Sacramento, CA 95814

20

Electronic copies of the Draft and Final EIS are available on compact disc for viewing at the following libraries.

21

22

Alameda County Library

23

1247 Marin Avenue

24

Albany CA 94706

25

Alameda County Library

26

200 Civic Plaza

27

Dublin CA 94568

28

Alameda County Library

29

6300 Civic Terrace Avenue

30

Newark CA 94560

31

Butte County Library

32

1108 Sherman Avenue

33

Chico CA 95926

34

Colusa County Free Library

35

738 Market Street

36

Colusa CA 95932

Chapter 24: Environmental Impact Statement Distribution List

- 1 Contra Costa County Library
- 2 501 W. 18th Street
- 3 Antioch CA 94509
- 4 Contra Costa County Library
- 5 104 Oak Street
- 6 Brentwood CA 94513
- 7 Contra Costa County Library
- 8 1050 Neroly Road
- 9 Oakley CA 94561
- 10 Contra Costa County Library
- 11 80 Power Avenue
- 12 Pittsburg CA 94565
- 13 Contra Costa County Library
- 14 1750 Oak Park Boulevard
- 15 Pleasant Hill CA 94523
- 16 El Dorado County Library
- 17 345 Fair Lane
- 18 Placerville CA 95667
- 19 Fresno County Library
- 20 2420 Mariposa Street
- 21 Fresno CA 93721
- 22 Glenn County Library
- 23 201 North Lassen Street
- 24 Willows CA 95988
- 25 Kern County Library
- 26 701 Truxton Avenue
- 27 Bakersfield CA 93301
- 28 Kings County - Hanford Branch Library
- 29 401 N Douty Street
- 30 Hanford CA 93230
- 31 Los Angeles County Central Library
- 32 630 West 5<sup>th</sup> Street
- 33 Los Angeles CA 90071
- 34 Madera County Library
- 35 121 North G Street
- 36 Madera CA 95637
- 37 Merced County Library
- 38 2100 O Street
- 39 Merced CA 95340

Chapter 24: Environmental Impact Statement Distribution List

- 1 Napa County Library
- 2 580 Coombs Street
- 3 Napa CA 94559
- 4 Orange County Library
- 5 11200 Stanford Avenue
- 6 Garden Grove CA 92840
- 7 Placer County Library
- 8 350 Nevada Street
- 9 Auburn CA 95603
- 10 Plumas County Library
- 11 445 Jackson Street
- 12 Quincy CA 95970
- 13 Riverside County Library
- 14 5840 Mission Boulevard
- 15 Riverside CA 92509
- 16 Sacramento County Library
- 17 170 Primasing Avenue
- 18 Courtland CA 95615
- 19 Sacramento County Library
- 20 8900 Elk Grove Boulevard
- 21 Elk Grove CA 95624
- 22 Sacramento County Library
- 23 412 Union Street
- 24 Isleton CA 95641
- 25 Sacramento Central Library
- 26 828 I Street
- 27 Sacramento CA 95814
- 28 Santa Barbara County Library
- 29 40 E Anapamu Street
- 30 Santa Barbara CA 93101
- 31 San Benito County Library
- 32 470 5th Street
- 33 Hollister CA 95023
- 34 San Bernardino County Library - Norman Feldheym Central Library
- 35 555 W 6th Street
- 36 San Bernardino CA 92410
- 37 San Diego County Public Library
- 38 330 Park Boulevard
- 39 San Diego CA 92101

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- 1 San Joaquin County - Escalon Branch Library
- 2 1540 2nd Street
- 3 Escalon CA 95320
- 4 San Joaquin County - Lathrop Branch Library
- 5 450 Spartan Way
- 6 Lathrop CA 95330
- 7 San Joaquin County - Manteca Public Library
- 8 320 W Center Street
- 9 Manteca CA 95336
- 10 San Joaquin County - Margaret K Troke Branch Library
- 11 502 W Benjamin Holt Drive
- 12 Stockton CA 95207
- 13 San Joaquin County - Cesar Chavez Central Library
- 14 605 N El Dorado Street
- 15 Stockton CA 95202
- 16 San Joaquin County - Tracy Branch Library
- 17 20 E Eaton Avenue
- 18 Tracy CA 95376
- 19 San Luis Obispo County Library
- 20 995 Palm Street
- 21 San Luis Obispo CA 93403
- 22 Santa Clara County - Cupertino Library
- 23 10800 Torre Avenue
- 24 Cupertino CA 95014
- 25 Santa Clara County - Milpitas Library
- 26 160 N Main Street
- 27 Milpitas CA 95035
- 28 Shasta County - Redding Public Library
- 29 1100 Parkview Avenue
- 30 Redding CA 96001
- 31 Solano County - Fairfield Civic Center Library
- 32 1150 Kentucky Street
- 33 Fairfield CA 94533
- 34 Solano County Fairfield Cordelia Library
- 35 5050 Business Center Drive
- 36 Fairfield CA 94534
- 37 Solano County - John F Kennedy Library
- 38 505 Santa Clara Street
- 39 Vallejo CA 94590

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- 1 Solano County - Springstowne Library
- 2 1003 Oakwood Avenue
- 3 Vallejo CA 94591
- 4 Solano County - Vacaville Public Library
- 5 1 Town Square Place
- 6 Vacaville CA 95688
- 7 Solano County - Vacaville Public Library
- 8 1020 Ulatis Drive
- 9 Vacaville CA 95687
- 10 Solano County - Rio Vista Library
- 11 44 S 2nd Street
- 12 Rio Vista CA 94571
- 13 Solano County - Suisun City Library
- 14 601 Pintail Drive
- 15 Suisun City CA 94585
- 16 Stanislaus County Library
- 17 1500 I Street
- 18 Modesto CA 95354
- 19 Sutter County Library
- 20 750 Forbes Avenue
- 21 Yuba City CA 95991
- 22 Tehama County Library
- 23 645 Madison Street
- 24 Red Bluff CA 96080
- 25 Trinity County Library
- 26 351 N Main Street
- 27 Weaverville CA 96093
- 28 Tulare County Library
- 29 200 W Oak Avenue
- 30 Visalia CA 93291
- 31 Ventura County - Ojai Library
- 32 111 E Ojai Avenue
- 33 Ojai CA 93023
- 34 Ventura County - E P Foster Library
- 35 651 E Main Street
- 36 Ventura CA 93001
- 37 Ventura County - Oak Park Library
- 38 899 Kanan Road
- 39 Oak Park CA 91377



- 1 Yolo County - Clarksburg Branch Library  
2 52915 Netherlands Road  
3 Clarksburg CA 95612  
4 Yolo County - Mary L Stephens Davis Branch Library  
5 315 E 14th Street  
6 Davis CA 95616  
7 Yolo County - Winters Branch Library  
8 708 Railroad Avenue  
9 Winters CA 95694  
10 Yolo County Library  
11 250 1st Street  
12 Woodland CA 95695  
13 Yolo County Branch Library  
14 37750 Sacramento Street  
15 Yolo CA 95697

16 **24.2 Agencies and Organizations Receiving Copies**  
17 **of the Draft Environmental Impact Statement**

18 All persons, agencies, and organizations listed in this chapter have been informed  
19 of the availability of and locations to obtain the Draft and Final EIS. Parties listed  
20 below have received an electronic copy on a compact disc of the Draft and Final  
21 EIS.

22 **24.2.1 Federal Agencies**

- 23 • Bureau of Indian Affairs  
24 • National Marine Fisheries Service  
25 • U.S. Army Corps of Engineers  
26 • U.S. Environmental Protection Agency  
27 • U.S. Fish and Wildlife Service  
28 • Western Area Power Administration

29 **24.2.2 Tribal Interests**

- 30 • California Valley Miwok Tribe  
31 • United Auburn Indian Community

32 **24.2.3 State Agencies**

- 33 • California Department of Fish & Wildlife  
34 • California Department of Water Resources  
35 • Delta Stewardship Council

36 **24.2.4 Regional and Local Entities**

- 37 • Alameda County Zone 7

- 1 • Anderson-Cottonwood Irrigation District
- 2 • Central Delta Water Agency
- 3 • Contra Costa Water District
- 4 • East Bay Municipal Utility District
- 5 • El Dorado County Water Agency
- 6 • El Dorado Irrigation District
- 7 • El Dorado Water and Power Authority
- 8 • Folsom, City of
- 9 • Friant Water Authority
- 10 • Glenn-Colusa Irrigation District
- 11 • Hesperia, City of
- 12 • Lower Tule River Irrigation District
- 13 • Oakdale Irrigation District
- 14 • Placer County Water Agency
- 15 • Reclamation District 108
- 16 • Roseville, City of
- 17 • Sacramento, City of
- 18 • San Diego County Water Authority
- 19 • San Juan Water District
- 20 • San Luis & Delta Mendota Water Authority
- 21 • Santa Clara Valley Water District
- 22 • South Delta Water Agency
- 23 • South San Joaquin Irrigation District
- 24 • Stanislaus, County of
- 25 • Stockton East Water District
- 26 • Sutter Mutual Water Company
- 27 • Tehama-Colusa Canal Authority
- 28 • Westlands Water District
  
- 29 **24.2.5 Other Interested Parties**
- 30 • AquAlliance
- 31 • The Bay Institute
- 32 • California Farm Bureau Federation
- 33 • Coalition for a Sustainable Delta
- 34 • California Water Impact Network
- 35 • California Sportfishing Protection Alliance
- 36 • The Center for Environmental Science Accuracy and Reliability
- 37 • Environmental Water Caucus
- 38 • Friends of the River
- 39 • Golden Gate Salmon Association
- 40 • Kern County Water Agency
- 41 • Northern California Water Agency
- 42 • Natural Resources Defense Council
- 43 • North Coast Rivers Alliance

## Chapter 24: Environmental Impact Statement Distribution List

- 1 • Pacific Coast Federation of Fisherman's Associations
- 2 • Restore the Delta
- 3 • South Valley Water Association
- 4 • State and Federal Contractors Water Authority
- 5 • State Water Contractors
- 6 • Water 4 Fish
- 7

**Chapter 25****1 List of Preparers**

2 The following individuals contributed to the preparation of this Environmental  
3 Impact Statement.

**4 Bureau of Reclamation**

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Ben Nelson	Natural Resources Specialist	5
Bonnie Van Pelt	Natural Resources Specialist	9
Carolyn Bragg	Natural Resources Specialist	8
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David van Rijn	Chief, Science Division	22
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Chapter 25: List of Preparers

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2 **RMann Economics**

<b>Name</b>	<b>Project Role</b>	<b>Education</b>
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3 **Stillwater Associates**

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1 **Chapter 26**

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